AC- 23/07/2020
Item No. - 123

UNIVERSITY OF MUMBAI

Program: Bachelor of Engineering in Electronics & Computer Science

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20
Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC - 23/07/2020
Item No. - 123

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year BE in Electronics & Computer Science**
2	Eligibility for Admission	**First Year Engineering passed in line with the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 Semesters**
6	Level	~~Certificate/Diploma~~/UG/~~PG~~ **(Strike out which is not applicable)**
7	Pattern	**Semester/~~Yearly~~** **(Strike out which is not applicable)**
8	Status	~~Revised~~/**New** **(Strike out which is not applicable)**
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date: 23rd July 2020

Signature:

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, the Faculty of Science and Technology (in particular Engineering), of University of Mumbai, has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes, understand the depth and approach of the course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process. However, content of courses is to be taught in 12-13 weeks and the remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.
There was a concern that the earlier revised curriculum was more focused on providing information and knowledge across various domains of the said program, which led to heavily loading students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of the entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum, skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of the curriculum proposed in the present revision is in line with the AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

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Incorporation and implementation of online Contents from NPTEL/ SWAYAM Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time, in particular Revised syllabus of 'C 'scheme, wherever possible, additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In earlier revisions of the curriculum in the years 2012 and 2016, in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum, overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HOD's/ Faculties of all the institutes are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses and on successful completion, they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface

Technical education in the country is undergoing a paradigm shift in current days. Think tank at national level are deliberating on the issues, which are of utmost importance and posed challenge to all the spheres of technical education. Eventually, impact of these developments was visible and as well adopted on bigger scale by almost all universities across the country. These are primarily an adoption of CBCS (Choice base Credit System) and OBE (Outcome based Education) with student centric and learning centric approach. Education sector in the country, as well, facing critical challenges, such as, the quality of graduates, employability, basic skills, ability to take challenges, work ability in the fields, adoption to the situation, leadership qualities, communication skills and ethical behaviour. On other hand, the aspirants for admission to engineering programs are on decline over the years. An overall admission status across the country is almost 50%; posing threat with more than half the vacancies in various colleges and make their survival difficult. In light of these, an All India Council for Technical Education (AICTE), the national regulator, took initiatives and enforced certain policies for betterment, in timely manner. Few of them are highlighted here, these are design of model curriculum for all prevailing streams, mandatory induction program for new entrants, introduction of skill based and inter/cross discipline courses, mandatory industry internships, creation of digital contents, mandate for use of ICT in teaching learning, virtual laboratory and so on.

To keep the pace with these developments in Technical education, it is mandatory for the Institutes & Universities to adopt these initiatives in phased manner, either partially or in toto. Hence, the ongoing curriculum revision process has a crucial role to play. The BoS of Electronics Engineering under the faculty of Science & Technology, under the gamut of Mumbai University has initiated a step towards adoption of these initiatives. We, the members of Electronics Engineering Board of Studies of Mumbai University feel privileged to present the revised version of curriculum for Electronics & Computer Science program to be implemented from academic year 2020-21. Consent was also extended by BoS Computer Science for this curriculkum. Some of the highlights of the revision are;

i. Curriculum has been framed with reduced credits and weekly contact hours, thereby providing free slots to the students to brain storm, debate, explore and apply the engineering principles. The leisure provided through this revision shall favour to inculcate innovation and research attitude amongst the students.
ii. New skill based courses have been incorporated in curriculum keeping in view AICTE model curriculum.
iii. Skill based Lab courses have been introduced, which shall change the thought process and enhance the programming skills and logical thinking of the students
iv. Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the group dynamics, develop leadership qualities, facilitate decision making and enhance problem solving ability with focus towards socio-economic development of the country. In addition, it shall be direct application of theoretical knowledge in practice, thereby, nurture learners to become industry ready and enlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystem with better means.
v. An usage of ICT through NPTEL/SWAYAM and other Digital initiatives of Govt. of India shall be encouraged, facilitating the students for self learning and achieve the Graduate Attribute (GA) specified by National Board of accreditation (NBA) i.e. lifelong learning.

Thus, this revision of curriculum aimed at creating deep impact on the teaching learning methodology to be adopted by affiliating Institutes, thereby nurturing the students fraternity in a multifaceted directions and create competent technical manpower with legitimate skills. In time to come, these graduates shall shoulder the responsibilities of proliferation of future technologies and support in a big way for 'Make in India' initiative a reality. In the process, BoS, Electronics Engineering got whole hearted support from all stakeholders including faculty, Heads of department of affiliating institutes, experts faculty who detailed out the course contents, alumni, industry experts and university official providing all procedural support time to time. We put on record their involvement and sincerely thank one and all for contribution and support extended for this noble cause.

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Boards of Studies in Electronics Engineering

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. R. N. Awale	Chairman	5	Dr. Rajani Mangala	Member
2	Dr. Jyothi Digge	Member	6	Dr. Vikas Gupta	Member
3	Dr. V. A. Vyawahare	Member	7	Dr. D. J. Pete	Member
4	Dr. Srija Unnikrishnan	Member	8	Dr. Vivek Agarwal	Member

Program Structure for Second Year Electronics and Computer Science

UNIVERSITY OF MUMBAI

(With Effect from 2020-2021)

Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 301	Engineering Mathematics - III	3	-	1	3	-	1	4
ECC 302	Electronic Devices	3	-	-	3	-	-	3
ECC 303	Digital Electronics	3	-	-	3	-	-	3
ECC 304	Data Structures and Algorithms	3	-	-	3	-	-	3
ECC 305	Database Management Systems	3	-	-	3	-	-	3
ECL301	Electronic Devices Lab	-	2	-	-	1	-	1
ECL302	Digital Electronics Lab	-	2	-	-	1	-	1
ECL303	Data Structures and Algorithms Lab	-	2	-	-	1	-	1
ECL304	Database Management Systems lab	-	2	-	-	1	-	1
ECL305	Skill-base Lab - OOPM: *(C++ and Java)*	-	4	-	-	2	-	2
ECM301	Mini-project -1 A	-	4$	-	-	2	-	2
	Total	15	16	1	15	08	1	24

$ indicates workload of learner(Not faculty), for mini-project

Programme Structure for Bachelor of Engineering (B.E.) – Electronics and Computer Science (Rev. 2019) 'C' Scheme

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Practical /Oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (inHrs)			
		Test 1	Test 2	Avg.					
ECC 301	Engineering Mathematics III	20	20	20	80	03	25	-	125
ECC 302	Electronic Devices	20	20	20	80	03	-	-	100
ECC 303	Digital Electronics	20	20	20	80	03	-	-	100
ECC 304	Data Structures and Algorithms	20	20	20	80	03	-	-	100
ECC 305	Database Management Systems	20	20	20	80	03	-	-	100
ECL 301	Electronic Devices Lab	-	-	-	-	-	25	25	50
ECL 302	Digital Electronics Lab	-	-	-	-	-	25	25	50
ECL 303	Data Structures and Algorithms Lab	-	-	--	-	-	25	25	50
ECL 304	Database Management systems lab	-	-	-	-	-	25	25	50
ECL 305	Skill base Lab - OOPM: *(C++ and Java)*	-	-	-	-	-	50	-	50
ECM 301	Mini Project - 1A						25	25	25
	Total	-	-	100	400	-	200	125	825

Note:

1. Students group and load of faculty per week.

   Mini Project 1 and 2:
   Students can form groups with minimum 3 (Three) and not more than 4 (Four).

   Faculty Load:1 hour per week per four groups

   Major Project 1 and 2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)

   Faculty Load: In Semester VII– ½ hour per week per project group

   In Semester VIII – 1 hour per week per project group

2. Out of 4 hours/week allotted for the mini-projects 1-A and 1-B, an expert lecture of at least one hour per week from industry/institute or a field visit to nearby domain specific industry should be arranged.

3. Mini-projects 2-A and 2-B should be based on DLOs.

Programme Structure for Bachelor of Engineering (B.E.) – Electronics and Computer Science (Rev. 2019) 'C' Scheme

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tutorial	Theory	TW/Pract.	Tutorial	Total
ECC301	Engineering Mathematics - III	03	-	01	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Term Work	Pract.	Oral	Total
		Internal Assessment			End Sem Exam				
		Test 1	Test 2	Avg of Test 1 & 2					
ECC301	Engineering Mathematics-III	20	20	20	80	25	-	-	125

Pre-requisite:

Engineering Mathematics-I, Engineering Mathematics-II, Scalar and Vector Product: Scalar and vector product of three and four vectors

Course Objectives: The course is aimed

1. To familiarize with the Laplace Transform, Inverse Laplace Transform of various functions, and its applications.
2. To acquaint with the concept of Fourier Series, its complex form and enhance the problem solving skills
3. To familiarize the concept of complex variables, C-R equations, harmonic functions, its conjugate and mapping in complex plane.
4. To understand the basics of Linear Algebra and its applications
5. To use concepts of vector calculus to analyze and model engineering problems.

Course Outcomes: On successful completion of course learner will be able to;

1. Apply the concept of Laplace transform to solve the real integrals in engineering problems.
2. Apply the concept of inverse Laplace transform of various functions in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Find orthogonal trajectories and analytic function by using basic concepts of complex variables.
5. Illustrate the use of matrix algebra to solve the engineering problems.
6. Apply the concepts of vectorcalculus in real life problems.

Module No	Contents	Hrs.
01	**Laplace Transform** 1.1 Definition of Laplace transform, Condition of Existence of Laplace transform. 1.2 Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. 1.3 Properties of Laplace Transform: Linearity, First Shifting theorem, Second Shifting Theorem, change of scale Property, multiplication by *t*, Division by *t*, Laplace Transform of derivatives and integrals (Properties without proof). 1.4 Evaluation of integrals by using Laplace Transformation. **Self-learning Topics:** Heaviside's Unit Step function, Laplace Transform of Periodic functions, Dirac Delta Function.	7
02	**Inverse Laplace Transform** 2.1. Inverse Laplace Transform, Linearity property, use of standard formulae to find inverse Laplace Transform, finding Inverse Laplace transform using derivatives. 2.2 Partial fractions method to find inverse Laplace transform. 2.3 Inverse Laplace transform using Convolution theorem (without proof). **Self-learning Topics:** Applications to solve initial and boundary value problems involving ordinary differential equations.	6
03	**Fourier Series** 3.1 Dirichlet's conditions, Definition of Fourier series and Parseval's Identity (without proof). 3.2 Fourier series of periodic function with period 2π and $2l$. 3.3 Fourier series of even and odd functions. 3.4 Half range Sine and Cosine Series. **Self-learning Topics:** Complex form of Fourier Series, Orthogonal and orthonormal set of functions.Fourier Transform.	7
04	**Complex Variables** 4.1 Function *f*(z)of complex variable, limit, continuity and differentiability of *f*(z)Analytic function, necessary and sufficient conditions for *f*(z) to be analytic (without proof). 4.2 Cauchy-Riemann equations in cartesian coordinates (without proof). 4.3 Milne-Thomson method to determine analytic function *f*(z)when real part (u) or Imaginary part (v) or its combination (u+v or u-v) is given. 4.4 Harmonic function, Harmonic conjugate and orthogonal trajectories **Self-learning Topics:** Conformal mapping, linear, bilinear mapping, cross ratio,fixed points and standard transformations.	7

05	**Linear Algebra: Matrix Theory** 5.1 Characteristic equation, Eigen values and Eigen vectors, Example based on properties of Eigen values and Eigen vectors.(Without Proof). 5.2 Cayley-Hamilton theorem (Without proof), Examples based onverification of Cayley-Hamilton theorem and compute inverse of Matrix. 5.3 Similarity of matrices, Diagonalization of matrices. Functions of square matrix **Self-learning Topics:** Application of Matrix Theory in machine learning and google page rank algorithms, derogatory and non-derogatory matrices**.**	6
06	**Vector Differentiation and Integra**l 6.1 **Vector differentiation**:Basics of Gradient, Divergence and Curl (Without Proof). 6.2 **Properties of vector field:** Solenoidal and irrotational(conservative) vector fields. 6.3 **Vector integral:**Line Integral,Green's theorem in a plane(Without Proof), Stokes' theorem (Without Proof) only evaluation. **Self-learning Topics:**Gauss' divergence Theorem and applications of Vector calculus.	6
	Total	**39**

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and secondclass test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

References:

1. Advanced Engineering Mathematics,H.K. Das, S. Chand, Publications
2. Higher Engineering Mathematics, B. V. Ramana, Tata Mc-Graw Hill Publication
3. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
4. Advanced Engineering Mathematics,Wylie and Barret, Tata Mc-Graw Hill.
5. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series
6. Vector Analysis Murry R. Spiegel, Schaum's outline series, Mc-Graw Hill Publication
7. Beginning Linear Algebra, Seymour Lipschutz, Schaum's outline series, Mc-Graw HillPublication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 302	Electronic Devices	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg. of Test 1 and Test 2						
ECC 302	Electronic Devices	20	20	20	80	03	--	--	--	100

Course Objectives:

1. To deliver the knowledge of basic semiconductor devices.
2. To enhance comprehension capabilities of students through understanding of electronic devices.
3. To introduce and motivate students to the use of advanced nanoelectronic devices
4. To analyse amplifiers using BJT and FET based devices.

Course Outcomes:

After successful completion of the course students will be able to:

1. Explain the working of semiconductor devices.
2. Interpret the characteristics of semiconductor devices.
3. Analyse Electronics circuits using BJT and FET (DC & AC analysis)
4. Compare various biasing circuits &configurations of BJT and MOSFETs.
5. Select best circuit for the given specifications/application.
6. Describe the working of advanced nanoelectronic devices

Module No.	Unit No.	Contents	Hrs.
1		**P-N Junction Diode & Applications**	07
	1.1	Theoretical description of basic structure & construction, symbol, operation under zero bias, forward bias & reverse bias, avalanche breakdown, V-I characteristics & temperature effects (no mathematical analysis or numerical examples)	
	1.2	Application of P-N junction diode as clippers & clampers (different types of configurations with input-output waveforms & transfer characteristics; theoretical description & analysis of each circuit; numerical examples)	
2		**Special Semiconductor Devices**	04
	2.1	Zener diode as the voltage regulator (theoretical description only which includes construction of circuit diagram, operation / working for varying DC input voltage & varying load resistance, concept of line regulation & load regulation – no numerical examples)	
	2.2	Construction, structure, symbol, operating principle, working & V-I characteristics of special semiconductor devices such as Varactor diode, Schottkey diode, Photo diode, Light emitting diode (LED) & Solar cells	
3		**Bipolar Junction Transistor (BJT)**	09
	3.1	BJT construction & structure, symbol, operation, voltages & currents, V-I characteristics of common emitter (CE), common base (CB) & common collector (CC) configuration, Early effect & concept of leakage current	
	3.2	DC Circuit Analysis: DC load line, Q-point & region of operation, common BJT configurations, biasing circuits, bias stability and concept of thermal runaway, analysis of biasing circuits (numerical examples to be included)	
	3.3	AC Analysis of BJT Amplifiers: AC load line, small signal models: h-parameter model, r_e model, hybrid-pi (r_π) model. AC equivalent circuits and analysis to obtain voltage gain, current gain, input impedance, output impedance of CE amplifier using hybrid-pi (r_π) model only	
4		**Field Effect Devices (FET)**	09
	4.1	JFET: Construction, symbol, operation, V-I & transfer characteristics MOSFET: Construction, operation, symbol, V-I & transfer characteristics of the D-MOSFET & E-MOSFET (theoretical description only for JFET & MOSFET)	
	4.2	DC Circuit Analysis: DC load line, Q-point & region of operation, common MOSFET configurations of common source (CS), common drain (CD) & common gate (CG), analysis of biasing circuits (numerical examples only for E-MOSFET & D-MOSFET; no JFET)	
	4.3	AC Analysis: AC load line, small signal (AC) model of the MOSFET & its	

		equivalent circuit, small signal (AC) analysis of common source (CS) configuration MOSFET amplifier only (numerical examples included)	
5		**Rectifiers &Filters**	05
	5.1	Rectifiers: Working & mathematical analysis of full – wave centre tapped rectifier & bridge type rectifier (mathematical analysis include expressions for the DC / average & RMS output voltage, DC / average & RMS output current & ripple factor; numerical examples included)	
	5.2	Filters: Capacitor (C), Inductor (L), Inductor – Capacitor (LC), C-L-C (π) with circuit diagram, waveforms, working / operation & expression for ripple factor (theoretical description only – no analysis or numerical examples to be included)	
6		**Emerging Electronic Devices**	05
	6.1	Single Electron Transistor (SET) & Quantum Dots (theoretical description only – construction, structure & nature of operation, characteristics & applications)	
	6.2	Memristor & Spintronic devices (theoretical description only – construction, structure & nature of operation, characteristics & applications)	
		Total	**39**

Text Books:

1. Donald A. Neamen, “Electronic Circuit Analysis and Design”, TATA McGraw Hill, 2nd Edition
2. Adel S. Sedra, Kenneth C. Smith and Arun N Chandorkar, “Microelectronic Circuits Theory and Applications”, International Version, OXFORD International Students Edition, Fifth Edition.
3. James Morris & Krzysztof Iniewski, Nano-electronic Device Applications Handbook by CRC Press

Reference Books:

1. Boylestead," Electronic Devices and Circuit Theory", Pearson Education
2. David A. Bell, “Electronic Devices and Circuits”, Oxford, Fifth Edition.
3. Muhammad H. Rashid, “Microelectronics Circuits Analysis and Design”, Cengage
4. S. Salivahanan, N. Suresh Kumar,“Electronic Devices and Circuits”, Tata McGraw Hill.
5. Millman and Halkies, “Integrated Electronics”, Tata McGraw Hill.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks.

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and oral	Tutorial	Theory	Practical and oral	Tutorial	Total
ECC303	Digital Electronics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC303	Digital Electronics	20	20	20	80	03	--	--	100

Course Pre-requisites:
Basic Electrical & Electronics Engineering

Course Objectives:
1. To understandvarious number systems&codes and to introduce students to various logic gates, SOP, POS form and their minimization techniques.
2. To teach the working of combinational circuits, their applications and implementation of combinational logic circuits using MSI chips.
3. To teach the elements of sequential logic design, analysis and design of sequential circuits.
4. To understand various counters and shift registers and its design using MSI chips.
5. To explain and describe various logic families and Programmable Logic Devices.
6. To train students in writing programs with Verilog hardware description languages.

Course Outcomes:
After successful completion of the course students will be able to
1. Perform code conversion and able to apply Boolean algebra for the implementation andminimisation of logic functions.
2. Analyse, design and implement Combinational logic circuits.
3. Analyse, design and implement Sequential logic circuits.
4. Design and implement various counter using flip flops and MSI chips.
5. Understand TTL & CMOS logic families, PLDs, CPLD and FPGA.
6. Understand basics of Verilog Hardware Description Language and its programming withcombinational and sequential logic circuits.

Module No.	Unit No	Contents	Hrs.
1		**Fundamentals of Digital Design**	07
	1.1	**Number Systems and Codes:** Review of Number System, Binary Code, Binary Coded Decimal, Octal Code, Hexadecimal Code and their conversions, Binary Arithmetic: One's and two's complements,	
	1.2	**Codes:**Excess-3 Code, Gray Code, Weighted code, Parity Code: Hamming Code	
	1.3	**Logic Gates and Boolean Algebra:** Digital logic gates, Realization using NAND, NOR gates, Boolean Algebra, De Morgan's Theorem, SOP and POS representation, K Map up to four variables	
2		**Combinational Circuits using basic gates as well as MSI devices**	07
	2.1	**Arithmetic Circuits:** Half adder, Full adder, Ripple carry adder, Carry Look ahead adder, Half Subtractor, Full Subtractor, multiplexer, cascading of Multiplexer, demultiplexer, decoder, Comparator (Multiplexer and demultiplexer gate level upto 4:1).	
	2.2	**MSI devices:** IC7483, IC74151, IC74138, IC7485.	
3		**Elements of Sequential Logic Design**	07
	3.1	**Sequential Logic:** Latches and Flip-Flops. RS, JK, Master slave flip flops, T & D flip flops with various triggering methods, Conversion of flip flops,	
	3.2	**Counters:** Asynchronous, Synchronous Counters, Up Down Counters, Mod Counters, Ring Counter, Twisted ring counter, Shift Registers, Universal Shift Register.	
4		**Sequential Logic Design:**	07
	4.1	**Sequential Logic Design:** Mealy and Moore Machines, Clocked synchronous state machine analysis, State reduction techniques (inspection, partition and implication chart method) and state assignment, sequence detector, Clocked synchronous state machine design.	
	4.2	**Sequential logic design practices:** MSI counters (7490, 7492, 7493,74163, 74169) and applications, MSI Shift registers (74194) and their applications.	
5		**Logic Families and Programmable Logic Devices**	05
	5.1	**Logic Families:** Types of logic families (TTL and CMOS), characteristic parameters (propagation delays, power dissipation, Noise Margin, Fan-out and Fan-in), transfer characteristics of TTL NAND(Operation of TTL NAND gate),CMOS Logic:CMOS inverter, CMOS NAND and CMOS NOR, Interfacing CMOS to TTL and TTL to CMOS.	
	5.2	**Programmable Logic Devices**: Concepts of PAL and PLA. Simple logic implementation using PAL and PLA, Introduction to CPLD and FPGA architectures, Numericals based on PLA and PAL	
6		**Introduction to Verilog HDL**	06
	6.1	**Basics**: Introduction to Hardware Description Language and its core features, synthesis in digital design, logic value system, data types, constants, parameters, wires and registers. **Verilog Constructs:** Continuous & procedural assignment statements, logical, arithmetic, relational, shift operator, always, if, case, loop statements, Gate level modelling, Module instantiation statements.	
	6.2	**Modelling Examples:** Combinational logic eg.Arithmetic circuits, Multiplexer, Demultiplexer, decoder, Sequential logic eg. flip flop, counters.	
		Total	**39**

Text Books:

1. R. P. Jain, Modern Digital Electronics, Tata McGraw Hill Education, Third Edition 2003.
2. Morris Mano, Digital Design, Pearson Education, Asia 2002.
3. J. Bhaskar, A Verilog HDL Primer, Third Edition, Star Galaxy Publishing, 2018.

Reference Books:

1. Digital Logic Applications and Design – John M. Yarbrough, Thomson Publications, 2006
2. John F. Warkerly, Digital Design Principles and Practices, Pearson Education, Fourth Edition, 2008.
3. Stephen Brown and ZvonkoVranesic, Fundamentals of digital logic design with Verilog design, McGraw Hill, 3rd Edition.
4. Digital Circuits and Logic Design – Samuel C. Lee, PHI
5. William I.Fletcher, "An Engineering Approach to Digital Design", PrenticeHall of India.
6. Parag K Lala, "Digital System design using PLD", BS Publications, 2003.
7. Charles H. Roth Jr., "Fundamentals of Logic design", Thomson Learning, 2004.

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and the secondclass test (Internal Assessment II) when additional 40% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on the entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to the number of respective lecture hours as mentioned in thesyllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 304	Data Structures and Algorithms	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC 304	Data Structures and Algorithms	20	20	20	80	03	--	--	100

Course Prerequisite:

C Programming

Course Objectives:

1. To understand and demonstrate basic data structures (such as Arrays, linked list, stack, queue, binary tree, graph).
2. Toimplement various operations on data structures.
3. To study different sorting and searching techniques.
4. Tochoose efficient data structures and apply them to solve real world problems.

Course Outcomes:

After successful completion of the course students will be able to;

1. Implement various linear data structures.
2. Implement various nonlinear data structures.
3. Select appropriate sorting and searching techniques for a given problem and use it.
4. Develop solutions for real world problems by selecting appropriate data structure and algorithms.
5. Analyse the complexity of the given algorithms.

Module No.	Contents	Hrs.
1	**Introduction to Data Structures** Introduction to Data Structures, Types of Data Structures – Linear and Nonlinear, Operations on Data Structures, Concept of array,Static arrays vs Dynamic Arrays, structures. Introduction to Analysis of Algorithms, characteristics of algorithms, Time and Space complexities, Asymptotic notations.	04
2	**Stack and Queues** Introduction,Basic Stack Operations, Representation of a Stack using Array, Applications of Stack – Well form-ness of Parenthesis, Infix to Postfix Conversion and Postfix Evaluation. Queue, Operations on Queue, queue-Round Robin Algorithm.	08
3	**Linked List** Introduction, Representation of Linked List, Linked List v/s Array, Types of Linked List - Singly Linked List (SLL), Operations on Singly Linked List: Insertion, Deletion,reversal of SLL, Print SLL. Implementation of Stack and Queue using Singly Linked List. Introduction to Do Representation of a Queue using array, Circular Queue, concept of priority Queue, Applications of Qubly Linked List and Circular Linked List	08
4	**Trees** Introduction, Tree Terminologies, Binary Tree, Types of Binary Tree, Representation of Binary Trees, Binary Tree Traversals, Binary Search Tree Operations on Binary Search Tree, Applications of Binary Tree – Expression Tree, Huffman Encoding.	08
5	**Graphs** Introduction, Graph Terminologies, Representation of graph (Adjacency matrix and adjacency list), Graph Traversals – Depth First Search (DFS) and Breadth First Search (BFS), Application – Topological Sorting.	04
6	**Introduction to Sorting and Searching** Introduction to Searching: Linear search, Binary search, Sorting: Internal VS. External Sorting, Sorting Techniques: Bubble, Insertion, selection, Quick Sort, Merge Sort, Comparison of sorting Techniques based on their complexity. Hashing Techniques, Different Hash functions, Collision & Collision resolution techniques:Linear and Quadratic probing, Double hashing.	07
	Total	**39**

Text Books:

1. Data Structures Using C, Aaron M Tenenbaum, YedidyahLangsam, Moshe J Augenstein, Pearson Education
2. Introduction to Data Structure and its Applications Jean-Paul Tremblay, P. G.Sorenson
3. Data Structures using C, Reema Thareja, Oxford
4. C and Data structures, Prof. P.S.Deshpande, Prof. O.G.Kakde, Dreamtech Press.
5. Data Structures: A Pseudocode Approach with C, Richard F. Gilberg& Behrouz A. Forouzan, Second Edition, CENGAGE Learning

Reference Books:

1. Data Structure Using C, Balagurusamy.
2. Data Structures using C and C++, Rajesh K Shukla, Wiley - India
3. ALGORITHMS Design and Analysis, Bhasin, OXFORD.
4. Data Structures Using C, ISRD Group, Second Edition, Tata McGraw-Hill.
5. Computer Algorithms by Ellis Horowitz and Sartaj Sahni, Universities Press.
6. Data Structures, Adapted by: GAV PAI, Schaum's Outlines.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as the final IA marks.

End Semester Examination:

1. Question paper will consist of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 305	Database Management Systems	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC 305	Database Management Systems	20	20	20	80	03	--	--	100

Course Objectives:

1. Develop entity relationship data model and its mapping to relational model
2. Learn relational algebra and formulate SQL queries
3. Apply normalization techniques to normalize the database
4. Understand concepts of transaction, concurrency control and recovery techniques

Course Outcomes:

After successful completion of the course students will be able to:

1. Recognize the need of database management system
2. Design ER and EER diagram for real life applications
3. Construct relational model and write relational algebra queries.
4. Formulate SQL queries
5. Apply the concept of normalization to relational database design.
6. Describe the concepts of transaction, concurrency and recovery.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Database Concepts**	03
	1..1	Introduction, Characteristics of databases	
	1.2	File systems v/s Database systems	
	1.3	Data abstraction and Data Independence	
	1.4	DBMS system architecture	
	1.5	Database Administrator	
2		**Entity–Relationship Data Model**	07
	2.1	The Entity-Relationship (ER) Model	
	2.2	Entity types: Weak and strong entity sets, Entity sets, Types of Attributes, Keys	
	2.3	Relationship constraints: Cardinality and Participation	
	2.4	Extended Entity-Relationship (EER) Model: Generalization, Specialization and Aggregation	
3		**Relational Model and Relational Algebra**	06
	3.1	Introduction to the Relational Model	
	3.2	Relational schema and concept of keys	
	3.3	Mapping the ER and EER Model to the Relational Model	
	3.4	Relational Algebra – operators, Relational Algebra Queries.	
4		**Structured Query Language (SQL)**	06
	4.1	Overview of SQL	
	4.2	Data Definition Commands	
	4.3	Integrity constraints: Key constraints, Domain Constraints, Referential integrity, Check constraints	
	4.4	Data Manipulation commands, Data Control commands	
	4.5	Set and string operations, aggregate function - group by, having	
	4.6	Views in SQL, joins, Nested and complex queries, Triggers	
5		**Relational–Database Design**	07
	5.1	Pitfalls in Relational-Database designs	

	5.2	Concept of normalization	
	5.3	Function Dependencies	
	5.4	First Normal Form, 2NF, 3NF, BCNF.	
6		**Transactions Management and Concurrency and Recovery**	10
	6.1	Transaction Concept, Transaction states	
	6.2	ACID properties	
	6.3	Transaction Control Commands	
	6.4	Concurrent Executions	
	6.5	Serializability:Conflict and View	
	6.6	Concurrency Control: Lock-based, Timestamp-based protocols	
	6.7	Recovery System: Log based recovery	
	6.8	Deadlock handling	
		Total	**39**

Text Books:

1. Korth, Slberchatz,Sudarshan, Database System Concepts, 6th Edition, McGraw Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, 5th Edition, Pearson education
3. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH

Reference Books:

1. Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management‖, Thomson Learning, 5th Edition.
2. Dr.P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, Dreamtech Press.
3. G. K. Gupta, Database Management Systems, McGraw Hill., 2012

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Total
ECL 301	Electronic Devices Lab	--	02	--	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL 301	Electronic Devices Lab	--	--	--	--	--	25	25	50

Laboratory Objectives:

1. To deliver a hands-on approach for studying electronic devices
2. To comprehend characteristics of electronic devices; thereby understanding their behaviour
3. To analyse& calculate inherent parameters of electronic devices through experimental approach
4. To introduce modern software simulation tools for modelling& simulation of electronic devices

Laboratory Outcomes:

After successful completion of the laboratory students will be able to

1. Explain the working of semiconductor devices.
2. Interpret the characteristics of semiconductor devices.
3. Analyse electronics circuits using BJT and FET (DC & AC analysis)
4. Simulate basic circuits using electronic devices through software simulation

Term Work:

At least 10 experiments covering entire syllabus of ECC 302 (Electronic Devices) should be set to have well predefined inference and conclusion. **This must include 60% Hardware and 40% Simulation experiments.** The experiments should be student centric and attempt should be made to make the experiments meaningful and interesting. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	HardwareExperiment Name
1	To study passive(R, L,C) and active (BJT, MOSFTET) components.
2	To study equipment (CRO, Function Generator, Power supply).
3	To perform characteristics of PN junction diode.
4	To perform Clippers and Clampers.
5	To perform analysis and design Fixed bias, Voltage divider bias for CE amplifier.
6	To perform CE amplifier as voltage amplifier (Calculate Av, Ai, Ri, Ro).
7	To perform CS MOSFET amplifier as voltage amplifier and measurement of its performance parameters.
8	To perform Full wave/Bridge rectifier with LC/pi filter.
9	To perform Zener as a shunt voltage regulator.
10	To simulate VI characteristics of MEMRISTOR using nanohub.org

List of Simulation Experiments

Sr. No.	Simulation Experiment Name
1	SPICE simulation of and implementation for junction analysis
2	SPICE simulation of and implementation for BJT characteristics
3	SPICE simulation of and implementation for JFET characteristics
4	SPICE simulation of for MOSFET characteristics
5	SPICE simulation of Full wave/Bridge rectifier with LC/pi filter.
6	SPICE simulation of CE amplifier
7	SPICE simulation of CS MOSFET amplifier.

(Expected percentage of H/w and software experiments should be 60% & 40% respoectively)

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Total
ECL 302	Digital Electronics Lab	--	02	--	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical &Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL 302	Digital Electronics Lab	-	-	-	-	-	25	25	50

Laboratory Objectives:

1. To learn the functionality of basic logic gates.
2. To construct combinational circuits and verify their functionalities.
3. To learn the functionality of flip flops and their conversion.
4. To design and implement synchronous and asynchronous counters, Shift registers using MSI
5. To simulate various combinational and sequential circuits and analyze the results using Verilog HDL.

Term Work:

At least 10 experiments covering the entire syllabus of ECC 303 (Digital Logic Circuits) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments meaningful and interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Hardware Experiments

Sr. No.	Experiment Title
1	To verify different logic gates and implement basic gates using universal gates
2	To implement Boolean function in SOP and POS form
3	To implement half adder, full adder, half Subtractor, full Subtractor
4	To implement BCD adder using binary adder IC 7483
5	To implement logic equations using Multiplexer IC 74151
6	To verify truth table of SR, JK,T and D flip flops
7	To perform Flip flop conversion JK to D, JK to T and D to T flip flop
8	To implement MOD N counter using IC 7490/7492/7493
9	To implement Synchronous counter using IC 74163/74169 **OR** To implement universal shift register using IC 74194

Suggested List of Simulation/Software Experiments

Sr. No.	Experiment Title
1	To design and simulate Full adder/full subtractor using Verilog HDL
2	To design and simulate Multiplexer/Demultiplexer using Verilog HDL
3	To design and simulate decoder 74138 using Verilog HDL
4	To simulate basic flip flops using Verilog HDL
5	To design and simulate 4 bit counter / up-down counter using Verilog HDL
6	To design and simulate Shift register using Verilog HDL

(Additional/ Suggested experiments (optional) -** Implementation of any of above using **FPGA/CPLD)

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Total
ECL 303	Data Structures and Algorithms Lab	--	02	--	--	01	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical &Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL 303	Data Structures and Algorithms Lab	--	--	--	--	--	25	25	50

Prerequisite:
C Programming Language

Laboratory Outcomes:
1. Students will be able to implement linear data structures & will be able to handle operations like insertion, deletion, searching and traversing on them.
2. Students will be able to implement nonlinear data structures & will be able to handle operations like insertion, deletion, searching and traversing on them.
3. Students will be able to choose appropriate data structure and apply it in various problem domains.
4. Students will be able to select appropriate searching techniques for given problems.

Term Work:
At least 10 experiments and 2 assignments covering entire syllabus of **Data Structures and Algorithms (ECC 304)** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments meaningful and interesting. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Total 25 Marks = (Experiments-15 mark + Attendance -5 mark + Assignments-05 mark)

Suggested List of Experiments

Sr. No.	Experiment Name
1	*Implement Stack ADT using array
2	*Convert an Infix expression to Postfix expression using stack ADT
3	Evaluate Postfix Expression using Stack ADT
4	Check whether parentheses are balanced or not.
5	*Implement Linear Queue ADT using array
6	Implement Circular Queue ADT using array
7	Implement Priority Queue ADT using array
8	*Implement Singly Linked List ADT
9	Implement Doubly Linked List ADT
10	*Implement Stack ADT using Linked List
11	*Implement Linear Queue ADT using Linked List
12	*Implement Binary Search Tree ADT using Linked List
13	*Implement Depth First Search and Breadth First Search Graph Traversal technique
14	*Implement searching algorithms -Linear search, Binary search
15	*Implement sorting algorithms (any 2)- bubble, selection, insertion, merge,quick

(*) marked experiments are compulsory.

Useful Links:

1.www.leetcode.com
2. www.hackerrank.com
3. www.cs.usfca.edu/~galles/visualization/Algorithms.html
4. www.codechef.com

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical		Total
ECL 304	Database Management Systems Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL 304	Database Management Systems lab	--	--	--	--	--	25	25	50

Laboratory Outcomes:

At the end of the course the student should be able to;

1. Design ER /EER diagram and convert to relational model for the realworld application.
2. Apply DDL, DML, DCL and TCL commands.
3. Write simple and complex queries
4. Use PL/SQL Constructs.
5. Demonstrate the concept of concurrent transactions execution and frontend-backend connectivity

Term Work:

At least 10 experiments covering the entire syllabus of Database Management Systems (ECC 305)should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make the experimentsmeaningful and interesting. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Identify the case study and detail statement of problem. Design an Entity-Relationship (ER) / Extended Entity-Relationship (EER) Model.
2	Mapping ER/EER to Relational schema model.
3	Create a database using Data Definition Language (DDL) and apply integrity constraints for the specified System
4	Apply DML Commands for the specified system
5	Perform Simple queries, string manipulation operations and aggregate functions.
6	Implementvarious Join operations.
7	Perform Nested and Complex queries
8	Perform DCL and TCL commands
9	Implement procedure and functions
10	Implementation of Views and Triggers.
11	Demonstrate Database connectivity
12	Implementation and demonstration of Transaction and Concurrency control techniques using locks.

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL305	Skill Base Lab-OOPM: *(C++ and Java)*	--	02* + 02	--	--	02	--	02
* Theory class to be conducted for full class								

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL305	Skill base Lab - OOPM: *(C++ and Java)*	--	--	--	--	--	50	--	50

Course Pre-requisites:

- Fundamentals of C-Programming
- Control Structures
- Arrays and String

Course Objectives:

1. To understand Object Oriented Programming basics and its features.
2. To understand and apply Object Oriented Programming (OOP) principles using C++
3. Able to implement Methods, Constructors, Arrays, Multithreading and Applet in java
4. Able to use a programming language to resolve problems.

Course Outcomes:

After successful completion of the course student will be able to

1. Use C++ in programming.
2. Use different control structures.
3. Understand fundamental features of an object-oriented language: object classes and interfaces, exceptions and libraries of object collections.
4. Understand Java Programming.
5. To develop a program that efficiently implements the features and packaging concept of java in laboratory.
6. To implement Exception Handling and Applets using Java.

Module No	Unit No.	Contents	Hrs.
1		**C++ Overview**	08
	1.1	Need of Object-Oriented Programming (OOP), Object Oriented Programming Paradigm, Basic Concepts of Object-Oriented Programming, Benefits of OOP and C++ as object-oriented programming language.	
	1.2	C++ programming Basics, Data Types, Structures, Enumerations, control structures, Arrays and Strings, Class, Object, class and data abstraction, class scope and accessing class members, separating interface from implementation, controlling access to members.	
2		**C++ Control Structures**	06
	2.1	**Branching -** If statement, If-else Statement, Decision. **Looping –** while, do-while, for loop **Nested control structure-** Switch statement, Continue statement, Break statement.	
	2.2	**Array-** Concepts, Declaration, Definition, Accessing array element, One dimensional and Multidimensional array.	
3		**Object-Oriented Programming using C++**	10
	3.1	**Operator Overloading-** concept of overloading, operator overloading, Overloading Unary Operators, Overloading Binary Operators, Data Conversion, Type casting (implicit and explicit), Pitfalls of Operator Overloading and Conversion, Keywords explicit and mutable. **Function-** Function prototype, accessing function and utility function, Constructors and destructors, Copy Constructor, Objects and Memory requirements, Static Class members, data abstraction and information hiding, inline function. **Constructor-** Definition, Types of Constructor, Constructor Overloading, Destructor.	
	3.2	**Inheritance-** Introduction, Types of Inheritance, Inheritance, Public and Private Inheritance, Multiple Inheritance, Ambiguity in Multiple Inheritance, Visibility Modes Public, Private, Protected and Friend, Aggregation, Classes Within Classes. Deriving a class from Base Class, Constructor and destructor in Derived Class, Overriding Member Functions, Class Hierarchies, **Polymorphism-** concept, relationship among objects in inheritance hierarchy, Runtime & Compile Time Polymorphism, abstract classes, Virtual Base Class.	
4		**Introduction to Java**	06
	4.1	Programming paradigms- Introduction to programming paradigms, Introduction to four main Programming paradigms like procedural, object oriented, functional, and logic & rule based. Difference between C++ and Java.	
	4.2	Java History, Java Features, Java Virtual Machine, Data Types and Size (Signed vs. Unsigned, User Defined vs. Primitive Data Types, Explicit Pointer type), Programming Language JDK Environment and Tools.	
5		**Inheritance, Polymorphism, Encapsulation using Java**	10
	5.1	**Classes and Methods**: class fundamentals, declaring objects, assigning object reference variables, adding methods to a class, returning a value, constructors, this keyword, garbage collection, finalize() method, overloading methods, argument passing, object as parameter, returning objects, access control, static, final, nested and inner classes, command line arguments, variable-length Arguments. **String:** String Class and Methods in Java.	

	5.2	**Inheritances:** Member access and inheritance, super class references, Using super, multilevel hierarchy, constructor call sequence, method overriding, dynamic method dispatch, abstract classes, Object class. **Packages and Interfaces:** defining a package, finding packages and CLASSPATH, access protection, importing packages, interfaces (defining, implementation, nesting, applying), variables in interfaces, extending interfaces, instance of operator.	
6.0		**Exception Handling and Applets in Java**	**08**
	6.1	**Exception Handling:** fundamental, exception types, uncaught exceptions, try, catch, throw, throws, finally, multiple catch clauses, nested try statements, built-in exceptions, custom exceptions (creating your own exception subclasses). **Managing I/O:** Streams, Byte Streams and Character Streams, Predefined Streams, Reading console Input, Writing Console Output, and Print Writer class. **Threading:** Introduction, thread life cycle, Thread States: new, runnable, Running, Blocked and terminated, Thread naming, thread join method, Daemon thread	
	6.2	**Applet:** Applet Fundamental, Applet Architecture, Applet Life Cycle, Applet Skeleton, Requesting Repainting, status window, HTML Applet tag, passing parameters to Applets, Applet and Application Program.	
		Total	**48**

Textbooks:

1. Bjarne Stroustrup, “The C++ Programming language”, Third edition, Pearson Education, 2000.
2. Deitel, “C++ How to Program”, 4th Edition, Pearson Education, 2005.
3. D. T. Editorial Services, “Java 8 Programming Black Book”, Dreamtech Press, Edition, 2015.
4. Yashwant Kanitkar, “Let Us Java”, BPB Publications, 4nd Edition, 2019.

Reference Books:

1. Herbert Schidt, “The Complete Reference”, Tata McGraw-Hill Publishing Company Limited, 10th Edition, 2017.
2. Harvey M. Deitel, Paul J. Deitel, Java: How to Program, 8th Edition, PHI, 2009.
3. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified ModelingLanguageser Guide”, Pearson Education.
4. Sachin Malhotra, Saurabh Chaudhary “Programming in Java”, Oxford University Press, 2010

Software Tools:

1. Raptor-Flowchart Simulation:http://raptor.martincarlisle.com/
2. Eclipse: https://eclipse.org/
3. Netbeans:https://netbeans.org/downloads/
4. CodeBlock:http://www.codeblocks.org/
5. J-Edit/J-Editor/Blue J

Online Repository:

1. Google Drive
2. GitHub
3. Code Guru

Suggested list of Experiments

Sr. No	C++ Programs
1	Add Two Numbers
2	Print Number Entered by User
3	Swap Two Numbers
4	Check Whether Number is Even or Odd
5	Find Largest Number Among Three Numbers
6	Create a simple class and object.
7	Create an object of a class and access class attributes
8	Create class methods
9	Create a class to read and add two distance
10	Create a class for student to get and print details of a student.
11	Demonstrate example of friend function with class
12	Implement inheritance.

Sr. No.	JAVA Programs
1	Display addition of number
2	Accept marks from user, if Marks greater than 40,declare the student as "Pass" else "Fail""
3	Accept 3 numbers from user. Compare them and declare the largest number (Using if-else statement).
4	Display sum of first 10 even numbers using do-while loop.
5	Display Multiplication table of 15 using while loop.
6	Display basic calculator using Switch Statement.
7	Display the sum of elements of arrays.
8	Accept and display the string entered and execute at least 5 different string functions on it.
9	Read and display the numbers as command line Arguments and display the addition of them
10	Define a class, describe its constructor, overload the Constructors and instantiate its object.
11	Illustrate method of overloading
12	Demonstrate Parameterized Constructor
13	Implement Multiple Inheritance using interface
14	Create thread by implementing 'runnable' interface or creating 'Thread Class.
15	Demonstrate Hello World Applet Example

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term Work:

At least **16** experiments (**08 experiments** each on **C++** and **JAVA**) covering entire syllabus should be set to have well predefined inference and conclusion. Teacher should refer the suggested experiments and can design additional experiment to maintain better understanding and quality.
The experiments should be students centric and attempt should be made to make experimentsmeaningful, interesting and innovative. Term work assessment must be based on the overall performance of the student, with experiments graded from time to time.

The grades will be converted to marks as per "**Choice Based Credit and Grading System**" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course code	Course Name	Credits
ECM 301	Mini Project - 1A	02

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECM 301	Mini Project - 1A	--	--	--	--	--	25	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:

Learner will be able to;

1. Identify problems based on societal /research needs.
2. Apply knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.

- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,

  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

AC- 23/07/2020
Item No. - 123

UNIVERSITY OF MUMBAI

Program: Bachelor of Engineering in Electronics & Computer Science

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20
Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC - 23/07/2020
Item No. - 123

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year BE in Electronics & Computer Science**
2	Eligibility for Admission	**First Year Engineering passed in line with the Ordinance 0.6242**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6242**
5	No. of Years / Semesters	**8 Semesters**
6	Level	~~Certificate/Diploma~~/UG/~~PG~~ **(Strike out which is not applicable)**
7	Pattern	**Semester**/~~Yearly~~ **(Strike out which is not applicable)**
8	Status	~~Revised~~/**New** **(Strike out which is not applicable)**
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date: 23rd July 2020

Signature:

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, the Faculty of Science and Technology (in particular Engineering), of University of Mumbai, has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes, understand the depth and approach of the course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process. However, content of courses is to be taught in 12-13 weeks and the remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.
There was a concern that the earlier revised curriculum was more focused on providing information and knowledge across various domains of the said program, which led to heavily loading students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of the entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum, skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of the curriculum proposed in the present revision is in line with the AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and implementation of online Contents from NPTEL/ SWAYAM Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time, in particular Revised syllabus of ‘C ‘scheme, wherever possible, additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In earlier revisions of the curriculum in the years 2012 and 2016, in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum, overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HOD’s/ Faculties of all the institutes are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses and on successful completion, they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

Technical education in the country is undergoing a paradigm shift in current days. Think tank at national level are deliberating on the issues, which are of utmost importance and posed challenge to all the spheres of technical education. Eventually, impact of these developments was visible and as well adopted on bigger scale by almost all universities across the country. These are primarily an adoption of CBCS (Choice base Credit System) and OBE (Outcome based Education) with student centric and learning centric approach. Education sector in the country, as well, facing critical challenges, such as, the quality of graduates, employability, basic skills, ability to take challenges, work ability in the fields, adoption to the situation, leadership qualities, communication skills and ethical behaviour. On other hand, the aspirants for admission to engineering programs are on decline over the years. An overall admission status across the country is almost 50%; posing threat with more than half the vacancies in various colleges and make their survival difficult. In light of these, an All India Council for Technical Education (AICTE), the national regulator, took initiatives and enforced certain policies for betterment, in timely manner. Few of them are highlighted here, these are design of model curriculum for all prevailing streams, mandatory induction program for new entrants, introduction of skill based and inter/cross discipline courses, mandatory industry internships, creation of digital contents, mandate for use of ICT in teaching learning, virtual laboratory and so on.

To keep the pace with these developments in Technical education, it is mandatory for the Institutes & Universities to adopt these initiatives in phased manner, either partially or in toto. Hence, the ongoing curriculum revision process has a crucial role to play. The BoS of Electronics Engineering under the faculty of Science & Technology, under the gamut of Mumbai University has initiated a step towards adoption of these initiatives. We, the members of Electronics Engineering Board of Studies of Mumbai University feel privileged to present the revised version of curriculum for Electronics & Computer Science program to be implemented from academic year 2020-21. Consent was also extended by BoS Computer Science for this curriculkum. Some of the highlights of the revision are;

i. Curriculum has been framed with reduced credits and weekly contact hours, thereby providing free slots to the students to brain storm, debate, explore and apply the engineering principles. The leisure provided through this revision shall favour to inculcate innovation and research attitude amongst the students.
ii. New skill based courses have been incorporated in curriculum keeping in view AICTE model curriculum.
iii. Skill based Lab courses have been introduced, which shall change the thought process and enhance the programming skills and logical thinking of the students
iv. Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the group dynamics, develop leadership qualities, facilitate decision making and enhance problem solving ability with focus towards socio-economic development of the country. In addition, it shall be direct application of theoretical knowledge in practice, thereby, nurture learners to become industry ready and enlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystem with better means.
v. An usage of ICT through NPTEL/SWAYAM and other Digital initiatives of Govt. of India shall be encouraged, facilitating the students for self learning and achieve the Graduate Attribute (GA) specified by National Board of accreditation (NBA) i.e. lifelong learning.

Thus, this revision of curriculum aimed at creating deep impact on the teaching learning methodology to be adopted by affiliating Institutes, thereby nurturing the students fraternity in a multifaceted directions and create competent technical manpower with legitimate skills. In time to come, these graduates shall shoulder the responsibilities of proliferation of future technologies and support in a big way for 'Make in India' initiative a reality. In the process, BoS, Electronics Engineering got whole hearted support from all stakeholders including faculty, Heads of department of affiliating institutes, experts faculty who detailed out the course contents, alumni, industry experts and university official providing all procedural support time to time. We put on record their involvement and sincerely thank one and all for contribution and support extended for this noble cause.

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Boards of Studies in Electronics Engineering

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. R. N. Awale	Chairman	5	Dr. Rajani Mangala	Member
2	Dr. Jyothi Digge	Member	6	Dr. Vikas Gupta	Member
3	Dr. V. A. Vyawahare	Member	7	Dr. D. J. Pete	Member
4	Dr. Srija Unnikrishnan	Member	8	Dr. Vivek Agarwal	Member

Program Structure for Second Year Electronics and Computer Science
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 401	Engineering Mathematics - IV	3	-	1	3	-	1	4
ECC 402	Electronic Circuits	3	-	-	3	-	-	3
ECC 403	Controls and Instrumentation	3	-	-	3	-	-	3
ECC 404	Microprocessors and Microcontrollers	3	-	-	3	-	-	3
ECC 405	Discrete Structures and Automata Theory	3	-	-	3	-	-	3
ECL 401	Electronic Circuits Lab		2			1		1
ECL 402	Controls and Instrumentation Lab	-	2	-	-	1	-	1
ECL 403	Microprocessors and Microcontrollers Lab	-	2	-	-	1	-	1
ECL 404	Skill-base Lab: *Python programming*	-	4	-	-	2	-	2
ECM 401	Mini-project -1 B	-	4$	-	-	2	-	2
	Total	15	14	1	15	7	1	23

$ indicates workload of learner (not faculty), for mini-project

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Practical/ Oral	Total
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)			
		Test1	Test2	Avg.					
ECC 401	Engineering Mathematics - IV	20	20	20	80	03	25	-	125
ECC 402	Electronic Circuits	20	20	20	80	03	-	-	100
ECC 403	Controls and Instrumentation	20	20	20	80	03	-	-	100
ECC 404	Microprocessors and Microcontrollers	20	20	20	80	03	-	-	100
ECC 405	Discrete structures and Automata Theory	20	20	20	80	03	-	-	100
ECL 401	Electronic Circuits Lab	-	-	-	-	-	25	25	50
ECL 402	Controls and Instrumentation Lab	-	-	-	-	-	25	25	50
ECL 403	Microprocessors and Microcontrollers Lab	-	-	-	-	-	25	25	50
ECL 404	Skill-based Lab: *Python programming*	-	-	-	-	-	50	-	50
ECM 401	Mini-project -1B	-	-	-	-	-	25	25	50
	Total	-	-	100	400	-	175	100	775

Note:

1. Students group and load of faculty per week.

Mini-Project 1 and 2:
Students can form groups with minimum 3 (Three) and not more than 4(Four)
Faculty Load :1 hour perweek per four groups

Major Project 1 and 2:
Students can form groups with minimum 2 (Two) and not more than 4 (Four)
Faculty Load: In Semester VII– ½ hour per week per project group
In Semester VIII – 1 hour per week per project group

2. Out of 4 hours/week allotted for the mini-projects 1-A and 1-B, an expert lecture of at least one hour per week from industry/institute or a field visit to nearby domain specific industry should be arranged.
3. Mini-projects 2-A and 2-B should be based on DLOs.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical and Oral	Tutorial	Theory	Practical and Oral	Tutorial	Total
ECC401	Engineering Mathematics - IV	03	--	01	03	--	01	04

<table>
<tr><th rowspan="4">Course Code</th><th rowspan="4">Course Name</th><th colspan="8">Examination Scheme</th></tr>
<tr><th colspan="5">Theory Marks</th><th>Term Work</th><th>Practical Oral</th><th>Total</th></tr>
<tr><th colspan="3">Internal assessment</th><th>End Sem. Exam</th><th>Exam duration Hours</th><th></th><th></th><th></th></tr>
<tr><th>Test 1</th><th>Test 2</th><th>Avg of Test 1 and Test 2</th><th></th><th></th><th></th><th></th><th></th></tr>
<tr><td>ECC401</td><td>Engineering Mathematics - IV</td><td>20</td><td>20</td><td>20</td><td>80</td><td>03</td><td>25</td><td>--</td><td>125</td></tr>
</table>

Pre-requisite:

Engineering Mathematics - I, Engineering Mathematics - II,
Engineering Mathematics - III, Binomial Distribution.

Course Objectives: The course is aimed;

1. To studythe line and contour integrals and expansion of complex valued function in a power series.
2. To understand the basic techniques of statistics for data analysis, Machine learning and AI.
3. To study the probability distributions and expectations.
4. To acquaint with the concepts of vector spaces used in the field of machine learning and engineering problems.
5. To familiarize withthe concepts of Quadratic forms and Singular value decomposition.
6. To learn the concepts of Calculus of Variations.

Course Outcomes:

On successful completion of course, learner will be able to;

1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
2. Demonstrate the use of Correlation and Regression to the engineering problems in data science, machine learning and AI.
3. Illustrate understanding of the concepts of probability and expectation for getting the spread of the data and distribution of probabilities.
4. Apply the concept of vector spaces and orthogonalization process in Engineering Problems.
5. Use the concept of Quadratic forms and Singular value decomposition in various Engineering applications.
6. Find the extremals of the functional using the concept of Calculus of variation.

Module No.	Detailed Contents	Hrs.
01	**Complex Integration** 1.1 Line Integral, Cauchy's Integral theorem for simple connected and multiply connected regions (without proof), Cauchy's Integral formula (without proof). 1.2 Taylor's and Laurent's series (without proof). 1.3 Definition of Singularity, Zeroes, poles of $f(z)$, Residues, Cauchy's Residue Theorem (without proof). **Self-learning Topics:** Application of Residue Theorem to evaluate realintegrations, Z-Transform.	7
02	**Statistical Techniques** 2.1 Karl Pearson's Coefficient of correlation (r) . 2.2 Spearman's Rank correlation coefficient (R) (repeated and non-repeated ranks) 2.3 Lines of regression. 2.4 Fitting of first and second degree curves. **Self-learning Topics:** Covariance, fitting of exponential curve.	6
03	**Probability Distributions** 3.1. Baye's Theorem, Random variable: Probability distribution for discrete and continuous random variables, Density function and distribution function. 3.2 Expectation, mean and variance. 3.3 Probability distribution: Poisson & normal distribution. **Self-learning Topics:** Moments, Moment Generating Function, Applications of Probability Distributions in Engineering.	7
04	**Linear Algebra: Vector Spaces** 4.1 Vectors in n-dimensional vector space, norm, dot product, The Cauchy Schwarz inequality (with proof), Unit vector. 4.2 Orthogonal projection, Orthonormal basis, Gram-Schmidt process for vectors. 4.3 Vector spaces over real field, subspaces. **Self-Learning Topics**:- Linear combinations, linear Dependence andIndependence, QR decomposition.	6

05	**Linear Algebra: Quadratic Forms** 5.1 Quadratic forms over real field, Linear Transformation of Quadratic form, Reduction of Quadratic form to diagonal form using congruent transformation. 5.2 Rank, Index and Signature of quadratic form, Sylvester's law of inertia, Value-class of a quadratic form-Definite, Semidefinite and Indefinite. 5.3 Reduction of Quadratic form to a canonical form using congruent transformations. 5.4 Singular Value Decomposition. **Self-learning Topics:** Orthogonal Transformations**,** Applications of Quadratic forms and SVD in Engineering.	7
06	**Calculus of Variations:** 6.1 Euler- Lagrange equation(Without Proof), When F does not contain y, When F does not contain x, When F contains x,y,y'. 6.2 Isoperimetric problems-Lagrange Method. 6.3 Functions involving higher order derivatives: Rayleigh-Ritz Method. **Self-Learning Topics:-**Brachistochrone Problem, Variational Problem,Hamilton Principle, Principle of Least action,Several dependent variables.	6
	Total	**39**

Term Work:

General Instructions:

1. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
2. A group of 4-6 students should be assigned a self-learning topic. Students should prepare a presentation/problem solving of 10-15 minutes. This should be considered as mini project in Engineering Mathematics. This project should be graded for 10 marks depending on the performance of the students.

The distribution of Term Work marks will be as follows –

1.	Attendance (Theory and Tutorial)	05 marks
2.	Class Tutorials on entire syllabus	10 marks
3.	Mini project	10 marks

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first-class test (Internal Assessment I) is to be conducted when approx. 40% syllabus is completed and secondclass test (Internal Assessment II) when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein 4 sub-questions of 5 marks each will be asked.
4. Remaining questions will be randomly selected from all the modules.
5. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

Reference Books:

1. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
2. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education.
3. Advanced engineering mathematics H.K. Das, S. Chand, Publications.
4. Higher Engineering Mathematics B. V. Ramana, Tata Mc-Graw Hill Publication
5. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Narosa publication
6. Advanced Engineering Mathematics Wylie and Barret, Tata Mc-Graw Hill.
7. Beginning Linear Algebra Seymour Lipschutz Schaum's Outline series, Mc-Graw Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication, 43rd edition, 2010.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC402	Electronic Circuits	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC 402	Electronic Circuits	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC 302:Electronic Devices.

Course Objectives:

1. To enhance comprehension capabilities of students through understanding of electronic circuits.
2. To perform low frequency and high frequency analysis of single stage amplifiers.
3. To teach fundamental principles of operational amplifiers.
4. To develop an overall approach for students from selection of integrated circuit, specification, functionality and applications

Course Outcomes:

After successful completion of the course students will be able to

1. Evaluate the performance of amplifiers through frequency response.
2. Analyse differential amplifiers for various performance parameters
3. Express mathematically the performance parameters in terms of circuit parameters
4. Choose appropriate circuit for the given specifications/ applications
5. Describe various applications and circuits based on operational amplifiers.
6. Design an application with the use of integrated circuits.

Module No.	Unit No.	Contents	Hrs
1		**Frequency Response of Amplifiers**	7
	1.1	Low frequency response & analysis, effect of the coupling, bypass & load capacitances on single stage MOSFET amplifier for common source (CS) configuration (mathematical analysis & numerical examples included)	
	1.2	High frequency response & analysis, effect of parasitic capacitances on MOSFET amplifier, high frequency equivalent circuit of MOSFET, Miller's theorem, effect of Miller's capacitance, unity gain bandwidth (mathematical analysis & numerical examples included)	
	1.3	Introduction to multi-stage amplifiers – need & necessity, different types of couplings (DC, R-C & transformer) with advantages & disadvantages, the MOSFET cascode amplifier (theoretical description only)	
2		**Differential Amplifiers**	7
	2.1	Basic MOSFET differential amplifier, DC characteristics, transfer characteristics, small signal (AC) analysis of only dual input balanced output (DIBO) for differential mode gain & common mode gain, common mode rejection ratio (CMRR) & input resistance / impedance	
	2.2	MOSFET differential amplifier with an active load (theoretical description & only mathematical analysis – no numerical examples)	
3		**Operational Amplifiers**	7
	3.1	The ideal operational amplifier (op-amp), internal block diagram of op-amp, characteristics of op-amp, ideal & practical op-amp parameters / specifications (no detailed description or any analysis), mathematical model of op-amp, IC 741 op-amp with pin diagram & description	
	3.2	Operational amplifier open loop & closed loop configurations (theoretical description only), the concept of virtual ground & virtual short	
4		**Applications of Operational Amplifier**	6
	4.1	Types of negative feedback – voltage series, voltage shunt, current series & current shunt (theoretical description only), the op-amp inverting amplifier & op-amp non-inverting amplifier (mathematical analysis for derivation of output voltage only, numerical examples & designing)	
	4.2	Adder, summing amplifier, averaging circuit, subtractor, integrator (ideal), differentiator (ideal), difference amplifier, current amplifier & 3 op-amp instrumentation amplifier (only mathematical analysis for derivation of output voltage with numerical examples & designing included)	
	4.3	Current to voltage converters (I to V) & voltage to current converters (V to I) – floating load & grounded load (mathematical analysis only – no numericals)	
5		**Oscillators &Comparators**	6
	5.1	Oscillators: RC phase shift oscillator, Wien bridge oscillator & the crystal oscillator (theoretical description only – no mathematical analysis), numerical example & design problem on RC phase shift oscillator & Wien bridge oscillator	
	5.2	Waveform Generators: Square wave generator & triangular wave generator (only	

		theoretical description – no mathematical analysis or designing examples)	
	5.3	Comparators: Inverting comparator, non-inverting comparator, zero crossing detector (ZCD) & Schmitt Trigger (numerical examples & designing problem on the inverting Schmitt Trigger for both symmetrical & non-symmetrical configurations), window detector / comparator (theoretical description only)	
6		**Special Purpose Integrated Circuits**	6
	6.1	IC 555 timer internal block diagram & pin configuration, operation in astable& monostable multivibrator with mathematical analysis & numerical examples, design problems on astable& monostable multivibrator, applications in astable& monostable configuration	
	6.2	ADC 0808 / 0809 & interfacing, DAC0808 & interfacing (theoretical description only)	
	6.3	Functional block diagram & working of the LT 1070 monolithic switching regulator (theoretical description only)	
		Total	**39**

Text Books:

1.Donald A. Neamen, “Electronic Circuit Analysis and Design”, TATA McGraw Hill, 2nd Edition.
2.Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson Prentice Hall, 4th Edition.

Reference Books:

1. Robert Boylestad," Electronic Devices and Circuit Theory", Pearson.
2.David A. Bell,“Electronic Devices and Circuits”, Oxford, Fifth Edition.
3. Muhammad H. Rashid, “Microelectronics Circuits Analysis and Design”, Cengage
4. S. Salivahanan, N. Suresh Kumar,“Electronic Devices and Circuits”, Tata McGraw Hill.
5. D. Roy Choudhury and S. B. Jain, “Linear Integrated Circuits”, New Age International Publishers, 4th Edition.
6. Sergio Franco, “Design with operational amplifiers &analog integrated circuits”, Tata McGraw Hill, 3rd edition
7. William D. Stanley, “Operational Amplifiers with Linear Integrated Circuits”, Pearson, 4th Edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as the final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.
5. Weightage of each module in question paper will be proportional to the number of respective lecture hours mentioned in the syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 403	Controls and Instrumentation	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC 403	Controls and Instrumentation	20	20	20	80	03	--	-- --	100

Course Pre-requisites:

1. Basic Electrical Engineering
2. Applied Mathematics (Laplace transform, ordinary differential equations)
3. Applied Physics

Course Objectives:

1. To develop the ability to model control systems and determine their time response and frequency response.
2. To develop the ability to analyse stability of control systems.
3. To develop the ability to understand instruments and data acquisition systems.

Course Outcomes:

After successful completion of the course students will be able to

1. Derive the transfer functions for the given control systems.
2. Analyse the performance of control systems based on the time domain and frequency domain specifications.
3. Judge the stability of the given control systems using appropriate stability criteria.
4. Understand and explainthe working principle of sensors and transducers.
5. Explain various parameters of data acquisition systems.
6. Describe instrument communication standards.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Control Systems and Mathematical Models**	7
	1.1	Introduction to control systems: The control system, servomechanisms, digital control.	
	1.2	Mathematical models: Transfer functions, block diagram algebra, block diagram reduction, signal flow graphs.	
2		**Time response analysis and stability analysis in time domain**	7
	2.1	Time response analysis: standard test signals, time response of first and second order systems, steady state errors and error constants.	
	2.2	Stability in time domain: The concept of stability, necessary conditions for stability, Hurwitz stability criterion, Routh stability criterion, relative stability analysis.	
	2.3	Stability analysis using root locus technique.	
3		**Stability Analysis in frequency domain and Introduction to advances in control systems**	7
	3.1	Introduction to frequency response analysis, correlation between time and frequency domain.	
	3.2	Stability analysis using Bode plots.	
	3.3	Nyquist stability criterion and stability analysis using Nyquist plot.	
	3.4	Introduction to advances in control systems: adaptive control, fuzzy logic control and neural networks. Introduction to distributed control systems.	
4		**Sensors and Transducers**	6
	4.1	Introduction to sensors and transducers. Various types of sensors. Various types of transducers and their principle of operation. Selection criteria of transducers.	
	4.2	Displacement and pressure transducers: potentiometers, pressure gauges, Linear variable differential transducer (LVDT), strain gauges.	
	4.3	Temperature transducers: working principle, ranges and applications of resistance temperature detectors (RTD), thermocouple and thermistor temperature transducers.	
5		**Signal conditioning DAS, Data logger and SCADA**	6
	5.1	Introduction to instrumentation systems, data acquisition system (DAS), use of DAS in Intelligent instrumentation system. Design of pressure and temperature measurement system using DAS. Data logger, its types and applications. SCADA-communication architecture, types, applications, open SCADA protocols. Cloud based SCADA systems. Introduction to fibre optic instrumentation.	

6		**Telemetry and Instrument communication standards**	**6**
	6.1	Introduction to telemetry, landline telemetry, radio telemetry and types of multiplexing.	
	6.2	Instrument interfacing, Current loop, RS232/485, Field bus, Modbus, GPIB, USB Protocol, and HART communication Protocol.	
Total			**39**

Text Books:

1. I. J. Nagrath, M. Gopal, "Control System Engineering", 5th edition, New Age International Publishers
2. B. S. Manke, "Linear Control Systems", Khanna Publishers, New Delhi.
3. D. Patranabis, "Principle of Industrial Instrumentation", Tata McGraw Hill.
4. A.K. Sawhney, "Electrical & Electronic Measurement & Instrumentation" – DRS. India
5. H.S.Kalsi, "Electronic Instrumentation"-TMH, 2nd Edition.

Reference Books:

1. K. Ogata, "Modern Control Engineering", PHI, New Delhi
2. Norman S. Nise, "Control System Engineering", John Wiley and Sons.
3. B. C. Kuo, "Automatic Control Systems", PHI, New Delhi
4. C. S. Rangan, G. R. Sharma and V. S. Mani, 'Instrumentation Devices and Systems', Tata McGraw-Hill Publishing Company Ltd.
5. Helfrick& Cooper, "Modern Electronic Instrumentation & Measuring Techniques" – PHI

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as the final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 404	Microprocessors and Microcontrollers	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC 404	Microprocessors and Microcontrollers	20	20	20	80	03	--	--	100

Course Pre-requisites:

1. Electronic Devices
2. Digital Electronics

Course Objectives:

1. To study the concepts and basic architecture of a Microprocessor and Microcontroller.
2. To write Assembly language programs for Microprocessors and Microcontrollersfor various applications.
3. To know the importance of different peripheral devices and their interfacing to 8086 and 8051.
4. To build Microprocessor and Microcontroller based systems.

Course Outcomes:

After successful completion of the course students will be able to;

1. Explain 16-bit Microprocessor architectures and fundamental concepts of Microcontrollers
2. To develop programming skills for Microprocessors and Microcontrollers
3. To interface various devices in Microprocessor and Microcontroller systems
4. To design and implement Microprocessor and Microcontroller based systems.

Module No.	Unit No.	Contents	Hrs.
1		**The 8086 Microprocessor**	06
	1.1	8086 Architecture	
	1.2	Memory Segmentation	
	1.3	8086 pin description	
	1.4	Interrupts and Interrupt service routines, **Dedicated interrupts, Software interrupts**	
2		**8086 programming**	06
	2.1	Addressing modes	
	2.2	Instruction Set and Assembler Directives	
	2.3	Assembly language programming	
3		**8086 Interfacing –Part I**	05
	3.1	Generating the 8086 System Clock and Reset Signals using 8284 clock generator	
	3.2	8086 Minimum and Maximum Mode CPU Modules	
	3.3	Minimum and Maximum Mode Timing Diagrams	
	3.4	Memory interfacing.	
4		**8086 Interfacing –Part II**	06
	4.1	8255-PPI:Functional Block Diagram and description, Operating Modes	
	4.2	8259- PIC: Functional Block Diagram and description, Cascaded mode of operation	
	4.3	System design (including Memory and I/O)	
5		**The 8051 Microcontroller**	08
	5.1	Differences between a Microprocessor and Microcontroller	
	5.2	Architecture of 8051	
	5.3	Memory Organization of the 8051	
	5.4	Addressing modes	
	5.5	Instruction set	
	5.6	Assembly language programming.	
6		**8051 Interfacing**	08
	6.1	I/O port programming	
	6.2	Programming 8051 Timers	
	6.3	Serial Port Programming	
	6.4	Interrupts Programming	
	6.5	LCD & Keyboard Interfacing	
	6.6	ADC, DAC & Sensor Interfacing	
	6.7	Stepper Motor and DC motor Interfacing	
		Total	**39**

Text Books:

1. 8086/8088 family: Design Programming and Interfacing: By John Uffenbeck (Pearson Education)
2. Microprocessor and Interfacing: By Douglas Hall (TMH Publication)
3. The 8051 Microcontroller and Embedded Systems Using Assembly and C: By M. A. Mazidi, J. C. Mazidi, Rolin D. McKinlay, Pearson Education, 2nd Edition.
4. The 8051 Microcontroller: ByKenneth J. Ayala, Cengage Learning India Pvt. Ltd, 3rd Edition

Reference Books:

1. Microcomputer Systems: 8086/8088 family Architecture, Programming and Design: By Liu & Gibson (PHI Publication).
2. The INTEL Microprocessors, Architecture, Programming and Interfacing: By Barry B. Brey (PearsonPublishers, 8th Edition)
3. Microcontrollers: Architecture, Programming, Interfacing and System Design: By RajKamal, Pearson Education, 2005.
4. The 8051 Microcontroller Based Embedded Systems: By Manish K Patel, McGraw Hill, 2014.
5. Microcontroller Theory And Applications:By Ajay V Deshmukh, Tata Mcgraw Hill

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as the final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. .Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 405	Discrete Structures and Automata Theory	03	-	--	03	-	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC 405	Discrete Structures and Automata Theory	20	20	20	80	03	-	-	100

Course Prerequisite:

Engineering Mathematics - I, II & III

Course Objectives:

1. To cultivate clear thinking for Creative Problem Solving.
2. To train students to understand and construct Mathematical Proofs.
3. To introduce the notions of Sets, Relations, Functions, Graphs and their applications.
4. To build concepts of theoretical design of Basic machines, Deterministic and NonDeterministic Finite statemachines and Pushdown Machines.
5. To gain the conceptual understanding of fundamentals of Grammars.
6. To prepare students with the mathematical aspects in other courses such as Formal Specification, Verification, Artificial Intelligence etc.

Course Outcomes:

After successful completion of the course students will be able to

1. Understand the notion of mathematical thinking, mathematical proofs and to apply them in problem solving.
2. Reason Logically.
3. Perform operations with Sets, Relations, Functions, Graphs and their applications.
4. Design Deterministic Finite Automata (DFA) and Non-deterministic Finite Automata (NFA) and Pushdown Automata with understanding of power and limitations.
5. Design Context Free Grammar and perform the operations like simplification and normal forms.
6. Apply Discrete Structures and Automata Theory concepts into solving real world computing problems in the domain of Formal Specification, Verification, Artificial Intelligence etc.

Module No.	Unit No.	Contents	Hrs
1		**Set Theory and Logic**	06
	1.1	Set Theory: Fundamentals - Sets and Subsets, Venn Diagrams, Operations on sets, Laws of Set Theory, Power Set,.	
	1.2	Principle of Inclusion and Exclusion, Mathematical Induction.	
	1.3	Propositions and Logical operations, Truth tables,Equivalence, Implications	
	1.4	Laws of Logic, Normal Forms, Inference	
	1.5	Predicates and Quantifiers	
2		**Relations and Functions**	07
	2.1	Relations- Definition, Properties of Relations	
	2.2	Types of binary relations (Equivalence and partial ordered relations),	
	2.3	Closures, Poset, Hasse diagram and Lattice	
	2.4	Functions-Definition,Types of Functions (Injective, Surjective and Bijective)	
	2.5	Identity and Inverse Functions	
	2.6	Pigeonhole Principle, Extended Pigeonhole Principle	
3		**Graph Theory**	07
	3.1	Graphs and their basic properties - degree, path, cycle, subgraphs, Types of graphs.	
	3.2	Definitions, Paths and circuits: Eulerian and Hamiltonian, Planner Graph.	
	3.3	Isomorphism of graphs, Dijkstra Shortest Path Algorithm	
	3.4	Trees, Types of Trees	
4		**Finite Automata**	07
	4.1	Introduction of Automata and its applications	
	4.2	Deterministic Finite Automata (DFA) and Nondeterministic Finite Automata (NFA): Definitions, transition diagrams and Language recognizers, NFA to DFA Conversion.	
	4.3	Eliminating epsilon-transitions from NFA.	
	4.4	FSM with output: Moore and Mealy machines.	
5		**Regular Expression (RE) and Regular Grammar (RG)**	05
	5.1	Regular Grammar and Regular Expression (RE): Definition,Equivalence and Conversion from RE to RG and RG to RE.	
	5.2	Equivalence of RE and FA, Converting RE to FA and FA to RE.	
6		**Context Free Grammar (CFG) and Push Down Automata(PDA)**	07
	6.1	Grammars: Chomsky hierarchy, CFG- Definition, Sentential forms, Leftmost and Rightmost derivations.	
	6.2	Context Free languages (CFL): Parsing and Ambiguity. CFLs: Simplification and Applications.	
	6.3	Normal Forms: Chomsky Normal Form	
	6.4	PDA- Definition, Transitions (Diagrams, Functions and Tables), Design of PDA with Graphical Notation and Instantaneous Descriptions.	
Total			**39**

Text Books:

1. BernadKolman, Robert Busby, Sharon Cutler Ross, Nadeem-ur-Rehman, “DiscreteMathematical Structures”, Pearson Education.
2. C.L.Liu, “Elements of Discrete Mathematics”, Second edition 1985, McGraw-HillBook Company, Reprinted 2000.
3. John E. Hopcroft, Rajeev Motwani, Jeffery D. Ullman, “Introduction to Automata Theory, Languages andComputation‖”, Pearson Education.
4. Vivek Kulkarni, “Theory of Computation”, Oxford University Press, India.

Reference Books:

1. K.H.Rosen, “Discrete Mathematics and applications”, fifth edition 2003, Tata McGraw Hill publishing Company.
2. Y N Singh, “Discrete Mathematical Structures”, Wiley-India.
3. J .L.Mott, A.Kandel, T.P .Baker, Discrete Mathematics for Computer Scientists and Mathematicians, second edition 1986, Prentice Hall of India.
4. J. P. Trembley, R. Manohar “Discrete Mathematical Structures with Applications to Computer Science”, Tata McGraw-Hill.
5. Seymour Lipschutz, Marc Lars Lipson,“ Discrete Mathematics” Schaum’s Outline, McGraw Hill Education.
6. Daniel I. A. Cohen,” Introduction to Computer Theory”, Wiley Publication.
7. Michael Sipser, “Theory of Computation”, Cengage learning.
8. J. C. Martin, “Introduction to Languages and the Theory of Computation”, Tata McGraw Hill.
9. Krishnamurthy E. V., “Introductory Theory of Computer Science”, East-West Press.
10. Kavi Mahesh, “Theory of Computation: A Problem Solving Approach“, Wiley-India.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered as the final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 401	Electronic Circuits Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical & Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL 401	Electronic Circuits Lab	--	--	--	--	--	25	25	50

Pre-requisite:
Electronic Devices Laboratory (ECL 302)

Laboratory Objectives:
1. To deliver a hands-on approach for studying electronic circuits using electronic devices
2. To practically analyze& compute performance parameters of various electronic circuits
3. To familiarize with principles of designing of practical electronic circuits as per given specifications
4. To develop overall approach for students from selection of integrated circuit, specification, functionality and applications

Laboratory Outcomes:
After successful completion of the laboratory students will be able to

1. Experimentally evaluate performance of amplifiers through frequency response.
2. Analyze differential amplifiers for various performance parameters
3. Implement practically various applications and circuits based on operational amplifiers.
4. Design an application with the use of integrated circuits as per the given specifications

Term Work:

At least 10 experiments covering entire syllabus of ECC 402 (Electronic Circuits) should be set to have well predefined inference and conclusion. **This must include 60% Hardware and 40% Simulation experiments.** The experiments should be student centric and attempt should be made to make experiments meaningful and interesting. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments:

Sr. No.	Experiment Name
1	To implement single stage MOSFET CS amplifier and study its frequency response
2	To implement Cascode amplifier and study its frequency response.
3	To determine input and output impedance of CS amplifier with and without feedback.
4	Experiment on op amp parameters
5	Experiment on design of application using op amp
6	Experiment on applications of opamp-comparator, zero crossing detector.
7	To perform an experiment to study the performance of RC phase shift oscillator.
8	To perform an experiment to study the performance of Crystal oscillator.
9	Experiment on ADC interfacing
10	Experiment on DAC interfacing

Simulation Experiments

Sr. No.	Experiment Name
1	SPICE simulation of frequency response of single stage CS MOSFET amplifier.
2	SPICE simulation of frequency response of Cascode amplifier
3	SPICE simulation on op amp parameters
4	SPICE simulation on design of application using op amp
5	SPICE simulation of applications of Opamps -Comparator, Zero crossing detector
6	SPICE simulation of RC phase shift oscillator.
7	SPICE simulation of Wien Bridge oscillator.
8	SPICE simulation of Crystal oscillator.

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 402	Controls and Instrumentation Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL 402	Controls and Instrumentation Lab.	--	--	--	--	25	--	25	50

Laboratory Objectives:

1. To determine the performance of control systems
2. To determine the stability of control systems
3. To understand the applications of instrumentation systems.

Laboratory Outcomes:

After successful completion of the course students will be able to

1. Simulate the performance of control systems
2. Analyse the stability of control systems via simulations
3. Develop the applications of Instrumentation systems

Term Work:

At least 10 experiments covering entire syllabus of Controls and Instrumentation (ECC 403) should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments meaningful and interesting. **Additionally, an Industrial Visit to any relevant industry is compulsory**. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments:

Sr. No.	Experiment Name
1	Obtain the transient response and time domain parameters for first and second order control systems. (using trainer kits or simulation)
2	Determine step and impulse response for Type '0', Type '1', and Type '2' systems. (Using trainer kits or simulation)
3	Determine root locus plot for second order system using simulation (MATLAB/ Scilab) and obtain controller domain specification parameters. (verify results theoretically)
4	Determine Bode plot using MATLAB/Scilab for second order control system and obtain frequency domain specification parameters. (verify results theoretically)
5	Analyze the effect of PI and PD controller on system performance (using trainer kits/MATLAB/Scilab)
6	Displacement measurement using LVDT.
7	Temperature measurement using thermistor, thermocouple and RTD.
8	Displacement measurement using capacitive transducer.
9	Pressure Measurement using Strain Gauge
10	Modification of Single channel DAS to Multichannel DAS
11	Demonstration of the SCADA system using open Source software
12	Design of 4-20 mA current loop
13	Use of any Industrial interface/BUS for effective communication.

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL403	Microprocessors and Microcontrollers Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECL 403	Microprocessors and Microcontrollers Lab	-	-	-	-	25	25	50

Laboratory Objectives:

1. To write Assembly language programs for Microprocessors and Microcontrollers for various applications.
2. To know the importance of different peripheral devices and their interfacing to 8086 and 8051.

Laboratory Outcomes:

After successful completion of the laboratory students will be able to

1. To develop programming skills for Microprocessors and Microcontrollers
2. To interface various devices in Microprocessor and Microcontroller systems

Term Work:

At least 10 experiments covering entire syllabus of Microprocessors and Microcontrollers **(ECC 404)**should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments meaningful and interesting. Simulation experiments are also encouraged. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments:

Sr. No.	Experiment Name
1	Arithmetic Operations(using 8086)
2	Logical Operations(using 8086)
3	BCD Operations(using 8086)
4	Arrange block of data in Ascending /Descending order (using 8086)
5	32 Bit multiplication (using 8086)
6	Password verification (using 8086)
7	String operations (Reversing of string and Palindrome) (using 8086)
8	Code conversions (using 8086)
9	Serial port programming of 8051
10	Applications of Timers of 8051
11	LCD Interfacing (using 8051)
12	Sensor interfacing using an ADC (using 8051)
13	Generation of different waveforms using DAC (using 8051)
14	Speed Control of DC Motor (using PWM) (using 8051)
15	Stepper Motor Interfacing (using 8051)

Note:
Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 404	Skill Base Lab: *Python Programming*	--	01$ + 03	--	--	02	--	02

$ One-hour theory per week for the complete class. (For simplifying its implementation, 2hrs. theory on alternate weeks can be conducted)

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL404	Skill-Based Lab: Python Programming	--	--	--	--	--	50	--	50

Course pre-requisite:

ECL 304 – Skill Lab: C++ and Java Programming

Course Objectives:

1. Describe the core syntax and semantics of Python programming language.
2. Explore file handling in Python
3. Infer the Object-oriented Programming concepts in Python
4. Formulate GUI Programming and Databases operations in Python
5. Develop applications using variety of libraries and functions

Course Outcomes:

After successful completion of the course student will be able to;

1. Describe syntax and semantics in Python
2. Illustrate different file handling operations
3. Interpret object-oriented programming in Python
4. Design GUI Applications in Python
5. Express proficiency in the handling Python libraries for data science
6. Develop machine learning applications using Python.

Module No.	Unit No.	Content	Hrs.
1		**Introduction to Python**	06
	1.1	Introduction to Python, Installation and resources, Identifiers and Keywords, Comments, Indentation and Multi-lining, Variables (Local and Global), data types, Arithmetic, Comparative, Logical and Identity Operators, Bitwise Operators, Expressions, Print statement and Formats, Input Statements in python.	
	1.2	Strings, Lists, Tuples, Dictionaries, Sets, Accessing Elements, Properties, Operations and methods on these data structures.	
	1.3	Decision Flow Control Statement: if and else statement, Nested If statement, Loop Statement: While Loop, do and while loop, for loop statement, Continue, Break and pass Statement, Conditional Statements.	
2		**Functions and File I/O Handling**	06
	2.1	Functions: Built-in-functions, library functions, Defining and calling the functions, Return statements, Passing the arguments, Lambda Functions, Recursive functions, Modules and importing packages in python code.	
	2.2	File Input/Output: Files I/O operations, Read / Write Operations, File Opening Modes, with keywords, Moving within a file, Manipulating files and directories, OS and SYS modules.	
3		**Object Oriented Programming**	08
	3.1	Classes and Objects, Public and Private Members, Class Declaration and Object Creation, Object Initialization, Class Variables and methods, Accessing Object and Class Attributes.	
	3.2	Intricacies of Classes and Objects, Inheritance, Constructor in Inheritance, Exception Handling, Link list, Stack, Queues.	
4		**Graphical User Interface and Image processing**	08
	4.1	Graphical User Interface using Tkinter Library module, creating simple GUI; Buttons, Labels, entry fields, widget attributes.	
	4.2	Database: Sqilite database connection, Create, Append, update, delete records from database using GUI.	
	4.3	Basic Image Processing using OpenCV library, simple image manipulation using image module.	
5		**Numpy, Pandas, Matplotlib, Seaborn, Scipy**	10
	5.1	Introduction to Numpy, Creating and Printing Ndarray, Class and Attributes of Ndarray, Basic operation, Copy and view, Mathematical Functions of Numpy.	
	5.2	Introduction to Pandas, Understanding Dataframe, View and Select Data, Missing Values, Data Operations, File read and write operation.	
	5.3	Introduction to Matplotlib library, Line properties, Plots and subplots, Types of Plots, Introduction to Seaborn.	
	5.4	Introduction to Scipy, Scipy Sub packages – Integration and Optimization, Eigen values and Eigen Vectors, Statistic, Weave and IO.	

6		**Python Applications**	10
	6.1	GUI based applications	
	6.2	Applications in Image Processing, Networking	
	6.3	Machine Learning, Linear Regression, Logistic Regression	
	6.4	Classification using K nearest neighbor	
	6.5	Support Vector Machines	
Total			**48**

Text Books:

1. YashvantKanetkar, “Let us Python: Python is Future, Embrace it fast”, BPB Publications; 1st edition (8 July 2019).
2. Dusty Phillips, “Python 3 object-oriented Programming”, Second Edition PACKT Publisher, August 2015.
3. John Grayson, “Python and Tkinter Programming”, Manning Publications (1 March 1999).
4. Core Python Programming, Dr. R. Nageswara Rao, Dreamtech Press
5. Beginning Python: Using Python 2.6 and Python 3.1. James Payne, Wrox publication
6. Introduction to computing and problem solving using python, E Balagurusamy, McGraw Hill Education

Reference books:

1. Eric Matthes, “Python Crash Course A hands-on, Project Based Introduction to programming” No Starch Press; 1st edition (8 December 2015).
2. Paul Barry, “Head First Python” O'Reilly; 2nd edition (16 December 2016)
3. Zed A. Shaw, “Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly
4. Beautiful World of Computers and Code”, Addison Wesley; 3rd edition (1 October 2013).
5. Andreas C. Mueller, “Introduction to Machine Learning with Python”, O’Reilly; 1st edition (7 October 2016)
6. David Beazley, Brian K. Jones, “Python Cookbook: Recipes for Mastering Python 3”, O'Reilly Media; 3rd edition (10 May 2013).
7. Bhaskar Chaudhary, “Tkinter GUI Application Development Blueprints: Master GUI
8. Programming in Tkinter as you design, implement, and deliver 10 real world application”, Packt Publishing (November 30, 2015)

Software Tools:

- Python IDE: https://www.python.org/downloads/
- Anaconda Environment: https://www.anaconda.com/distribution/

Online Repository:

1. Github
2. Python 3 Documentation: https://docs.python.org/3/

3. "The Python Tutorial", http://docs.python.org/release/3.0.1/tutorial/
4. http://spoken-tutorial.org
5. Python 3 Tkinter library Documentation: https://docs.python.org/3/library/tk.html
6. Numpy Documentation: https://numpy.org/doc/
7. Pandas Documentation: https://pandas.pydata.org/docs/
8. Matplotlib Documentation: https://matplotlib.org/3.2.1/contents.html
9. Scipy Documentation: https://www.scipy.org/docs.html
10. Machine Learning Algorithm Documentation: https://scikit-learn.org/stable/
11. https://nptel.ac.in/courses/106/106/106106182/

Sr. No.	Problem Statement	Module No.
1	1. Write python programs to understand expressions, variables, quotes, basic math operations, list, tuples, dictionaries, arrays etc. 2. Write Python program to implement byte array, range, set and different STRING Functions (len, count, lower, sorted etc) 3. Write Python program to implement control structures. 4. Assume a suitable value for distance between two cities (in km). 5. Write a program to convert and print this distance in meters, feet, inches and centimeter. 6. Write a program to carry out the following operations on the given set 7. s = {10, 2, -3, 4, 5, 88} a) Number of items in sets s b) Maximum element in sets s c) Minimum element in sets s d) Sum of all elements in sets s e) Obtain a new sorted set from s, set s remaining unchanged f) Report whether 100 is an element of sets s g) Report whether -3 is not an element of sets s.	Module 1
2	1. Write python program to understand different File handling operations 2. Create 3 lists – a list of names, a list of ages and a list of salaries. 3. Generate and print a list of tuples containing name, age and salary from the 3 lists. From this list generate 3 tuples – one containing all names, another containing all ages and third containing all salaries.	Module 2
3	1. Write Python program to implement classes, object, Static method and inner class 2. If any integer is given as in input through the keyboard, write a program to find whether it is odd or even number. 3. If ages of Ram, Shyam, and Ajay are given as an input through the keyboard, write a program to determine the youngest of the three. 4. Write a program that prints square root and cube root of numbers from 1 to 10, up to 4 decimal places. Ensure that the output is displayed in separate lines, with number center-justified and square and cube roots right-justified.	Module 3

<table>
<tr><td></td><td>5. Write a program to find the factorial value of any number enteredthrough the keyboard.
6. Write a program that defines a function count_lower_upper( ) that accepts a string and calculates the number of uppercase and lowercase alphabets in it. It should return these values as a dictionary. Call this function for some sample strings.
7. A 5-digit positive integer is entered through the keyboard, write arecursive function to calculate sum of digits of 5-digit number.</td><td></td></tr>
<tr><td>4</td><td>1. Write Python program to create, append, update, delete records from database using GUI.
2. Write Python program to obtain histogram of any image
3. Write Python Program to split color image in R,G,B and obtain
a. individual histograms.
4. Write Python program for histogram equalization
5. Write Python Program for edge detection
6. Write Python Program for image segmentation
7. Write Python program to implement GUI Canvas application using Tkinter
8. Write Python program to implement GUI Frame application using Tkinter</td><td>Module 4</td></tr>
<tr><td>5</td><td>1. Write Python program to study define, edit arrays and perform arithmetic operations.
2. Write python program to study selection, indexing, merging, joining, concatenation in data frames
3. Evaluate the dataset containing the GDPs of different countries to:
a) Find and print the name of the country with the highest GDP
b) Find and print the name of the country with the lowest GDP
c) Print text and input values iteratively
d) Print the entire list of the countries with their GDPs
e) Print the highest GDP value, lowest GDP value, mean GDP value, standardized GDP value, and the sum of all the GDPs
4. Analyze the Federal Aviation Authority (FAA) dataset using Pandas to do the following:
a) View: aircraft make name, state name, aircraft model name, text information, flight phase, event description type, fatal flag
b) Clean the dataset and replace the fatal flag NaN with “No”.
c) Find the aircraft types and their occurrences in the dataset
d) Remove all the observations where aircraft names are not available
e) Display the observations where fatal flag is “Yes”
5. Analyze the “auto mpg data” and draw a pair plot using seabornlibrary for mpg, weight, and origin.
(a) Origin: This dataset was taken from the StatLib library maintained at Carnegie Mellon University.
• Number of Instances: 398
• Number of Attributes: 9 including the class attribute
• Attribute Information:
• mpg: continuous
• cylinders: multi-valued discrete
• displacement: continuous</td><td>Module 5</td></tr>
</table>

	• horsepower: continuous • weight: continuous • acceleration: continuous • model year: multi-valued discrete • origin: multi-valued discrete • car name: string (unique for each instance) 6. Write python program to use SciPy to solve a linear algebraproblem. 7. There is a test with 30 questions worth 150 marks. The test has twotypes of questions: 1. True or false – carries 4 marks each 2. Multiple-choice – carries 9 marks each. Find the number of true or false and multiple-choice questions.	
6	1. Write python program to study linear regression 2. Write python program to study multiple linear regression 3. Write python program to study logistic regression 4. Write python program to study Support Vector Machine 5. Write python program to study decision tree algorithm 6. Write python program to study two-way communication between client and server.	Module 6

Suggested list of course projects:

- Speed typing Test using Python
- Music player in Python
- Calculator app using tkinter
- Train announcement system using python
- Dice rolling simulator
- Expense tracker
- Contact book using python
- Develop classification model using freely available datasets
- Develop python application for sentiment analysis

Note:

Suggested List of Experiments is indicative. However, flexibilities lies with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Term Work:

At least 12 experiments and 1 course project should be performed. Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per "Credit and Grading System" manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

Course Code	Course Name	Credits
ECM 401	Mini Project - 1B	02

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal Assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECM 401	Mini Project-1B	--	--	--	--	--	25	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentalsto attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:

Learner will be able to…

1. Identify problems based on societal /research needs.
2. Apply Knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/ experimental/simulations.
5. Analyse the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity;however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
  - First shall be for finalisation of problem
  - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
  - First review is based on readiness of building working prototype to be conducted.
  - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
  - Identification of need/problem
  - Proposed final solution
  - Procurement of components/systems
  - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
  - First shall be for finalisation of problem and proposed solution
  - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project:

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on the following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

AC- 29/06/2021
Item No. - 6.14

UNIVERSITY OF MUMBAI

Program: Bachelor of Engineering in Electronics & Computer Science

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20
Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC – 29/06/2021

Item No. – 6.14

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Third Year BE in Electronics & Computer Science**
2	Eligibility for Admission	**Second Year Engineering passed in line with the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 Semesters**
6	Level	~~Certificate/Diploma~~/UG/~~PG~~ **(Strike out which is not applicable)**
7	Pattern	**Semester**/~~Yearly~~ **(Strike out which is not applicable)**
8	Status	**Revised**/~~New~~ **(Strike out which is not applicable)**
9	To be implemented from Academic Year	**With effect from Academic Year: 2021-2022**

Date: Signature:

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, the Faculty of Science and Technology (in particular Engineering), of University of Mumbai, has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes, understand the depth and approach of the course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process. However, content of courses is to be taught in 12-13 weeks and the remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum was more focused on providing information and knowledge across various domains of the said program, which led to heavily loading students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of the entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum, skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of the curriculum proposed in the present revision is in line with the AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and implementation of online contents from NPTEL/ SWAYAM Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time, in particular Revised syllabus of ‘C ‘scheme, wherever possible, additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In earlier revisions of the curriculum in the years 2012 and 2016, in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum, overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HOD’s/ Faculties of all the institutes are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses and on successful completion, they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

Technical education in the country is undergoing a paradigm shift in current days. Think tank at national level are deliberating on the issues, which are of utmost importance and posed challenge to all the spheres of technical education. Eventually, impact of these developments was visible and as well adopted on bigger scale by almost all universities across the country. These are primarily an adoption of CBCS (Choice base Credit System) and OBE (Outcome based Education) with student centric and learning centric approach. Education sector in the country, as well, facing critical challenges, such as, the quality of graduates, employability, basic skills, ability to take challenges, work ability in the fields, adoption to the situation, leadership qualities, communication skills and ethical behaviour. On other hand, the aspirants for admission to engineering programs are on decline over the years. An overall admission status across the country is almost 50%; posing threat with more than half the vacancies in various colleges and make their survival difficult. In light of these, an All India Council for Technical Education (AICTE), the national regulator, took initiatives and enforced certain policies for betterment, in timely manner. Few of them are highlighted here, these are design of model curriculum for all prevailing streams, mandatory induction program for new entrants, introduction of skill based and inter/cross discipline courses, mandatory industry internships, creation of digital contents, mandate for use of ICT in teaching learning, virtual laboratory and so on.

To keep the pace with these developments in Technical education, it is mandatory for the Institutes & Universities to adopt these initiatives in phased manner, either partially or in toto. Hence, the ongoing curriculum revision process has a crucial role to play. The BoS of Electronics Engineering under the faculty of Science & Technology, under the gamut of Mumbai University has initiated a step towards adoption of these initiatives. We, the members of Electronics Engineering Board of Studies of Mumbai University feel privileged to present the revised version of curriculum for Electronics & Computer Science program to be implemented from academic year 2020-21. Consent was also extended by BoS Computer Science for this curriculum. Some of the highlights of the revision are;

i. Curriculum has been framed with reduced credits and weekly contact hours, thereby providing free slots to the students to brain storm, debate, explore and apply the engineering principles. The leisure provided through this revision shall favour to inculcate innovation and research attitude amongst the students.
ii. New skill based courses have been incorporated in curriculum keeping in view AICTE model curriculum.
iii. Skill based Lab courses have been introduced, which shall change the thought process and enhance the programming skills and logical thinking of the students
iv. Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the group dynamics, develop leadership qualities, facilitate decision making and enhance problem solving ability with focus towards socio-economic development of the country. In addition, it shall be direct application of theoretical knowledge in practice, thereby, nurture learners to become industry ready and enlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystem with better means.
v. An usage of ICT through NPTEL/SWAYAM and other Digital initiatives of Govt. of India shall be encouraged, facilitating the students for self-learning and achieve the Graduate Attribute (GA) specified by National Board of accreditation (NBA) i.e. lifelong learning.

Thus, this revision of curriculum aimed at creating deep impact on the teaching learning methodology to be adopted by affiliating Institutes, thereby nurturing the students fraternity in a multifaceted directions and create competent technical manpower with legitimate skills. In time to come, these graduates shall shoulder the responsibilities of proliferation of future technologies and support in a big way for 'Make in India' initiative a reality. In the process, BoS, Electronics Engineering got whole hearted support from all stakeholders including faculty, Heads of department of affiliating institutes, experts faculty who detailed out the course contents, alumni, industry experts and university official providing all procedural support time to time. We put on record their involvement and sincerely thank one and all for contribution and support extended for this noble cause.

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Boards of Studies in Electronics Engineering

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. R. N. Awale	Chairman	5	Dr. Rajani Mangala	Member
2	Dr. Jyothi Digge	Member	6	Dr. Vikas Gupta	Member
3	Dr. V. A. Vyawahare	Member	7	Dr. D. J. Pete	Member
4	Dr. Srija Unnikrishnan	Member	8	Dr. Vivek Agarwal	Member

Program Structure for Third Year Electronics Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester V

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ECC 501	Communication Engineering	3	-	-	3	-	-	3
ECC 502	Computer Organization and Architecture	3	-	-	3	-	-	3
ECC 503	Software Engineering	3	-	-	3	-	-	3
ECC 504	Web Technologies	3	-	-	3	-	-	3
ECC DO501	Department Optional (Course - I)	3	-	-	3	-	-	3
ECL501	Communication Engineering Lab	-	2			1		1
ECL502	Software Engineering and Web Technologies Lab	-	2	-	-	1	-	1
ECL503	Department Optional (Course - I) Lab	-	2	-	-	1	-	1
ECL504	Professional Communication and Ethics-II	-	4	-	-	2	-	2
ECM501	Mini project - 2A	-	4$	-	-	2	-	2
Total		15	14	-	15	7	-	22

**Theory class; $ indicates workload of learner (Not faculty), for mini-project*

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Av					
ECC 501	Communication Engineering	20	20	20	80	03	-	-	100
ECC 502	Computer Organization and Architecture	20	20	20	80	03	-	-	100
ECC 503	Software Engineering	20	20	20	80	03	-	-	100
ECC 504	Web Technologies	20	20	20	80	03	-	-	100
ECC DO501	Department Level Optional Course - I	20	20	20	80	03	-	-	100
ECL501	Communication Engineering Lab	-	-	-	-	-	25	25	50
ECL502	Software Engineering and Web Technologies lab	-	-	-	-	-	25	25	50
ECL503	Department Optional Course -I lab	-	-	-	-	-	25	25	50
ECL504	Professional Communication and Ethics-II	-	-	-	-	-	25	25	50
ECM501	Mini project - 2A						25	25	50
Total				100	400	-	150	100	750

Department Level Optional Course - I (DO 501):

1. Software Testing and Quality Assurance	**3.** Information Theory and Coding
2. ASIC Verification	**4.** Sensors and Applications

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 501	Communication Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg. of Test 1 and Test 2						
ECC 501	Communication Engineering	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

- ECC 301 Applied Mathematics-III
- ECC 401 Applied Mathematics-IV
- ECC 303 Digital Electronics
- ECC 302 Electronic Devices

Course Objectives:

1. To understand and analyse the need for various analog modulation techniques
2. To analyse the characteristics of the receivers
3. To understand pulse modulation methods
4. To understand the effect of ISI in Baseband transmission of a digital signal
5. To analyse various Digital modulation techniques

Course Outcomes:

After successful completion of the course students will be able to:

1. Analyse various analog modulation methods.
2. Explain various pulse modulation techniques.
3. Evaluate the impact of Inter Symbol Interference in Baseband transmission and methods to mitigate its effect.
4. Compare various Digital modulation methods based on spectral efficiency, Euclidean distance etc
5. Analyse the characteristics of radio receivers

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Electronic Communication**	04
	1.1	Electromagnetic Spectrum	
	1.2	Block diagram of Analog communication system	
	1.3	Need for modulation	
	1.4	Types of Noise, Signal-to-noise ratio, Noise factor, Noise Figure, Noise Temperature	
2		**Analog Modulation Systems**	12
	2.1	Principle of Amplitude Modulation (AM): Representation of AM wave (Mathematical & Graphical), Frequency spectrum of AM wave, AM Power Distribution, AM for a Complex Modulating Signal	
	2.2	Types of AM: Generation of DSB-SC using diode based balanced modulator, Generation of SSB using phase shift method	
	2.3	Principles of Angle Modulation: Theory of Frequency Modulation (FM) & Phase Modulation (PM) - Basic Concepts, Spectrum Analysis of FM Wave, Noise triangle, Pre-emphasis, De-emphasis	
	2.4	Comparison of AM, FM and PM	
3		**Radio Transmitters and Receivers**	04
	3.1	Radio Transmitters: Block diagram of AM & FM transmitters	
	3.2	Radio receivers: Receiver Characteristics, Superheterodyne Receiver, diode detector, Automatic gain control (AGC), Automatic frequency control (AFC)	
4		**Pulse Modulation**	05
	4.1	Sampling theorem and quantization of signals	
	4.2	Generation and Detection of Pulse Amplitude Modulation (PAM)	
	4.3	Pulse Code Modulation (PCM), and Delta Modulation (DM)	
	4.4	Multiplexing Techniques: Time Division Multiplexing (TDM):T1 carrier system, Frequency Division Multiplexing (FDM)	
5		**Pulse Shaping for Optimum Transmission**	04
	5.1	Line codes and their desirable properties, PSD of digital data	
	5.2	Concept of Inter symbol interference (ISI), Eye diagram: Quality Factor and BER, Nyquist Bandwidth	
	5.3	Types of equalizers: Linear equalizer	
	5.4	Correlative coding: Duo-binary encoding and modified duo-binary encoding	
6		**Digital Modulation Techniques**	10
	6.1	Bandpass digital transmitter and receiver model	
	6.2	Generation, detection, signal space diagram, power spectral density and spectrum efficiency analysis of: Binary Phase Shift Keying (BPSK), Quaternary Phase Shift Keying (QPSK), M-ary PSK, Binary Amplitude Shift Keying (BASK), Quadrature Amplitude Modulation (QAM), Binary Frequency Shift Keying (BFSK), Minimum Shift Keying (MSK).	
		Total	**39**

Text Books:

1. Simon Haykin, “*Communication System*”, John Wiley And Sons ,4th Ed

2. Taub Schilling & Saha, "*Principles Of Communication Systems*", Tata Mc-Graw Hill, Third Ed
3. Kennedy and Davis "Electronics Communication System", Tata McGraw Hill
4. T. L. Singal, "Analog and Digital Communication," Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
5. Sklar B, and Ray P. K., "Digital Communication: Fundamentals and Applications," Pearson, Dorling Kindersley (India), Delhi, Second Edition, 2009.

Reference Books:

1. Bernad Sklar,- "Digital communication", Pearson Education, 2nd Ed.
2. Simon Haykin, "Digital communication", John Wiley and sons
3. Wayne Tomasi, "Electronics Communication Systems" Pearson Education, Third Edition, 2001.
4. R P Singh &S. Sapre, "Analog and Digital Communication", Tata McGraw Hill 2nd Ed.
5. Haykin Simon, "Digital Communication Systems," John Wiley and Sons, New Delhi, Fourth Edition, 2014.
6. Proakis & Salehi, "Communication System Engineering", Pearson Education.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 502	Computer Organization and Architecture	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC 502	Computer Organization and Architecture	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

1. Digital Electronics
2. Fundamental concepts of processing
3. Data structures

Course Objectives:

1. To introduce the learner to the design aspects which can lead to maximized performance of a Computer.
2. To introduce basic concepts and functions of operating systems.
3. To understand the concepts of process synchronization and deadlock.
4. To understand various Memory, I/O and File management techniques
5. To introduce the learner to various concepts related to Parallel Processing
6. To highlight the various architectural enhancements in modern processors.

After successful completion of the course students will be able to:

1. Define the performance metrics of a Computer
2.Explain the design considerations of Processor, Memory and I/O in Computer systems
3.Interpret the objectives and functions of an Operating System
4 Analyze the concept of process management and evaluate performance of process scheduling algorithms
5. Evaluate the advantages and limitations of Parallelism in systems
6. Discuss the various architectural enhancements in modern processors

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Computer Organization**	02
	1.1	Fundamental Units of a Computer, Basic Measures of Computer Performance - Clock Speed, CPI, MIPs and MFlops	
	1.2	Number Representation methods- Integer and Floating-point	
2		**Processor Organization and Architecture**	05
	2.1	CPU Architecture, Register Organization, Instruction cycle, Instruction Formats	
	2.2	Control Unit Design- Hardwired and Micro-programmed Control: Vertical and Horizontal Micro-Instructions, Nano-programming	
	2.3	Comparison between CISC and RISC architectures	
3		**Memory and I/O Organization**	09
	3.1	Classification of Memories-Primary and Secondary Memories, ROM and RAM, Memory Inter- leaving	
	3.2	Memory Hierarchy, Cache Memory Concepts, Mapping Techniques, Write Policies, Cache Coherency	
	3.3	Virtual Memory Management-Concept, Segmentation, Paging, Page Replacement policies	
	3.4	Types of I/O devices and Access methods, Types of Buses, Bus Arbitration	15
4		**Operating System concepts**	
	4.1	Concept of a Process, Process States, Process Description, Process Control Block	
	4.2	Process scheduling -Pre-emptive and Non pre-emptive scheduling algorithms (FCFS, Priority, SJF), Concept of Multi-Threading	
	4.3	Inter-Process Communication, Process Synchronization, Deadlock and Prevention	
	4.4	File Management -File Organization and Access	
	4.5	I/O Management and Disk Scheduling: FCFS, SSTF	
5		**Parallelism**	04
	5.1	Introduction to Parallel Processing Concepts, Flynn's classification, Amdahl's law	
	5.2	Pipelining - Concept, Speedup, Efficiency, Throughput, Types of Pipeline hazards and solutions	
6		**Architectural Enhancements**	04
		Superscalar Architectures, Out-of-Order Execution, Multi-core processors, Clusters, GPU	
		Total	**39**

Text Books:

1. William Stallings, "*Computer Organization and Architecture: Designing for Performance*", Eighth Edition, Pearson.
2. C. Hamacher, Z. Vranesic and S. Zaky, "Computer Organization", McGraw Hill,2002.
3. William Stallings, Operating System: Internals and Design Principles, Prentice Hall, 8th Edition
4. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, John Wiley &Sons, Inc., 9th Edition,

Reference Books:

1. P. Hayes, "Computer Architecture and Organization", McGraw-Hill,1998.
2. B. Govindarajulu, "*Computer Architecture and Organization: Design Principles and Applications*", Second Edition, Tata McGraw-Hill.
3. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", MorganKaufmann,1998.
4. Achyut Godbole and Atul Kahate, Operating Systems, McGraw Hill Education, 3rd Edition
5. Andrew Tannenbaum, Operating System Design and Implementation, Pearson, 3rd Edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 503	Software Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC 503	Software Engineering	20	20	20	80	03	--	--	--	100

Course Pre-requisites:

1. Knowledge of Software Application Domains, Software Engineering Practices.
2. Knowledge of any Programming Language

Course Objectives:

1. To learn the basics of software engineering and software development process models, agile software development and other agile practices.
2. To Identify, Specify, analyse Software Requirements and prepare model.
3. To understand concepts and principles of software design and Development.
4. To learn about Project Scheduling concept and Software Cost Estimation Techniques.
5. To understand concept of software quality assurance and Risk Management.
6. To learn different software testing strategies and tactics.

Course Outcomes:
After successful completion of the course Students will be able to:

1. Apply software engineering concept and choose process models for a software project development.
2. Analyse and specify software requirement specification (SRS) for software system.
3. Convert requirement model into the design model and demonstrate the use of software and user-interface design principles.
4. Generate the project schedule and estimate the cost of software system.
5. Identify risks and prepare RMMM plan for quality software system.
6. Apply testing strategies and tactics for software system.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Software Engineering and Process Models**	7
	1.1	Nature of Software, Software Process framework	
	1.2	Prescriptive Models: Waterfall Model, Incremental, RAD Models Evolutionary Process Models: Prototyping, Spiral and Concurrent Development Model. Specialized Models: Component based	
	1.3	Agile process, Agility Principles, Extreme Programming (XP), Scrum.	
2		**Requirement Engineering and Modelling**	8
	2.1	Types of Requirements, Requirement Engineering Task, Software Requirement Specification (SRS), Developing Use Cases (UML)	
	2.2	Requirement Model: Scenario-based model, Class-based model, Behavioural model.	
3		**Design Engineering**	6
	3.1	Design Concepts, Design Principles	
	3.2	Architecture Design, Component Level Design, System Level Design, User Interface Design	
4		**Project scheduling & Cost Estimation**	6
	4.1	Project Scheduling, defining a Task Set for the Software Project, Gantt charts, Program Evaluation Review Techniques (PERT), Tracking the Schedule	
	4.2	Software Project Estimation, Decomposition Techniques, LOC based, FP based and Use case-based estimations, Empirical estimation Models. COCOMO II Model.	
5		**Software Risk &Quality Management**	6
	5.1	Software Risk, Types of Risk, Risk Identification, Risk Assessment, Risk Projection, RMMM.	
	5.2	Software Quality Assurance Task and Plan, McCall's Quality Factors, Software Reliability, Formal Technical Review (FTR), Walkthrough	
6		**Software Testing Strategies and Tactics**	6
	6.1	Software Testing Fundamentals, Testing strategies for conventional and Object-Oriented architectures, Unit testing, Integration testing, System Testing, Validation and System Testing.	
	6.2	Testing Tactics: White-Box Testing, Basis Path Testing, Control Structure Testing, Black-Box Testing.	
		Total	**39**

Text Books:

1. Roger S Pressman "Software Engineering: A Practitioner's Approach" 8th Edition McGraw-Hill, ISBN:978-0-07-802212-8
2. Pankaj Jalote, "An integrated approach to Software Engineering", Springer/Narosa

Reference Books:

1. Ian Sommerville, “Software Engineering”, Pearson Education (9th edition)
2. Jibitesh Mishra and Ashok Mohanty, “Software Engineering”, Pearson edition
3. Rajib Mall, "Fundamentals of Software Engineering", Prentice Hall India
4. Hans Van Vilet, “Software Engineering Principles and Practice” 3rd edition Wiley

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus where in sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC504	Web Technologies	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC504	Web Technologies	20	20	20	80	03	--	--	-	100

Course Pre-requisite: Basics of programming languages, basic knowledge of HTML

Course Objectives:

1. To design and create web pages using HTML5 and CSS3.
2. To implement client-side scripting to static web pages.
3. To create dynamic web pages using server-side scripting.
4. To use MVC framework for web application development.

Course Outcomes:

After successful completion of the course students will be able to:

1. Design static web pages using HTML5.
2. Design the layout of web pages using CSS3.
3. Apply the concepts of client-side validation and scripts to static web pages using JavaScript and JQuery.
4. Build responsive web pages using front-end framework Bootstrap.
5. Build dynamic web pages using server -side scripting.
6. Develop a web application using appropriate web development framework.

Module	Unit No.	Contents	Hrs.
1		**Introduction to HTML5**	
	1.1	Basic structure of an HTML5 document, Creating an HTML5 document, Mark up Tags, Heading-Paragraphs, line Breaks HTML5 Tags - Introduction to elements of HTML, Working with Text, Lists, Tables and Frames, Hyperlinks, Images and Multimedia, Forms and other HTML5 controls.	4
	1.2	Self-Learning: HTML5 based game development	
2		**Static Web Page Design**	
	2.1	Concept of CSS, Creating Style Sheet, CSS Properties, CSS Styling (Background, Text Format, Controlling Fonts), Working with block elements and objects, Lists and Tables, CSS Id and Class, Box Model(Introduction, Border properties, Padding Properties, Margin properties) CSS Advanced: (Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector)	4
	2.2	Self-Learning: Creating page Layout and Site Designs	
3		**Client-side scripting**	
	3.1	**JavaScript**	
		Introduction to JavaScript, Lexical Structure, Types, Values, Variables, Expressions and Operators, Statements, Objects, Arrays, Functions, Pattern matching with regular expressions, JavaScript in Web Browsers, The Window object, Scripting Documents, Scripting CSS, Handling Events	6
	3.2	**jQuery**	
		jQuery Basics, jQuery Getters and Setters, Altering Document Structure, Handling events with jQuery, Animated Effects, Utility functions, jQuery Selectors and Selection Methods, Extending jQuery with Plug-ins, The jQuery UI Library	4
	3.3	Self-Learning: JavaScript Framework -AngularJS	
4		**Bootstrap**	
	4.1	Introduction to Bootstrap, downloading and installing Bootstrap. **The Grid System**: Introducing the Grid, Offsetting and Nesting, Responsive Features, Utility Classes, and Supported Devices. **CSS Foundations**: Typography in Bootstrap, Styling Tables, Styling Forms, Styling Buttons, Images, icons, and Thumbnails. **Navigation Systems**: Tabs, Pills, and Lists, Breadcrumbs and Pagination, Navigation Bar, Making the Navigation Bar Responsive. **JavaScript Effects**: Drop-downs, Modal Windows, Tooltips and Popovers, Navigation Aids: Tabs, Collapse, Affix, Carousel.	6
	4.2	Self-Learning: Bootstrap Customization: Combining Elements in Bootstrap, Customizing by Components, Plugins, and Variables	
5		**Server side-scripting**	
	5.1	Introduction to PHP, PHP Tags, Adding Dynamic content, Accessing form variables, Identifiers, user-declared variables, Data types, Constants,	10

		Operators, Control structures, Conditionals, Iteration constructs, Using arrays, string manipulation and regular expressions, reusing code and writing functions, Designing and creating your web database, Accessing MySQL database from the Web with PHP, Session Control in PHP.	
	5.2	Self-Learning: PHP-NoSQL Database connectivity e.g. PHP-MongoDB connectivity	
6		**Web Development Framework**	5
	6.1	MVC architecture - Introduction and applications	
		Server side-scripting – Laravel Framework Managing Your Project Controllers, Layout, Views, and Other Assets, Talking to the Database, Model Relations, Scopes, and Other Advanced Features, Integrating Web Forms, Authenticating and Managing Your Users, Deploying, Optimizing and Maintaining Your Application	
	6.2	Self-learning: Django Framework, Interactive web sites, web-based information system, blogs, social networking sites,	
		Total	**39**

Text Books:

1. Ralph Moseley, M.T. Savliya , “Developing Web Applications”, Willy India, Second Edition,
2. “Web Technology Black Book”, Dreamtech Press, First Edition, 978-7722-997
3. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition,O'REILLY,2014.(http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascript_CSS_HTML5__Robin_Nixon_3e.pdf)
4. Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward Benson, Wiley publications. **https://ebooks-it.org/0470082801-ebook.htm**
5. Jennifer Kyrnin, “SAMS Teach Yourself Bootstrap in 24 hours”, 1st edition, Pearson Education.
6. Martin Bean, “Laravel 5 Essentials”, PACKT Publishing Ltd

Reference Books:

1. Harvey & Paul Deitel& Associates, Harvey Deitel and Abbey Deitel, “Internet and World Wide Web - How To Program”, Fifth Edition, Pearson Education, 2011.
2. Achyut S Godbole and Atul Kahate, “Web Technologies”, Second Edition, Tata McGraw Hill, 2012.
3. Thomas A Powell, Fritz Schneider, “JavaScript: The Complete Reference”, Third Edition, Tata McGraw Hill, 2013.
4. David Flanagan, “JavaScript: The Definitive Guide, Sixth Edition”, O'Reilly Media, 2011
5. Steven Holzner, “The Complete Reference – PHP”, Tata McGraw Hill, 2008
6. Mike Mcgrath, “PHP & MySQL in easy Steps”, Tata McGraw Hill, 2012.
7. J. Millman and A. Grabel, “Head First HTML and CSS”, 2nd edition, O‟ Reilly.
8. Ben Frain, “Responsive Web design with HTML5 and CSS3”, PACKT Publishing Ltd.
9. L. Welling and L. Thomson, “PHP and MySQL Web Development”, 4th edition, Adison Wesley Professional.

Digital Material:

1. www.nptelvideos.in
2. www.w3schools.com
3. http://spoken-tutorial.org

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDO501	Software Testing & Quality Assurance	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical/Oral	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECCDO501	Software Testing & Quality Assurance	20	20	20	80	03	--	--	--	100

Course Pre-requisite: Programming Language (C++, Java), Software Engineering

Course Objectives:

1. To provide students with knowledge in Software Testing techniques.
2. To provide knowledge of Black Box and White Box testing techniques.
3. To provide skills to design test case plans for testing software.
4. To prepare test plans and schedules for testing projects.
5. To understand how testing methods can be used in a specialized environment.
6. To understand how testing methods can be used as an effective tool in providing quality assurance concerning software.

Course Outcomes:

After successful completion of the course students will be able to:

1. Investigate the reason for bugs and analyse the principles in software testing to prevent and remove bugs.
2. Understand various software testing methods and strategies.
3. Design test planning.
4. Manage the test process.
5. Apply the software testing techniques in the commercial environment.
6. Use practical knowledge of a variety of ways to test software and quality attributes

Module No.	Unit No.	Contents	Hrs.
1		**Testing Methodology**	8
	1.1	Introduction to Software Testing: Introduction, Goals of Software Testing, Software Testing Definitions, Model for Software Testing, Effective Software Testing vs Exhaustive Software Testing, Software Failure Case Studies	
	1.2	Software Testing Terminology and Methodology: Software Testing Terminology, Software Testing Life Cycle (STLC), Software Testing methodology	
	1.3	Verification and Validation: Verification, Verification requirements, Validation	
2		**Testing Techniques**	9
	2.1	Black Box testing: boundary value analysis, equivalence class testing, state table-based testing, cause-effect graphing based testing, error guessing.	
	2.2	White box Testing Techniques: need, logic coverage criteria, basis path testing, graph matrices, loop testing, data flow testing, mutation testing, Static Testing.	
	2.3	Validation Activities: Unit validation, Integration, Function, System, Acceptance Testing.	
	2.4	Regression Testing: Progressive vs. Regressive	
3		**Managing the Test Process**	7
	3.1	Test Management: test organization, structure and of testing group, test planning, detailed test design and test specification.	
	3.2	Software Metrics: need, definition and classification of software matrices.	
	3.3	Efficient Test Suite Management: minimizing the test suite and its benefits	
4		**Test Automation**	4
	4.1	Automation and Testing Tools: need, categorization, selection and cost in testing tool,	
	4.2	Guidelines for testing tools.	
5		**Testing for specialized environment**	5
	5.1	Agile Testing, Agile Testing Life Cycle, Challenges in Agile Testing	
	5.2	Testing Object-Oriented Software: OOT Basics, Object-oriented Testing	
6		**Quality Management**	6
	6.1	Software Quality Management, McCall's quality factors and Criteria	
	6.2	ISO9000:2000, SIX Sigma	
		Total	**39**

Text Books:

1. Software Testing Principles and Practices, Naresh Chauhan, Oxford Higher Education
2. Software Testing and quality assurance theory and practice, Kshirasagar Naik, Priyadarshi Tripathy, Wiley Publication

Reference Books:

1. Effective Methods for Software Testing, Willam E. Perry, Wiley Publication, third edition
2. Software Testing Concepts and Tools, Nageswara Rao Pusuluri, Dreamtech press

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO501	ASIC Verification	03		--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical/ Oral	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO501	ASIC Verification	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Digital Electronics (ECC 303)

Course Objectives:

1. To introduce the learner System Verilog concepts for verification.
2. To provide understanding of System Verilog and SVA for verification, and understand the improvements in verification efficiency.
3. To introduce the learner advanced verification features such as practical use of classes, randomization, checking and coverage.
4. To highlight the significance of verification in VLSI industry.

Course Outcomes:

After successful completion of the course students will be able to:

1. Demonstrate an understanding of programmable devices and verification methodologies.
2. Exploit new constructs in System Verilog.
3. Summarize ASIC verification techniques such as Randomization, assertions, coverage etc.
4. Create layered test benches for digital designs in system Verilog.
5. Carry out verification of design successfully using simulators.

Module No.	Unit No.	Contents	Hrs.
1		**Programmable Devices and Verification Basics**	7
	1.1	**Programmable Devices**: Different types of Integrated Circuits- CPLD, FPGA, ASIC, SoC (System-on-Chip), SiP (System-in-Package), MCM (Multi-Chip Module), SoP (System-on-Package), Choices based on application and cost, Architecture of FPGA, CPLD (Xilinx and Altera family devices) , Difference between ASIC, FPGA and CPLD, ASIC flow and overview of types of tools used in each stage of lifecycle	
	1.2	**Verification Basics**: Introduction, Verification Process, Verification Plan, Verification Methodology options, Basic Testbench Functionality, Directed Testing, Constrained-Random Stimulus, Functional Coverage, Testbench Components, Layered Testbench, Technology challenges test, Verification languages, Verification IP reuse, Verification approaches.	
2		**Data types, Procedural statements, Connecting the Test bench and Design**	8
	2.1	Data Types: Built-in Data Types, Logic Data type, Fixed-Size Arrays (Packed and Unpacked arrays), Dynamic Arrays, Queues, associative array, array methods – Reduction, Locator & ordering, Creating New Types with typedef, Creating User-Defined Structures, Enumerated Types, Constants, Strings, Expression width.	
	2.2	**Procedural statements:** Procedural Statements, Tasks, Functions, and Void Functions, routine arguments, returning from a routine, Time values.	
	2.3	**Connecting the Test bench and Design:** Separating the test-bench and design, The Interface construct, Grouping Signals in an Interface using Modports, Creating Interface Monitor, Stimulus timing with Clocking Block, Test-bench design Race Condition, Program Block, Connecting it all together, Top level Scope, Program-Module interactions.	
3		**Basic Object -Oriented Programming**	6
	3.1	**OOP**: Class, Creating new objects, Where to Define a Class, OOP Terminology, Understanding Dynamic objects, Object Deallocation, using objects, Static vs Global Variables, Class methods, Defining methods outside class, Scoping rules, Using one class inside another, Understanding Dynamic objects, Copying objects, public vs. local, Building a test-bench	
4		**Randomization and Inter-process Communication**	7
	4.1	**Randomization:** Randomization in system Verilog, Constraint details, Solution probabilities, Controlling multiple constraint blocks, Valid constraints, In-line constraints, The pre-randomize and post-randomize functions, Random number functions, Constraints tips and techniques.	
	4.2	**Threads and Inter-process Communication:** Working with threads, disabling threads, inter-process communication, Events, Semaphores, Mailboxes, building a test-bench with threads and IPC.	
5		**System Verilog Assertions and Functional Coverage**	7
	5.1	**System Verilog Assertions**: Types of Assertions and examples, Immediate	

		Assertions, Concurrent Assertions, SVA Property and Sequences, Implication (Overlapped & Non-Overlapped) Operator and Repetition Operator, System Verilog Assertion built-in methods ($rose, $fell, $stable, $past)	
	5.2	**Functional Coverage**: Coverage Types, Functional Coverage Strategies, Simple Functional Coverage Example, anatomy of a cover group, triggering a cover group, data sampling, cross coverage, generic cover groups, Coverage Options, Parameterized Cover Groups, Analysing Coverage Data, Measuring Coverage Statistics During Simulation.	
6		**System Verilog Test-bench Case studies**	4
	6.1	A complete System Verilog Layered Test-Bench for the simple design of ADDER and Memory module- Test-Bench Architecture, Transaction Class, Generator Class, Interface, Driver Class, Monitor, Scoreboard, Environment, Test, Test Bench Top	
		Total	**39**

Text Books:

1. Chris Spear, "System Verilog for Verification: A guide to learning the testbench language features", Springer, 3rd Edition.
2. Janick Bergeron, "Writing Testbenches Using System Verilog", Springer 2006.
3. Stuart Sutherland, Simon Davidmann, and Peter Flake, "System Verilog for Design: A guide to using system verilog for hardware design and modeling", Springer, 2nd Edition.

Reference Books:

1. Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper, "System Verilog Assertions Handbook", Vhdl Cohen Publishing, 3rd edition
2. S Prakash Rashinkar, Peter Paterson and Leena Singh, "System on Chip Verification Methodologies and Techniques", Kluwer Academic, 1st Edition.
3. System Verilog Language Reference manual
4. Samir Palnitkar, "Verilog HDL: A guide to Digital Design and Synthesis" second edition, Pearson – IEEE 1364-2001 compliant.
5. Spartan and Virtex family user manuals from Xilinx
6. Verilog Language Reference manual

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO501	Information Theory and Coding	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO501	Information Theory and Coding	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Engineering Mathematics - IV **ECC 401**

Course Objectives:

1. To learn the principles and applications of information theory in communication systems.
2. To study various data compression methods.
3. To model the continuous and discrete communication channels.
4. To understand the theoretical framework upon which error-control codes are designed.

Course Outcomes:

After successful completion of the course students will be able to:

1. Comprehend the significance of this quantitative measure of information in the communication systems.
2. Explain entropy, joint entropy, relative entropy, conditional entropy, and channel capacity of a system.
3. Obtain knowledge in designing various source codes and channel codes.
4. Differentiate between lossy and lossless compression techniques.
5. Analyze an efficient data compression scheme for a given information source.
6. Apply the concepts of multimedia communication.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Information Theory**	07
	1.1	Introduction to Probability theory: Axiomatic definition of probability, Bayes Theorem.	

	1.2	One random variable: Types of random variable, Discrete & Continuous, PMF, PDF and Cumulative distribution Function, Conditional Probability, Independent Event.	
	1.3	Two Random Variable: Discrete and Continuous, Joint probability density function, Joint Distribution function, Marginal probabilities, joint conditional probability.	
	1.4	Concept of amount of information, information units, Entropy: marginal, conditional, joint and relative entropies.	
	1.5	Relation among entropies Mutual information, information rate.	
2		**Source Coding Techniques**	**06**
	2.1	Block Diagram of Digital Communication system.	
	2.2	Encoding techniques, Purpose of encoding, Instantaneous codes, Construction of instantaneous codes, Kraft's inequality, Coding efficiency and redundancy	
	2.3	Source coding theorem. Construction of basic source codes: Shannon Fano coding.	
	2.4	Huffman codes, Extended Huffman coding, Arithmetic Coding, Lempel - Ziv Algorithm-LZW	
3		**Information Channels**	**06**
	3.1	Information Channels: Communication Channels	
	3.2	Channel Models, Channel Matrix, Joint probability Matrix, Binary Symmetric Channel, System Entropies, Mutual Information, Channel Capacity	
	3.3	Discrete Memoryless channels: Binary Symmetric Channel (BSC), Channel Capacity of BSC, redundancy and efficiency of channels.	
	3.4	Channel Capacity: Hartley – Shannon law.	
		Codes for error detection and correction	**08**
4	**4.1**	Parity check coding, Linear block codes, Error detecting and correcting capabilities	
	4.2	Generator and Parity check matrices, Standard array and Syndrome decoding, Hamming codes.	
	4.3	Cyclic codes: Generator polynomial, Generator and Parity check matrices, Encoding of cyclic codes.	
	4.4	Syndrome computation and error detection, Decoding of cyclic codes.	
5		**Convolution Codes**	**06**
	5.1	Encoding and State, Tree and Trellis diagrams.	
	5.2	Maximum likelihood decoding of convolution codes, Viterbi algorithm, Sequential decoding -Stack algorithm.	
	5.3	Interleaving techniques: Block and convolution interleaving.	
6		**Audio and Video Coding**	**06**
	6.1	Linear Predictive coding, code excited LPC, Perceptual coding, MPEG audio coders, Dolby audio coders.	
	6.2	Video compression: Principles, Introduction to H.265& MPEG-4 Part 10 Video standards.	
		Total	**39**

Text Books:

1. Simon Haykin, *Communication Systems*, 4th Edition, John Wiley and Sons.
2. Ranjan Bose, *Information theory, coding and cryptography*, 2nd Edition,Tata McGraw-Hill.
3. R. Togneri, C.J.S deSilva, *Fundamentals of Information Theory and Coding Design*, 1st Edition,Taylor and Francis.
4. Fred Halsall, *Multimedia Communications, Applications Networks Protocols and Standards*, Pearson Education, 1st Edition, Asia.

Reference Books:

1. Bernard Sklar, *Digital Communications Fundamentals and Applications*,2nd Edition, Person Education Asia.
2. Taub and Schilling, *Principles of Communication Systems* , 2nd Edition, Tata McGraw-Hill.
3. Glover and Grant, *Digital Communication*, 2ndEdition, Pearson.
4. T. M. Cover, J. A. Thomas, *Elements of Information Theory*, 2nd Edition,Wiley.
5. Mark Nelson, *Data Compression Book*, 2nd Edition, BPB Publication.
6. Watkinson J, *Compression in Video and Audio*, 1st Edition, Focal Press, London.
7. R. J. McEliece, *The Theory of Information and Coding*, 1st Edition, Cambridge University Press.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.3.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO501	Sensors and Applications	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO501	Sensors and Applications	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

1. Concept of internal characteristics of passive elements like resistor, capacitor, inductor etc.,
2. Diode and transistor
3. Working, knowledge of basic fundamentals of mechanical terms like position, strain, stress etc

Course Objectives:

1. To understand the stages of product (hardware / software) design & development
2. To learn different considerations of analog, digital & mixed circuit design
3. To be acquainted with methods of PCB design & different tools used for the same
4. To be aware of the importance of testing in product design cycle
5. To gain knowledge about various processes & importance of documentation

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand the concept of sensors and its characteristics
2. Understand the practical approach in design of technology based on different sensors
3. Learn various sensor materials and technology used in designing sensors
4. Implement a prototype for demonstrating the application of the sensors
5. Demonstrate problem solving & troubleshooting skills in sensor applications

Module No.	Unit No.	Contents	Hrs.
1		**Sensors Fundamentals and Characteristics Sensors, Signals and Systems**	06
	1.1	Sensor Classification–Physical, Mechanical, Electrical, Chemical, electro-chemical	
	1.2	Functional unit of sensor: receptor and transducer; Units of Measurements	

	1.3	Sensor Characteristics, Physical Principles of Sensing Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements	
2		**Interface Electronic Circuits**	06
	2.1	Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits	
	2.2	Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors	
	2.3	Analog and digital filtering	
3		**Sensors in Different Applications**	08
	3.1	Area Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors	
	3.2	Temperature Sensors; Biosensors, Gas sensors, proximity sensor. (Correlation of output with the parameter being measured in engineering terms): Only Working principle of each type of sensors and transduction action (for example: detection of change in temperature and conversion to electrical quantity say resistance and corresponding correlation)	
	3.3	Case study of Applications of sensors in Automotive, Manufacturing plants, digital devices such as mobile phone, house-hold instrument such as washing machine (name of various sensors and their usability in each of these applications).	
4		**Sensor Materials and Technologies**	07
	4.1	MEMS-cantilever based sensors and their types such as, accelerometer, gyroscopes: Structure, material used (polysilicon, Silicon etc), working principle, applications.	
	4.2	Metal oxide semiconductor (nano-particles) based sensors such as gas sensors, biomedical sensors, chemical sensors (Structure, material used, working principle, applications)	
5		**Smart Sensors**	06
	5.1	4-20 mA Current Loop	
	5.2	Types of smart Sensors, Limitations of single sensor and applicability of Array-based sensor technology, Electronic-Nose sensors	
	5.3	HART, Industrial buses such as Profibus, CANbus, etc.	
6		**Industrial standards for the sensors and its calibration**	06
	6.1	Basic knowledge about IEC 60601-1-1: Medical Electrical Equipment – Part 1-1, ISA S82.01, NEMA standards	
	6.2	PCI 6.5 to SOX compliance, HIPAA compliance, and FISMA compliance in software development: Basic introduction about each of these standards, Calibration and compatibility	
		Total	**39**

Text Books:

1. Jacob Fraden,Handbook of Modern Sensors Physics, Designs, and Applications, Fourth Edition, Springer
2. D. Patranabis, Sensors and Transducers, 2nd Edition, PHI Publication, New Delhi

3. Mechatronics- Ganesh S. Hegde, Published by University Science Press, 2nd Edition, An imprint of Laxmi Publication Private Limited
4. Terry Bartelt, Process Control Systems and Instrumentation, Delmar Cengage Learning India Edition New edition

Reference Books:

1. www.nptel.ac.in
2. G. Eranna , Metal Oxide Nanostructures as Gas Sensing Devices, Publisher: CRC Press
3. ISA S82.01 - Safety Standard for Electrical & Electronic Test, Measuring, Controlling Related Equipment
4. http://www.ebme.co.uk/arts/safety/part6.htm

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.3.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 501	Communication Engineering Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 501	Communication Engineering Lab	--	--	--	--	--	25	--	25	50

Laboratory Outcomes:

After successful completion of the course students will be able to:

1. Perform hardware implementation of various analog and digital modulation methods.
2. Illustrate generation and detection of various pulse modulation techniques.
3. Apply techniques to insert Inter Symbol Interference and methods to mitigate its effect.
4. Simulate various analog and digital modulation methods.
5. Demonstrate multiplexing and de-multiplexing of signals using multiplexing techniques.
6. Illustrate the effect of sampling frequency on the reconstructed signal.

Term Work:

At least 10 experiments covering entire syllabus should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiments based on laboratory setups
1	Analog Modulation and demodulation: AM
2	Analog Modulation and demodulation: FM

3	Pre-emphasis & De-emphasis
4	Analog Pulse modulation (PAM/PWM/PPM)
5	Time division multiplexing
6	Frequency division multiplexing
7	Verification of Sampling theorem
8	Generation of Line codes
9	Binary modulation and demodulation of BASK
10	Binary modulation and demodulation of BPSK
11	Binary modulation and demodulation of BFSK
	Simulation-based experiments
12	Simulation of AM and FM
13	Simulation of PAM, PPM, PWM
14	Simulation of BPSK/BASK/MSK modulation
15	Simulation of duobinary encoder, decoder

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL502	Software Engineering and Web Technologies Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme									
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL502	Software Engineering and Web Technologies Lab	--	--	--	--	--	25	--	25	50

Laboratory Outcomes:

After successful completion of the course students will be able to:

1. Identify requirements and apply process model to selected case study.
2. Analyse and design models for the selected case study using UML modelling
3. Use various Software Engineering and Project Management Tools
4. Design static web pages using HTML5, CSS3, Bootstrap.
5. Apply the concepts of Client-side validation and scripts to static web pages using JavaScript and JQuery.
6. Build dynamic web pages using Server-Side Scripting.

Term Work:

At least 10 experiments covering entire syllabus of **Software Engineering and Web Technologies (50% Software Engineering and the remaining 50% Web Technologies)** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
	Software Engineering
1	Prepare detailed statement of problem with feasibility study and identify suitable process model for the same with justification. *
2	Develop Software Requirement Specification (SRS) document in IEEE format for the project. *
3	Prepare schedule for the project using any project management tool *
4	Prepare RMMM plan for the project.
5	Identify scenarios & develop UML Use case and Class Diagram for the project. *
6	Develop Activity / State Transition diagram and Sequence diagram for the project. *
7	Develop test cases for the project using white box testing.
	Web Technologies
1	a) Installation and Setting of LAMP / WAMP / XAMP.
	b) Develop a Prototype of the selected problem statement (UI and UX).
2	Design and Implement web pages using HTML5 and CSS3 on the selected problem statement.
3	Design Form using javascript/HTML/JQuery with client-side validations on the selected problem statement.
4	Design Interactive web pages using PHP (any framework) with database connectivity to MySQL on the selected problem statement.
5	Design and Implement web pages with PHP and Ajax on the selected problem statement.
6	Enhance the web page designed in experiment number 2 using bootstrap.

- *Practicals (Software Engineering) can be conducted using any open-source software tools like **Dia, Star UML, Project Libre** etc.*
- *Students are expected to pick up one **Case study/Mini Project** such as hospital management, student management, e-shop etc., and perform all the experiments based on that.*

Text Books:

1. "The Unified Modelling Language User Guide" by Grady Booch, James Rumbaugh, Ivar Jacobson, Pearson Publication, ISBN 978-81-7758-372-4

References:

1. UML – Tutorial "www.tutorialspoints.com/uml/"
2. "Fundamentals of Object-Oriented Design in UML", Meilir Page-Jones, Pearson Education
3. UML Basics— an Introduction to the Unified Modeling Language – IBM "www.ibm.com › Learn › Rational"
4. UML in 24 Hours

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 503	Software Testing & Quality Assurance Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 503	Software Testing & Quality Assurance Lab	--	--	--	--	--	25	--	25	50

Laboratory Outcomes:

After successful completion of the laboratory, students will be able to:

1. Understand the system thoroughly (for requirement, designing and implementation).
2. Recognize failures in the system.
3. Investigate the reason for bugs.
4. Design test plan and test cases.
5. Execute the test cases manually and using automated tools.
6. Manage the testing process.

Term Work:

At least 10 experiments covering entire syllabus should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Write programs in C Language to demonstrate the working of the following a. constructs: i) do...while ii) while....do iii) if...else iv)switch

2	Write a program for any one function of the selected system. Introspect the causes for its failure and write down the possible reasons for its failure.
3	Study the system, requirement specifications and Designing the system.
4	Write the brief test plan.
5	Select the test cases(positive and negative scenarios) for the selected system.
6	Design Test cases for the system using boundary value analysis or equivalent class partitioning.
7	Manual execution of test cases and prepare defect reports.
8	Identify regression scenarios for automation for any one/two test case.
9	Study of any testing tool (e.g. Selenium).
10	Automate the scenario in exp 8 with a testing tool. (e.g. Selenium)
11	Study of any test management tool (e.g. Qase).
12	Writing down test cases and execution using tools (e.g. Qase).
13	Study defect management (e.g. JIRA)
14	Design quality matrix for your system.
Consider one system (e.g. Library Management System, ATM system, Banking application, Library Management System) and use throughout the lab.	

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 503	ASIC Verification	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	ractical/ Oral	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 503	ASIC Verification	--	--	--	--	--	25	25	--	50

Laboratory Outcomes:

After successful completion of the laboratory students will be able to;

1. Create test plan and test cases to verify any digital design.
2. Apply the advanced verification techniques like Randomization on set of inputs.
3. Create a transaction class and apply object -oriented programming for Verification.
4. Carry out simulation of designs using System Verilog hardware verification language.
5. Develop a complete Layered Test-bench for any digital design.

Term Work:

At least 10 experiments covering entire syllabus should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Write Verilog code for 4:1 MUX using all Verilog modeling styles and simulate the same.
2	Write Verilog code and test-bench for D flip flop and 4 bit counter and simulate the same.
3	Create a test plan and self-checking test-bench for the ALU.
4	Create dynamic arrays, associative arrays, and queues using System Verilog.

5	Write test bench using dynamic arrays, associative arrays with System Verilog to test a synchronous 8-bit x64K (512kBit) RAM.
6	Create an Interface for a Memory Design. Use Modport to assign direction to signal.
7	Create class and its objects and perform deep copy and shallow copy.
8	Create an Interface for a Memory Design. (without modport)
9	To understand and create Virtual interface and use it in a class.
10	Given design specifications, draw waveform and write SVA expressions.
11	Given design specifications, draw waveform and write clock based Sequences
12	Create IPCs like events, mailbox and semaphores to interact between threads.
13	Find coverage by writing cover groups for a design.
14	Implementation of parallel processes using Fork Join/ join_any/ join_none statement.
15	Create a layered test-bench for a simple design like Adder.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 503	Information Theory and Coding	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical/Oral	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 503	Information Theory and Coding	--	--	--	--	--	25	25	--	50

Laboratory Outcomes:

After successful completion of the laboratory students will be able to

1. Understand the basics of information theory, source coding techniques and calculate Entropy of source.
2. Implement Shannon-Hartley equation to find the upper limit on the Channel Capacity.
3. Apply various channel coding schemes & demonstrate their capabilities towards the improvement of the noise performance of communication system.
4. Apply the knowledge of digital electronics and describe the error control codes like block code, cyclic code and convolutional codes.
5. Implement audio and video compression techniques

Term Work:

At least 10 experiments covering entire syllabus of **Information Theory and Coding (ECC DO501)** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Write a program for determination of entropy and mutual information of a given channel: Noise free channel.

2	Write a program for determination of entropy and mutual information of a given channel: Binary symmetric channel.
3	Write a program for Shannon-Hartley equation to find the upper limit on the Channel Capacity
4	Write a program for generation and evaluation of variable length source coding Shannon – Fano Coding and decoding.
5	Write a program for generation and evaluation of variable length source coding Huffman Coding and decoding.
6	Write a program for generation and evaluation of variable length source coding LZW Coding and decoding.
7	Write a program for Forward error correction system with a given Linear block code.
8	Write a Program for coding & decoding of Linear block codes.
9	Write a Program for coding & decoding of Cyclic codes.
10	Write a program for coding and decoding of Convolutional codes.
11	Write a program for computing the LPC coefficients.
12	Write a program for video compression.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL503	Sensors and Applications	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical/ Oral	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL503	Sensors and Applications	--	--	--	--	--	25	25	--	50

Laboratory Outcomes:
After successful completion of the laboratory students will be able to

1. Choose proper sensor with its thorough understanding of the characteristics.
2. Design suitable signal conditioning circuit for the chosen sensors
3. Perform characterization of sensor materials and technology used in different sensors
4. Implement a prototype for demonstrating the application of the sensors
5. Demonstrate problem solving & troubleshooting skills in sensor applications

Term Work:

At least 10 experiments covering entire syllabus of **Sensors and Applications** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Characteristics of temperature sensors
2	Characteristics of optical Sensors
3	I to V and V to I converter
4	Frequency to voltage converter using OpAmp

5	Inverting and non-inverting amplifier using OpAmp
6	LVDT Sensor construction and characteristics
7	Instrumentation Amplifier Design
8	Filter Design (Analog)
9	Filter Design (Digital Simulation)
10	Case study on any house hold appliance
11	4-20mA Current Loop
12	Interface with Real word using A/D converters
13	Simulations of Micro-sensors
14	Simulations of micro-actuators such as micro-heater/ micro-motors

Case study: Make a detailed report on industrial applications of sensor: Automotive, mobile phone, consumer products or household equipment such as fridge, washing machine (anyone, all students in a batch should take up different problem statement). The case study should include:

1. Name of equipment
2. Application of selected equipment
3. Sensors used in that equipment, working principle of each type of sensor
4. Draw the complete block diagram of equipment and explain the working of each block.
5. Summary
6. References

References:

1. https://www.microchip.com/stellent/groups/sitecomm_sg/documents/devicedoc/en542976.pdf
2. Practical Design Techniques for Sensor Signal Conditioning, 1999, Edited by Walt Kester, Analog Devices, 1999, ISBN-0-916550-20-6 https://www.analog.com/en/education/education-library/practical-design-techniques-sensor-signal-conditioning.html#

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL504	Professional Communication and Ethics-II	--	2*+ 2 Hours (Batch-wise)	--	--	02	--	02

**Theory class to be conducted for full class.*

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL504	Professional Communication and Ethics - II	--	--	--	--	--	25	--	25	50

Course Objectives:

Learners should be able to:

1. Discern and develop an effective style of writing important technical/business documents.
2. Investigate possible resources and plan a successful job campaign.
3. Understand the dynamics of professional communication in the form of group discussions, meetings, etc. required for career enhancement.
4. Develop creative and impactful presentation skills.
5. Analyse personal traits, interests, values, aptitude and skills.
6. Understand the importance of integrity and develop a personal code of ethics

Course Outcomes:

After successful completion of the course students will be able to:

1. Plan and prepare effective business/ technical documents which will in turn provide solid foundation for their future managerial roles.
2. Strategize their personal and professional skills to build a professional image and meet the demands of the industry.
3. Emerge successful in group discussions, meetings and result-oriented agreeable solutions in group communication situations.
4. Deliver persuasive and professional presentations.
5. Develop creative thinking and interpersonal skills required for effective professional communication.
6. Apply codes of ethical conduct, personal integrity and norms of organizational behavior.

Module No.	Unit No.	Contents	Hrs.
1		**ADVANCED TECHNICAL WRITING: PROJECT/PROBLEM BASED LEARNING (PBL)**	06
	1.1	**Purpose and Classification of Reports** Classification on the basis of: Subject Matter (Technology, Accounting, Finance, Marketing, etc.), Time Interval (Periodic, One-time, Special), Function (Informational, Analytical, etc.), Physical Factors (Memorandum, Letter, Short & Long)	
	1.2	**Parts of a Long Formal Report** Prefatory Parts (Front Matter), Report Proper (Main Body), Appended Parts (Back Matter)	
	1.3	**Language and Style of Reports** Tense, Person & Voice of Reports, Numbering Style of Chapters, Sections, Figures, Tables and Equations, Referencing Styles in APA & MLA Format, Proof-reading through Plagiarism Checkers	
	1.4	**Definition, Purpose & Types of Proposals** Solicited (in conformance with RFP) & Unsolicited Proposals, Types (Short and Long proposals)	
	1.5	**Parts of a Proposal** Elements, Scope and Limitations, Conclusion	
	1.6	**Technical Paper Writing** Parts of a Technical Paper (Abstract, Introduction, Research Methods, Findings and Analysis, Discussion, Limitations, Future Scope and References), Language and Formatting, Referencing in IEEE Format	
2		**EMPLOYMENT SKILLS**	06
	2.1	**Cover Letter & Resume** Parts and Content of a Cover Letter, Difference between Bio-data, Resume & CV, Essential Parts of a Resume, Types of Resume (Chronological, Functional & Combination)	
	2.2	**Statement of Purpose** Importance of SOP, Tips for Writing an Effective SOP	
	2.3	**Verbal Aptitude Test** Modelled on CAT, GRE, GMAT exams	
	2.4	**Group Discussions** Purpose of a GD, Parameters of Evaluating a GD, Types of GDs (Normal, Case-based & Role Plays), GD Etiquette	
	2.5	**Personal Interviews** Planning and Preparation, Types of Questions, Types of Interviews (Structured, Stress, Behavioral, Problem Solving & Case-based), Modes of Interviews: Face-to-face (One-to one and Panel) Telephonic, Virtual	
3		**BUSINESS MEETINGS**	02
	3.1	**Conducting Business Meetings** Types of Meetings, Roles and Responsibilities of Chairperson, Secretary and Members, Meeting Etiquette	
	3.2	**Documentation** Notice, Agenda, Minutes	

4		**TECHNICAL/ BUSINESS PRESENTATIONS**	02
	4.1	**Effective Presentation Strategies** Defining Purpose, Analyzing Audience, Location and Event, Gathering, Selecting &Arranging Material, Structuring a Presentation, Making Effective Slides, Types of Presentations Aids, Closing a Presentation, Platform Skills	
	4.2	**Group Presentations** Sharing Responsibility in a Team, Building the contents and visuals together, Transition Phases	
5		**INTERPERSONAL SKILLS**	08
	5.1	**Interpersonal Skills** Emotional Intelligence, Leadership & Motivation, Conflict Management & Negotiation, Time Management, Assertiveness, Decision Making	
	5.2	**Start-up Skills** Financial Literacy, Risk Assessment, Data Analysis (e.g. Consumer Behavior, Market Trends, etc.)	
6		**CORPORATE ETHICS**	02
	6.1	**Intellectual Property Rights** Copyrights, Trademarks, Patents, Industrial Designs, Geographical Indications Integrated Circuits, Trade Secrets (Undisclosed Information)	
	6.2	**Case Studies** Cases related to Business/ Corporate Ethics	
		Total	**26**

LIST OF ASSIGNMENTS FOR TERMWORK:
(In the form of Short Notes, Questionnaire/ MCQ Test, Role Play, Case Study, Quiz, etc.)

1. Cover Letter and Resume
2. Short Proposal
3. Meeting Documentation
4. Writing a Technical Paper/ Analyzing a Published Technical Paper
5. Writing a SOP
6. IPR
7. Interpersonal Skills
8. Aptitude test (Verbal Ability)

Note:

1. *The Main Body of the project/book report should contain minimum 25 pages (excluding Front and Back matter).*
2. *The group size for the final report presentation should not be less than 5 students or exceed 7 students.*
3. *There will be an end–semester presentation based on the book report.*

GUIDELINES FOR INTERNAL ASSESSMENT

Term Work:

Term work shall consist of minimum 8 experiments.

The distribution of marks for term work shall be as follows:

Assignment	: 10 Marks
Attendance	: 5 Marks
Presentation slides	: 5 Marks
Book Report (hard copy)	: 5 Marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

Internal oral:

Oral Examination will be based on a GD & the Project/Book Report presentation.

Group Discussion	:10 marks
Project Presentation	:10 Marks
Group Dynamics	:5 Marks

Text books and Reference books:

1. Arms, V. M. (2005). *Humanities for the engineering curriculum: With selected chapters from Olsen/Huckin: Technical writing and professional communication, second edition*. Boston, MA: McGraw-Hill.
2. Bovée, C. L., &Thill, J. V. (2021). *Business communication today*. Upper Saddle River, NJ: Pearson.
3. Butterfield, J. (2017). *Verbal communication: Soft skills for a digital workplace*. Boston, MA: Cengage Learning.
4. Masters, L. A., Wallace, H. R., & Harwood, L. (2011), *Personal development for life and work*. Mason: South-Western Cengage Learning.
5. Robbins, S. P., Judge, T. A., & Campbell, T. T. (2017). *Organizational behaviour*. Harlow, England: Pearson.
6. Meenakshi Raman, Sangeeta Sharma (2004) Technical Communication, Principles and Practice. Oxford University Press
7. Archana Ram (2018) Place Mentor, Tests of Aptitude For Placement Readiness. Oxford University Press
8. Sanjay Kumar &Pushp Lata (2018). Communication Skills a workbook, New Delhi: Oxford University Press.

Subject Code	Subject Name	Credits Assigned
ECM501	Mini project - 2A	02

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal Assessment			End Sem Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECM501	Mini project - 2A	--	--	--	--	--	25	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:
Learner will be able to;

1. Identify problems based on societal /research needs.
2. Apply knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/experimental/simulations.
5. Analyze the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices.
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Major focus of Mini-project 2 shall be towards exploration and applicability of

knowledge acquired in the domain areas of DLOs available for the year.
- Student shall give special consideration to identify and provide solutions to the burning societal and/or environmental issues which may affect the mankind to larger extend.
- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.

A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on
  self- learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case-to-case basis.

Guidelines for Assessment of Mini Project:

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester. In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below;

Marks awarded by guide/supervisor based on logbook	***:***	***10***
Marks awarded by review committee	***:***	***10***
Quality of Project report	***:***	***05***

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

In **first semester** entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.

- First on identification and finalization of problem
- Second on proposed solution for the problem.

In **second semester** expected work shall be procurement of component’s/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.

- First review shall base on readiness of building working prototype.
- Second review shall be based on poster presentation-cum-demonstration of working model in last month of the said semester.

Half-year project:

In this case students’ group shall complete project in all aspects, in a semester, including;

- Identification of need/problem
- Proposed acceptable solution for the identified problem
- Procurement of components/systems, if any,
- Building a working prototype and testing

The group shall be evaluated twice during the semester by review committee, mainly look for the progress as;

- First review focus shall be towards identification & selection of problem and probable solution proposal.
- Second review shall be for implementation and testing of solution. (Innovative/out of box solution)

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria:

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Innovativeness and out of box thinking
6. Cost effectiveness and Societal impact
7. Functional working model as per stated requirements
8. Effective use of skillsets acquired through curriculum including DLOs
9. Effective use of standard engineering practices & norms
10. Contribution of an individual as team member/Leader
11. Feasibility to deploy the solution on large scale
12. Clarity in written and oral communication

In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini-project.
In case of **half year project** all criteria's in generic may be considered for performance evaluation of students in mini-project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

Report should be prepared as per the guidelines issued by the University of Mumbai. Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations, having experience of more than five years approved by head of the Institute.

Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed by team of external & internal examiner at the end of semester/year. Performance shall be evaluated based on;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Implementation of working model
5. Effective use of diversified skill-set
6. Effective use of standard engineering practices & norms
7. Contribution of an individuals as a member/Leader
8. Clarity in written and oral communication

AC- 29/06/2021
Item No. - 6.14

UNIVERSITY OF MUMBAI

Program: Bachelor of Engineering in Electronics & Computer Science

Second Year with Effect from AY 2020-21
Third Year with Effect from AY 2021-22
Final Year with Effect from AY 2022-23

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20
Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

AC – 29/06/2021

Item No. – 6.14

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Third Year BE in Electronics & Computer Science**
2	Eligibility for Admission	**Second Year Engineering passed in line with the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 Semesters**
6	Level	~~Certificate/Diploma~~/UG/~~PG~~ **(Strike out which is not applicable)**
7	Pattern	**Semester/~~Yearly~~ (Strike out which is not applicable)**
8	Status	**Revised/~~New~~ (Strike out which is not applicable)**
9	To be implemented from Academic Year	**With effect from Academic Year: 2021-2022**

Date: Signature:

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this, the Faculty of Science and Technology (in particular Engineering), of University of Mumbai, has taken a lead in incorporating the philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes, understand the depth and approach of the course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process. However, content of courses is to be taught in 12-13 weeks and the remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum was more focused on providing information and knowledge across various domains of the said program, which led to heavily loading students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of the entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum, skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of the curriculum proposed in the present revision is in line with the AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and implementation of online contents from NPTEL/ SWAYAM Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time, in particular Revised syllabus of 'C 'scheme, wherever possible, additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In earlier revisions of the curriculum in the years 2012 and 2016, in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum, overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HOD's/ Faculties of all the institutes are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses and on successful completion, they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

Technical education in the country is undergoing a paradigm shift in current days. Think tank at national level are deliberating on the issues, which are of utmost importance and posed challenge to all the spheres of technical education. Eventually, impact of these developments was visible and as well adopted on bigger scale by almost all universities across the country. These are primarily an adoption of CBCS (Choice base Credit System) and OBE (Outcome based Education) with student centric and learning centric approach. Education sector in the country, as well, facing critical challenges, such as, the quality of graduates, employability, basic skills, ability to take challenges, work ability in the fields, adoption to the situation, leadership qualities, communication skills and ethical behaviour. On other hand, the aspirants for admission to engineering programs are on decline over the years. An overall admission status across the country is almost 50%; posing threat with more than half the vacancies in various colleges and make their survival difficult. In light of these, an All India Council for Technical Education (AICTE), the national regulator, took initiatives and enforced certain policies for betterment, in timely manner. Few of them are highlighted here, these are design of model curriculum for all prevailing streams, mandatory induction program for new entrants, introduction of skill based and inter/cross discipline courses, mandatory industry internships, creation of digital contents, mandate for use of ICT in teaching learning, virtual laboratory and so on.

To keep the pace with these developments in Technical education, it is mandatory for the Institutes & Universities to adopt these initiatives in phased manner, either partially or in toto. Hence, the ongoing curriculum revision process has a crucial role to play. The BoS of Electronics Engineering under the faculty of Science & Technology, under the gamut of Mumbai University has initiated a step towards adoption of these initiatives. We, the members of Electronics Engineering Board of Studies of Mumbai University feel privileged to present the revised version of curriculum for Electronics & Computer Science program to be implemented from academic year 2020-21. Consent was also extended by BoS Computer Science for this curriculum. Some of the highlights of the revision are;

i. Curriculum has been framed with reduced credits and weekly contact hours, thereby providing free slots to the students to brain storm, debate, explore and apply the engineering principles. The leisure provided through this revision shall favour to inculcate innovation and research attitude amongst the students.
ii. New skill based courses have been incorporated in curriculum keeping in view AICTE model curriculum.
iii. Skill based Lab courses have been introduced, which shall change the thought process and enhance the programming skills and logical thinking of the students
iv. Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the group dynamics, develop leadership qualities, facilitate decision making and enhance problem solving ability with focus towards socio-economic development of the country. In addition, it shall be direct application of theoretical knowledge in practice, thereby, nurture learners to become industry ready and enlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystem with better means.
v. An usage of ICT through NPTEL/SWAYAM and other Digital initiatives of Govt. of India shall be encouraged, facilitating the students for self-learning and achieve the Graduate Attribute (GA) specified by National Board of accreditation (NBA) i.e. lifelong learning.

Thus, this revision of curriculum aimed at creating deep impact on the teaching learning methodology to be adopted by affiliating Institutes, thereby nurturing the students fraternity in a multifaceted directions and create competent technical manpower with legitimate skills. In time to come, these graduates shall shoulder the responsibilities of proliferation of future technologies and support in a big way for 'Make in India' initiative a reality. In the process, BoS, Electronics Engineering got whole hearted support from all stakeholders including faculty, Heads of department of affiliating institutes, experts faculty who detailed out the course contents, alumni, industry experts and university official providing all procedural support time to time. We put on record their involvement and sincerely thank one and all for contribution and support extended for this noble cause.

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Boards of Studies in Electronics Engineering

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. R. N. Awale	Chairman	5	Dr. Rajani Mangala	Member
2	Dr. Jyothi Digge	Member	6	Dr. Vikas Gupta	Member
3	Dr. V. A. Vyawahare	Member	7	Dr. D. J. Pete	Member
4	Dr. Srija Unnikrishnan	Member	8	Dr. Vivek Agarwal	Member

Program Structure for Third Year Electronics Engineering

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract.	Tut	Total
ECC 601	Embedded Systems and RTOS	3	-	-	3	-	-	**3**
ECC 602	Artificial Intelligence	3	-	-	3	-	-	**3**
ECC 603	Computer Networks	3	-	-	3	-	-	**3**
ECC 604	Data Warehousing and Mining	3	-	-	3	-	-	**3**
ECC DO601	Department Level Optional Course -II	3	-	-	3	-	-	**3**
ECL 601	Embedded Systems Lab	-	2			1		**1**
ECL602	Artificial Intelligence and Computer Networks Lab	-	2	-	-	1	-	**1**
ECL603	Data Warehousing and Mining Lab	-	2	-	-	1	-	**1**
ECL 604	Skill-based Laboratory	-	4	-	-	2	-	**2**
ECM601	Mini Project 2B	-	4$	-	-	2	-	**2**
Total		**15**	**14**	-	**15**	**7**	-	**22**

$ indicates workload of learner (Not faculty), for mini-project

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Av					
ECC 601	Embedded Systems and RTOS	20	20	20	80	03	-	-	**100**
ECC 602	Artificial Intelligence	20	20	20	80	03	-	-	**100**
ECC 603	Computer Networks	20	20	20	80	03	-	-	**100**
ECC 604	Data Warehousing and Mining	20	20	20	80	03	-	-	**100**
ECC DO601	Department Level Optional Course -II	20	20	20	80	03	-	-	**100**
ECL 601	Embedded Systems Lab	-	-	-	-	-	25	25	**50**
ECL602	Artificial Intelligence and Computer Networks Lab	-	-	-	-	-	25	25	**50**
ECL603	Data Warehousing and Mining Lab	-	-	-	-	-	25	25	**50**
ECL 604	Skill-based Laboratory	-	-	-	-	-	50	-	**50**
ECM601	Mini Project - 2B						25	25	**50**
Total				**100**	**400**	-	**150**	**100**	**750**

Department Level Optional Course - II (DO 601):

1. Machine Learning	**3.** Digital Signal Processing
2. Industrial Automation	**4.** Electronic Product Design

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 601	Embedded Systems and RTOS	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC 601	Embedded Systems and RTOS	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Digital Electronics (**ECC 303)**
Microprocessors and Microcontrollers (**ECC 404)**

Course Objectives:

1. To study concepts involved in Embedded Hardware and Software for System realisation.
2. To learn the concepts of modern microcontroller cores like the ARM-Cortex
3. To learn Real-time programming to design time-constrained embedded systems

Course Outcomes:
After successful completion of the course students will be able to:

1. Identify and describe various characteristic features and applications of Embedded systems.
2. Analyse and select hardware for Embedded system implementation.
3. Evaluate various communication protocols for Embedded system implementation.
4. Compare GPOS and RTOS and investigate the concepts of RTOS.
5. Evaluate and use various tools for testing and debugging embedded systems
6. Design a system for different requirements based on life-cycle for the embedded system, keeping oneself aware of ethics and environmental issues.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Embedded Systems**	03
	1.1	Definition, Characteristics, Classification, Applications	
	1.2	Design metrics of Embedded system and Challenges in optimization of metrics	
2		**Embedded Hardware Elements**	13
	2.1	Features of Embedded cores- µC, ASIC, ASSP, SoC, FPGA, RISC and CISC cores. Types of memories.	
	2.2	Case Study: ARM Cortex-M3 Features, Architecture, Programmer's model, Special Registers, Operating Modes and States, MPU, Memory map and NVIC.	
	2.3	Low power: - Need and techniques. Case study of Low Power modes in Cortex-M3.	
	2.4	Communication Interfaces: Comparative study of Serial communication Interfaces (RS-232, RS-485), SPI, I2C, CAN, USB (v2.0), Bluetooth, Zig-Bee. *(Frame formats of above protocols are not expected)*	
	2.5	Selection criteria of Sensors and Actuators	
3		**Embedded Software**	12
	3.1	Program Modelling concepts: DFG, CDFG, FSM.	
	3.2	Real-time Operating system: - Need of RTOS in Embedded system software and comparison with GPOS, Task, Task states, Multi-tasking, Task scheduling, and Algorithms-Preemptive SJF, Round-Robin, Priority, Rate Monotonic Scheduling, Earliest Deadline First. Inter-process communication: Message queues, Mailbox, Event timers. Task synchronization: Need, Issues - Deadlock, Race condition, live Lock, Solutions using Mutex, Semaphores. Shared data problem, Priority inversion.	
4		**Introduction to Free RTOS**	03
		Free RTOS Task Management features, Resource Management features, Task Synchronization features, Event Management features, Calculate the CPU Utilization of an RTOS, Interrupt Management features, Time Management features.	
5		**Testing and Debugging Methodology**	02
	5.1	Testing & Debugging: Hardware testing tools, Boundary-scan/JTAG interface concepts, Emulator.	
	5.2	Software Testing tools, simulator, debugger. White-Box and Black-Box testing.	
6		**System Integration (Case Studies)**	06
	6.1	Embedded Product Design Life-Cycle (EDLC)- Waterfall Model	
	6.2	Hardware-Software Co-design	
	6.3	Case studies for Automatic Chocolate Vending Machine, Washing Machine, Smart Card, highlighting i) Specification requirements (choice of components), ii) Hardware architecture iii) Software architecture	
		Total	**39**

Note: *- Referring to data sheets while selecting hardware components must be encouraged.*

Text Books:

1. Dr. K. V. K. K. Prasad, "Embedded Real Time System: Concepts, Design and Programming", Dreamtech, New Delhi, Edition2014.
2. Rajkamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill Education (India) Private Limited, New Delhi, 2015, 3rd Edition.
3. Sriram Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata McGraw Hill Publishing Company ltd., 2003.
4. Joseph Yiu, "The Definitive guide to ARM CORTEX-M3 & CORTEX-M4 Processors", Elsevier, 2014, 3rd Edition.
5. www.freertos.org

Reference Books:

1. David Simon, "An Embedded Software Primer", Pearson,2009.
2. Jonathan W. Valvano, "Embedded Microcomputer Systems – Real Time Interfacing", Publisher - Cengage Learning, 2012 3rd Edition.
3. Andrew Sloss, Domnic Symes, Chris Wright, "ARM System Developers Guide Designing and Optimising System Software", Elsevier, 2004.
4. FrankVahid, Tony Givargis, "Embedded System Design – A Unified Hardware/SoftwareIntroduction", John Wiley & Sons Inc., 2002.
5. Shibu K V, "Introduction to Embedded Systems", Tata McGraw Hill Education Private Limited, New Delhi,2009

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC602	Artificial Intelligence	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC602	Artificial Intelligence	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Data structures and algorithms,
Discrete mathematics,
Basic Mathematics

Course Objectives:

1. To gain perspective of AI and its foundations.
2. To study different agent architectures and properties of the environment.
3. To understand the basic principles of AI towards problem solving, inference, perception, knowledge representation, and learning.
4. To investigate probabilistic reasoning under uncertain and incomplete information.
5. To explore the current scope, potential, limitations, and implications of intelligent systems.

Course Outcomes:

After successful completion of the course students will be able to:

1. Identify the characteristics of the environment and differentiate between various agent architectures.
2. Apply the most suitable search strategy to design problem solving agents.
3. Represent a natural language description of statements in logic and apply the inference rules to design Knowledge Based agents.
4. Apply a probabilistic model for reasoning under uncertainty.
5. Comprehend various learning techniques.
6. Describe the various building blocks of an expert system for a given real world problem.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Artificial Intelligence**	3
	1.1	Artificial Intelligence (AI), AI Perspectives: Acting and Thinking humanly, Acting and Thinking rationally	
	1.2	History of AI, Applications of AI, The present state of AI, Ethics in AI	
2		**Intelligent Agents**	4
	2.1	Introduction of agents, Structure of Intelligent Agent, Characteristics of Intelligent Agents	
	2.2	Types of Agents, Simple Reflex, Model Based, Goal Based, Utility Based Agents.	
	2.3	Environment Types, Deterministic, Stochastic, Static, Dynamic, Observable, Semi-observable, Single Agent, Multi Agent	
3		**Solving Problems by Searching**	12
	3.1	Definition, State space representation, Problem as a state space search, Problem formulation, Well-defined problems	
	3.2	Solving Problems by Searching, Performance evaluation of search strategies, Time Complexity, Space Complexity, Completeness, Optimality	
	3.3	Uninformed Search, Depth First Search, Breadth First Search, Depth Limited Search, Iterative Deepening Search, Uniform Cost Search, Bidirectional Search	
	3.4	Informed Search, Heuristic Function, Admissible Heuristic, Informed Search Technique, Greedy Best First Search, A* Search, Local Search, Hill Climbing Search, Simulated Annealing Search, Optimization, Genetic Algorithm	
	3.5	Game Playing, Adversarial Search Techniques, Mini-max Search, Alpha-Beta Pruning	
4		**Knowledge and Reasoning**	10
	4.1	Definition and importance of Knowledge, Issues in Knowledge Representation, Knowledge Representation Systems, Properties of Knowledge Representation Systems	
	4.2	Propositional Logic (PL), Syntax, Semantics, Formal logic-connectives, truth tables, tautology, validity, well-formed-formula,	
	4.3	Predicate Logic, FOPL, Syntax, Semantics, Quantification, Inference rules in FOPL, Introduction to logic programming (PROLOG)	
	4.4	Forward Chaining, Backward Chaining and Resolution in FOPL	
5		**Reasoning Under Uncertainty**	5
	5.1	Handling Uncertain Knowledge, Random Variables, Prior and Posterior Probability, Inference using Full Joint Distribution	
	5.2	Bayes' Rule and its use, Bayesian Belief Networks, Reasoning in Belief Networks	
6		**Planning and Learning**	
	6.1	The planning problem, Partial order planning, total order planning.	
	6.2	Learning in AI, Learning Agent, Concepts of Supervised, Unsupervised, Semi -Supervised Learning, Reinforcement Learning, Ensemble Learning.	5

	6.3	Expert Systems, Components of Expert System: Knowledge base, Inference engine, user interface, working memory, Development of Expert Systems	
		Total	**39**

Text Books:

1. Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach —Second Edition" Pearson Education.
2. Elaine Rich and Kevin Knight —Artificial Intelligence‖ Third Edition, Tata McGraw-Hill Education Pvt. Ltd., 2008.
3. George F Luger "Artificial Intelligence" Low Price Edition, Pearson Education., Fourth edition.

Reference Books:

1. Ivan Bratko "PROLOG Programming for Artificial Intelligence", Pearson Education, Third Edition.
2. D. W. Patterson, Artificial Intelligence and Expert Systems, Prentice Hall.
3. Saroj Kaushik "Artificial Intelligence", Cengage Learning.
4. Davis E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y., 1989.
5. Patrick Henry Winston, "Artificial Intelligence", Addison-Wesley, Third Edition.
6. N. P. Padhy, "Artificial Intelligence and Intelligent Systems", Oxford University Press.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will consist of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 603	Computer Networks	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC 603	Computer Networks	20	20	20	80	03	--	--	--	100

Course Pre-requisite: Communication Engineering

Course Objectives:

1. To understand the fundamental concepts of computer networking, protocols, architectures, and applications.
2. To study the multiple layer design issues, services, and state-of-the-art protocols of TCP/IP and OSI based Architectures.
3. To help students to acquire knowledge of address in the configuration of various scales of networks
4. To be conversant with the principles of Network Application Programming

Course Outcomes:

After successful completion of the course students will be able to:

1. Enumerate the layers of OSI model and TCP/IP model and describe their functions.
2. Identify the characteristics of network devices and media used to design networks.
3. Demonstrate the knowledge of networking protocols at various layers of TCP/IP model.
4. Classify the routing protocols and analyse how to assign the IP addresses for a given network
5. Design and configure the networks using IP addressing and sub-netting / super-netting schemes.
6. Explain the functions of Application layer and Presentation layers, their paradigms and Protocols.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Data Communications and Networking**	05
	1.1	Introduction to computer networks, Network software, Layers and services, Network topologies, protocol hierarchies, design issues for the layers, connection oriented and connectionless services	
	1.2	Reference models: Layer details of OSI, TCP/IP models. Communication between layers. Internet	

2		**Physical Layer**	06
	2.1	Guided Transmission Media: Twisted pair, Coaxial, Fiber optics.	
	2.2	Unguided media (Wireless Transmission): Radio Waves, Microwave, Bluetooth, Infrared, Circuit and Packet Switching	
	2.3	Network Devices: Repeaters, Hubs, Switches, Routers and Gateways	
3		**Data Link Layer**	08
	3.1	DLL Design Issues - Services, Framing, Error Control, Flow Control, Error Detection and Correction Elementary Data Link protocols, Stop and Wait, Sliding Window - Go Back N, Selective Repeat.	
	3.2	Medium Access Control sublayer: Channel Allocation problem, Multiple access Protocol (Aloha, Carrier Sense Multiple Access (CSMA/CD), Local Area Networks - Ethernet (802.3), Introduction to wireless LAN: 802.11x	
4		**Network layer**	08
	4.1	Network Layer design issues, Communication Primitives: Unicast, Multicast, Broadcast. Network Layer Protocols: IPv4 Datagram Format, IPv4 Addresses, IPv4 Addressing (classfull and classless), Sub-netting and Super-netting design problems, IPv4 Protocol, IPv6 Packet Format, IPv6 Addressing, Transition from IPv4 to IPv6	
	4.2	Routing algorithms: Intra-domain Routing -Shortest Path, Distance Vector Algorithms, Link State Routing, Inter-domain Routing Protocols.	
	4.3	Congestion control algorithms: Open loop congestion control, Closed loop congestion control, QoS parameters.	
5		**Transport Layer**	07
	5.1	The Transport Service: Transport service primitives, Berkeley Sockets, Connection management (Handshake), UDP, TCP, TCP state transition, TCP timers	
	5.2	TCP Flow control (sliding Window), TCP Congestion Control: Slow Start	
6		**Application layer**	05
	6.1	Application layer Paradigms, Client-Server Paradigm: Application Programming Interface	
	6.2	Standard Client Server applications: World Wide Web and HTTP, FTP, Electronic Mail, TELNET, Secure Shell (SSH), Domain Name System (DNS)	
		Total	**39**

Text Books:

1. Andrew S Tanenbaum, Computer Networks -, 4th Edition, Pearson Education
2. Behrouz A. Forouzan, Forouzan Mosharrat, Computer Networks A Top down Approach, McGraw Hill education
3. Ranjan Bose, Information Theory, Coding and Cryptography, Ranjan Bose, Tata McGraw Hill, Second Edition.

Reference Books:

1. James F. Kurose, K. W. Ross, Computer Networking: A Top-Down Approach Featuring the Internet, 3rd Edition, Pearson Education.

2. S. Keshav, An Engineering Approach to Computer Networks, 2nd Edition, Pearson Education.
3. W. A. Shay, Understanding communications and Networks, 3rd Edition, W. A. Shay, Cengage Learning.
4. L. L. Peterson and B. S. Davie, Computer Networks: A Systems Approach, 4th Ed, Elsevier India

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC604	Data Warehousing and Mining	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC604	Data Warehousing and Mining	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Database Concepts, Algorithm Design and Analysis Concepts, Data Structures

Course Objectives:

1. To identify the scope and understand the fundamentals of Data Warehousing and Mining.
2. To understand the importance of data warehouse that would assist in providing business insights for data mining applications.
3. To instigate research interest towards advances in Data Mining.

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand Data Warehousing fundamentals and Dimensionality modelling principles
2. Understand the use of ETL techniques and apply OLAP operations.
3. Perceive the importance of data pre-processing and basics of data mining techniques.
4. Relate to the concepts of market basket analysis in real world applications.
5. Apply classification algorithms in real world dataset for classification and prediction.
6. Visualize the concept of clustering and its applications.

	Unit No.	Contents	Hrs.
1		**Data Warehousing and Dimension Modelling**	8
	1.1	Introduction to Data Warehouse, Characteristics of Data Warehouse	
	1.2	Components of Data warehouse Architecture, Data warehouse architecture	
	1.3	Data warehouses versus Data Marts,	
	1.4	E-R Modelling versus Dimensional Modelling,	
	1.5	Data Warehouse Schemas; Star Schema, Snowflake Schema, Fact Less Fact Table, Fact Constellation Schema.	
	1.6	Inside Dimensional Table, Inside Fact Table,	
	1.7	Update to the dimension tables. OLTP Systems versus OLAP	

2		**ETL and OLAP**	6
	2.1	Major steps in ETL process	
		Data Extraction Methods	
	2.2	Data Transformation; Basic Tasks in Transformation, Major Data Transformation Types	
	2.3	Data Loading Techniques	
	2.4	What is Multidimensional Data, OLAP Models: MOLAP, ROLAP.	
	2.5	OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot.	
3		**Data Mining and Data pre-processing**	6
	3.1	Introduction to data mining, Architecture for Data Mining,	
	3.2	KDD process, Data Mining Functionalities, Interestingness Measures,	
	3.3	Classification of data mining system, major issues in data mining.	
	3.4	Data Summarization, Data Cleaning, Data Integration and Transformation,	
	3.5	Data Reduction, Data Discretization And Concept Hierarchy Generalization.	
4		**Mining frequent patterns and associations**	7
	4.1	Market Basket Analysis, Frequent Item sets, Closed Item sets, and Association Rule	
	4.2	Frequent Pattern Mining, Efficient and Scalable Frequent Item set Mining Methods: Apriori Algorithm, Association Rule Generation, Improving the Efficiency of Apriori,	
	4.3	FP growth	
	4.4	Mining various kinds of association rules – Multilevel and Multidimensional	
5		**Classification and Prediction**	5
	5.1	Definition, Decision tree induction	
	5.2	Bayesian classification	
	5.3	Introduction to prediction, Linear and logistic regression techniques	
	5.4	Accuracy and error measures.	
6		**Cluster analysis**	7
	6.1	Definition, Distance Measures,	
	6.2	Clustering Algorithms: Partitioning- K means and K-medoids,	
	6.3	Hierarchical clustering- Agglomerative clustering and Divisive clustering	
		Total	**39**

Text Books:

1. Paulraj Ponniah, "Data Warehousing: Fundamentals for IT Professionals‖", Wiley India.
2. Han, Kamber, "Data Mining Concepts and Techniques", Morgan Kaufmann
3. Reema Theraja," Data warehousing, Oxford University Press.
4. M.H. Dunham, "Data Mining Introductory and Advanced Topics", Pearson Education.

Reference Books:

1. Ian H. Witten, Eibe Frank and Mark A. Hall, "Data Mining ", 3rd Edition Morgan Kaufmann publisher.
2. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, Introduction to Data Mining", Person Publisher.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDO601	Machine Learning	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECCDO 601	Machine Learning	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Data Structures, Basic Probability and Statistics, Algorithms

Course Objectives:

1. To introduce Machine learning concepts
2. To develop mathematical concepts required for Machine learning algorithms
3. To understand various Regression techniques
4. To understand Clustering techniques
5. To develop Neural Network based learning models

Course Outcomes:

After successful completion of the course students will be able to:

1. Comprehend basics of Machine Learning
2. Build Mathematical foundation for machine learning
3. Understand various Machine learning models
4. Select suitable Machine learning models for a given problem
5. Build Neural Network based models
6. Apply Dimensionality Reduction techniques

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to Machine Learning**	6
	1.1	Introduction to Machine Learning, Issues in Machine Learning, Application of Machine Learning, Steps of developing a Machine Learning Application.	
	1.2	Supervised and Unsupervised Learning: Concepts of Classification, Clustering and prediction, Training, Testing and validation dataset, cross validation, overfitting and under fitting of model	
	1.3	Performance Measures: Measuring Quality of model- Confusion Matrix, Accuracy, Recall, Precision, Specificity, F1 Score, RMSE	

2		**Mathematical Foundation for ML**	5
	2.1	System of Linear equations, Norms, Inner products, Length of Vector, Distance between vectors, Orthogonal vectors	
	2.2	Symmetric Positive Definite Matrices, Determinant, Trace, Eigenvalues and vectors, Orthogonal Projections, Diagonalization, SVD and its applications.	
3		**Liner models**	7
	3.1	The least-squares method, Multivariate Linear Regression, Regularised Regression, Using Least-Squares Regression for classification	
	3.2	Support Vector Machines	
4		**Clustering**	4
	4.1	Hebbian Learning rule	
	4.2	Expectation -Maximization algorithm for clustering	
5		**Classification models**	12
	5.1	Introduction, Fundamental concept, Evolution of Neural Networks, Biological Neuron, Artificial Neural Networks, NN architecture, McCulloch-Pitts Model. Designing a simple network, Non-separable patterns, Perceptron model with Bias. Activation functions, Binary, Bipolar, continuous, Ramp. Limitations of Perceptron.	
	5.2	Perceptron Learning Rule. Delta Learning Rule (LMS-Widrow Hoff), Multi-layer perceptron network. Adjusting weights of hidden layers. Error back propagation algorithm.	
	5.3	Logistic regression	
6		**Dimensionality Reduction**	5
	6.1	Curse of Dimensionality.	
	6.2	Feature Selection and Feature Extraction	
	6.3	Dimensionality Reduction Techniques, Principal Component Analysis.	
		Total	**39**

Text Books:

1. Nathalie Japkowicz & Mohak Shah, "Evaluating Learning Algorithms: A Classification Perspective", Cambridge.
2. Marc Peter Deisenroth, Aldo Faisal, Cheng Soon Ong, "Mathematics for machine learning"
3. Samir Roy and Chakraborty, "Introduction to soft computing", Pearson Edition.
4. Ethem Alpaydın, "Introduction to Machine Learning", MIT Press
5. Peter Flach, "Machine Learning", Cambridge University Press

Reference Books:

1. Tom M. Mitchell, "Machine Learning", McGraw Hill
2. Kevin P. Murphy, "Machine Learning — A Probabilistic Perspective", MIT Press
3. Stephen Marsland, "Machine Learning an Algorithmic Perspective", CRC Press
4. Shai Shalev-Shwartz, Shai Ben-David, "Understanding Machine Learning", Cambridge University Press
5. Peter Harrington, "Machine Learning in Action", DreamTech Press

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO601	Industrial Automation	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO601	Industrial Automation	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

Knowledge of Basic Electrical Engineering,
Basic Electronics,
Digital Electronics,
Electronics Measurement and Instruments

Course Objectives:

1. To measure industrial parameters like temperature, pressure, force, displacement, speed, flow, level, humidity and pH.
2. To explain fundamentals of process control
3. To list basic devices used in automated systems
4. To use programmable logic controllers for industrial automation
5. To draw block diagram of supervisory control and data acquisition (SCADA) and integrate it with PLC systems
6. To use Internet of Things for Industrial Automation
7. To make use of robots for industrial applications

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand and draw block diagram of industrial automation and control system
2. Understand various automation components and systems
3. Explain architecture of industrial automation system
4. Demonstrate working of PLC and SCADA and interface the same.
5. Demonstrate the use of IOT and robotics in Automation
6. Distinguish between the usage of custom embedded systems, FPGAs and PLCs

Module No.	Unit No.	Contents	Hrs.
1		**Introduction**	06
	1.1	Automation overview, Requirement of automation systems,	
	1.2	Architecture of Industrial Automation system, Parameters of Industrial Revolution 4.0	
	1.3	Introduction of PLC and supervisory control and data acquisition (SCADA)	
	1.4	Industrial bus systems: Mod bus & Profi-bus & Ether CAT	
2		**Automation components**	07
	2.1	Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement.	
	2.2	Actuators, process control valves, Introduction of DC and AC servo drives for motion control. Use of Contactors, Isolators, MCB, MCCB, Earth Breakers etc	
3		**Computer aided measurement and control systems**	08
	3.1	Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques	
	3.2	Computer aided process control software, Computer based data acquisition system	
	3.3	Internet of things (IoT) for plant automation	
4		**Programmable logic controllers**	06
	4.1	Programmable controllers, Programmable logic controllers, Analog digital input and output modules	
	4.2	PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking	
	4.3	PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.	
5		**Distributed Control System**	06
	5.1	Overview of DCS, DCS software configuration,	
	5.2	DCS communication, DCS Supervisory Computer Tasks,	
	5.3	DCS integration with PLC and Computers, Features of DCS, Advantages of DCS	
6		**Overview of Industrial automation using robots**	06
	6.1	Basic construction and configuration of robot Pick and place robot	
	6.2	Welding robot.	
	6.3	Robots in the medical field	
		Total	**39**

Text Books:

1. S. K. Singh, "Industrial Instrumentation and Control", The McGraw Hill Companies
2. C.D. Johnson, "Process Control Instrumentation Technology", PHI
3. E. Andrew Parr, "Industrial control handbook", Newnem publication

Reference Books:

1. Garry Dunning, Introduction to Programmable logic controller, Delmar Thomson Learning,
2. Norman A. Anderson, Instrumentation and Process measurements and Control 2nd Edition. CRC Press

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO601	Digital Signal Processing	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO601	Digital Signal Processing	20	20	20	80	03	--	--	--	100

Prerequisite Courses:

Engineering Mathematics - III

Course Objectives:

1. To make conversant with the fundamentals of digital signal processing
2. To familiarise with the transforms used in Digital Signal Processing
3. To familiarise with the design techniques and performance analysis of digital filters
4. To introduce digital signal processors and applications

Course Outcomes:

After successful completion of this course students will be able to

1. Apply the concept of DT Signal and DT Systems.
2. Classify and analyse discrete time signals and systems
3. Implement Digital Signal Transform techniques DTFT, DFT and FFT.
4. Design FIR and IIR digital filters to meet arbitrary specifications and Develop algorithms for implementation
5. Use signal processing techniques and digital signal processors in various applications

Module No.	Unit No.	Contents	Hrs.
1		**Discrete-Time Signal and Discrete-Time Systems**	08
	1.1	Introduction to Digital Signal Processing, Sampling and Reconstruction, Standard DT Signals, Concept of Digital Frequency, Representation of DT signal using Standard DT Signals, Signal Manipulations-shifting, reversal, scaling, addition, multiplication.	
	1.2	Classification of Discrete-Time Signals, Classification of Discrete-Systems, LTI system, Impulse Response.	

	1.3	Linear Convolution, Circular Convolution- Emphasis on graphical method, linear convolution using Circular Convolution. Software simulation - Impulse Response, Step Response, convolution, Correlation.	
2		**Frequency Domain Analysis using DTFT and Z Transform**	07
	2.1	Introduction to DTFT. Properties of DTFT.	
	2.2	Z transform - definition, properties of unilateral and bilateral Z Transform, Z transform of standard signals, ROC, poles and zeros of transfer function, Inverse Z transform	
	2.3	Analysis and characterization of LTI system using Z transform, impulse and step response, causality, stability, stability of causal system	
3		**Discrete Fourier Transform and Fast Fourier Transform**	06
	3.1	DFT, Relation between DFT and DTFT, IDFT	
	3.2	Properties of DFT, circular convolution of sequences using DFT	
	3.3	Fast Fourier transforms (FFT), Radix-2 decimation in time and decimation in frequency FFT algorithms, inverse FFT	
4		**IIR Digital Filters**	09
	4.1	Comparison of IIR and FIR filters, Types of IIR Filters, Analog filter approximations: Butterworth, Chebyshev I and II	
	4.2	Mapping of S-plane to Z-plane, impulse invariance method, bilinear transformation method, Design of IIR digital filters from analog filters with examples, Software simulation – Design of IIR Filters	
	4.3	Analog and digital frequency transformations	
5		**FIR Digital Filters**	05
	5.1	Characteristics of FIR digital filters, Minimum Phase, Maximum Phase, Mixed Phase and Linear Phase Filters Frequency response, location of the zero of linear phase FIR filters	
	5.2	Design of FIR filters using window techniques -Rectangular, Hamming, Hanning, Blackman, Bartlett, Software simulation – Design of FIR Filters.	
6		**DSP Processors and Applications**	04
	6.1	General purpose digital signal processors, DSP processor architecture, Selecting digital signal processors, Special purpose DSP hardware	
	6.2	Applications of DSP: Radar Signal Processing and Speech Processing	
		Total	**39**

Text Books:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, "*Digital Signal Processing*", A Practical Approach by, Pearson Education – Second edition
2. Tarun Kumar Rawat, "*Digital Signal Processing*", Oxford University Press, 2015
3. S Salivahanan, A Vallavaraj, C Gnanapriya. "Digital Signal Processing" – TMH, 2007

Reference Books:

1. ProakisJ., Manolakis D., "*Digital Signal Processing*", 4th Edition, Pearson Education
2. Sanjit K. Mitra, "Digital Signal Processing – A Computer Based Approach", edition 4e McGraw Hill Education (India) Private Limited
3. Oppenheim A, Schafer R, Buck J., "*Discrete Time Signal Processing*", 3rd Edition, Pearson Education.

4. B. Venkata Ramani and, M. Bhaskar, “Digital Signal Processors, Architecture, Programming and Applications”, Tata McGraw Hill, 2nd edition 2017.
5. L. R. Rabiner and B. Gold, “Theory and Applications of Digital Signal Processing”, Prentice-Hall of India, 2015.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO601	Electronic Product Design	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO601	Electronic Product Design	20	20	20	80	03	--	--	--	100

Course Pre-requisite: Electronic Circuits, Controls and Instrumentation

Course Objectives:

1. To understand the customer need-based product development process
2. To understand the Lab to market challenges in the product design and development
3. To understand the electronic product development stages
4. To understand the development consideration of hardware and software design and various testing method
5. To gain knowledge about various processes, safety & qualification certifications & the importance of documentation

Course Outcomes:

After successful completion of the course students will be able to:

1.Importance of customer-centric approach in the electronic product development process
2. Electronic product development stages and challenges
3. Implement learning for meeting a prototype as per industry standard/specification
4. Demonstrate problem-solving & troubleshooting skills in electronic product design
5. Prepare the relevant set of design documentation & present it as a case study

Module No.	Unit No.	Contents	Hrs.
1		**CUSTOMER CENTRIC APPROACH FOR PRODUCT DEVELOPMENT**	08
	1.1	Prototype, MVP, commercial product and related terminologies	
	1.2	Basics of customer discovery process, customer and value proposition	
	1.3	Understand product market fit, product failure, internal challenges for product development.	
	1.4	Identify the available market place for the product.	
2		**PRODUCT DEVELOPMENT CHALLENGES**	06
	2.1	Idea segmentation, product features, lab to market journey, Product development	

		stages, product development challenges.	
	2.2	Electronic product classification and certifications requirement. Indian and international standard for product compliance.	
3		**HARDWARE DESIGN & TESTING METHODS**	07
	3.1	Design process, identifying the requirements, formulating specifications, design specifications, system partitioning, functional design, architectural design,	
	3.2	Component selection criteria	
	3.3	Functional model v/s architectural model, prototyping, performance & efficiency measures, formulating a test plan, writing all the specifications, test procedures & test cases, design reviews, module debug & testing – black box testing, white box testing, grey box testing	
4		**SOFTWARE DESIGN & TESTING METHODS**	06
	4.1	Types of software, the waterfall model of software development, models, metrics & software limitations, risk abatement & failure prevention	
	4.2	Software bugs & testing	
	4.3	Good programming practice, user interface, embedded & real-time software	
5		**PRODUCT DEBUGGING & TESTING**	06
	5.1	Steps of debugging, the techniques for troubleshooting	
	5.2	Characterization, electromechanical components, passive components, active components, active devices, operational amplifier, analog-to-digital conversion, digital components,	
	5.3	Inspection & testing of components, process of simulation, prototyping & testing, integration, validation & verification, EMI & EMC issues	
6		**THE DOCUMENTATION PROCESS**	06
		Definition, needs & types of documentation, records, accountability & liability, audience, steps in preparation, presentation & preservation of documents	
		Methods of documentation, visual techniques, layout of documentation, bills of materials, manuals – instructional or operating manual, service and maintenance manual,	
		Fault finding tree, software documentation practices	
		Total	**39**

Text Books:

1. Phillip Kotler, Kevin Lane keller, Abraham Koshi, Mithieshwar Zha, “Marketing management” 13th edition
2. Alexander Osterwalder & Yves Pigneur, “Business model generation”
3. Alex Osterwalder, Yves Pigneur, Greg Bernarda, Alan Smith, “Value Proposition design”
4. G. C. Loveday, “Electronic Testing & Fault Diagnosis”, 4th edition, A. H. Wheeler Publishing
5. James K. Peckol, “Embedded Systems – A Contemporary Design Tool”, 1st edition, Wiley Publication
6. J. C. Whitaker, “The Electronics Handbook”, CRC Press

Reference Books:

1. GIFF CONSTABLE, Talking to humans
2. R. G. Kaduskar & V. B. Baru, Electronic Product Design, 3rd edition, Wiley India
3. Kim Fowler, Electronic Instrument Design, 2nd edition, Oxford University Press
4. Robert J. Herrick, PCB Design Techniques for EMC Compliance, 2nd edition, IEEE Press

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 601	Embedded Systems Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical /Oral	Oral	Total
		Internal assessment			End Sem Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 601	Embedded Systems Lab	--	--	--	--	--	25	25	--	50

Prerequisite:

1. Basics of Microcontroller programming
2. C programming

Laboratory Outcomes:

After successful completion of the course students will be able to:

1. Interface various sensors and actuators to embedded cores.
2. Write code using RTOS for multi-tasking Embedded systems
3. Design applications using different embedded cores

Term Work:

At least 10 experiments covering entire syllabus of **Embedded Systems and RTOS (ECC 601)** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Interfacing of LEDs /switches with any embedded core. (8051/ARM/STM32, etc)
2	Interfacing of Temperature sensor with any embedded core. (8051/ARM/STM32, etc)

3	Interfacing of LCD/ Seven segment display with any embedded core. (8051/ARM/STM32,etc)
4	Interfacing of Ultrasonic/Humidity sensor with any embedded core. (8051/ARM/STM32,etc)
5	Interfacing of a relay with any embedded core. (8051/ARM/STM32,etc)
6	Interfacing of a DC motor (speed and Direction control) with any embedded core.(8051/ARM/STM32,etc)
7	Interfacing of a stepper motor (to move by a particular angle) with any embedded core. (8051/ARM/STM32, etc)
8	Implement power management in any embedded core of your choice
9	Implement the I2C communication to connect to DS1307 RTC
10	Porting of FreeRTOS to Arduino/STM32.
11	Write a Program to Create Multiple Tasks and understand the Multitasking capabilities of RTOS(FreeRTOS).
12	Write a Program to illustrate the Queue Management Features of FreeRTOS.
13	Write a Program to illustrate the Event Management Features of FreeRTOS.
14	Write a Program to illustrate the use of Binary and Counting Semaphore for Task Synchronisation using FreeRTOS.
15	Build a Multitasking Real-Time Applications using the above IPC Mechanisms (Message Queue, EventGroup, Semaphores) with FreeRTOS on Arduino/STM32.
• *Students must perform the experiments using Simulation as well as in Hardware.* • *Experiments must include a minimum of 3 experiments using FreeRTOS*	

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 602	Artificial Intelligence and Computer Networks Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical/ Oral	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 602	Artificial Intelligence and Computer Networks Lab	--	--	--	--	--	25	25	--	50

Laboratory Outcomes (LO)

At the end of the course, students will be able to;

1. Identify suitable Agent Architecture for a given real world AI problem
2. Implement simple programs using Prolog.
3. Implement various search techniques for a Problem-Solving Agent.
4. Represent natural language description as statements in Logic and apply inference rules to it.
5. Construct a Bayesian Belief Network for a given problem and draw probabilistic inferences from it.
6. Design and implement various network applications such as data transmission between client and server, file transfer etc. using Socket Programming
7. Determine how to assign the IP addresses and configure a network on different operating environments.
8. Configure the networks using IP addressing and subnetting / supernetting schemes using various OS commands

Term Work:

At least 10 experiments covering entire syllabus of **Artificial Intelligence and Computer Networks (50 % Artificial intelligence and the remaining 50% Computer Networks experiments)** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
	Artificial Intelligence
1	Provide the PEAS description and TASK Environment for a given AI problem. Identify suitable Agent Architecture for the problem
2	Write simple programs using PROLOG as an AI programming Language
3	Implement any one of the Uninformed search techniques
4	Implement any one of the Informed search techniques E.g. A-Star algorithm for 8 puzzle problem
5	Implement adversarial search using min-max algorithm.
6	Write a program to implement genetic algorithm.
7	Prove the goal sentence from the following set of statements in FOPL by applying forward, backward and resolution inference algorithms.
8	Create a Bayesian Network for the given Problem Statement and draw inferences from it. (You can use any Belief and Decision Networks Tool for modeling Bayesian Networks)
	Computer Networks
1	Use a tool (Eg. NS2) to implement a specific Network topology with respect to the given number of nodes and physical configuration and do: • Graphical simulation of network with Routing Protocols and traffic consideration (TCP, UDP) • Analysis of network performance for quality parameters such as packet-delivery-ratio, delay, and throughput
2	Socket programming using TCP and/or UDP
3	Use basic networking commands in Linux (ping, tracert, nslookup, netstat, ARP, RARP, ip, ifconfig, dig, route, etc) and set up a network environment with multiple IP addresses and configuration of ARP tables. Set up a network environment in Windows platform also
4	Working with routing in Linux/windows: • View the current routing table • Add and delete routes • Change default gateway Perform IP Tables for IP forwarding
5	Set up and configuration of firewalls in Linux/windows (Use IPTables)
6	Packet Sniffing using Wireshark

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL603	Data Warehousing and Mining Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical/ Oral	Oral	Total
		Internal assessment			End Sem Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL603	Data Warehousing and Mining Lab	--	--	--	--	--	25	25	--	50

Laboratory Outcomes (LOs):

At the end of the course the student should be able to:

1. Design data warehouse using dimensional modelling
2. Perform different OLAP operations
3. Differentiate among different data mining techniques and decide the applicability for each.
4. Demonstrate classifications, prediction, etc. on datasets using open source tools
5. Perform Market basket analysis in real world data using data mining tools
6. Appreciate and visualize clustering techniques

Term Work:

At least 10 experiments covering entire syllabus of **Data Warehousing and Mining** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	One case study on building Data warehouse/Data Mart • Write Detailed Problem statement and design dimensional modelling (creation of star and snowflake schema) • Implementation of all dimension table and fact table

2	Implementation of OLAP operations: Slice, Dice, Rollup, Drilldown and Pivot for the above problem statement (experiment 1)
3	Implementation of Classification algorithm(Decision Tree/Naive Bayes)
4	Implementation of Clustering algorithm(K-means/Agglomerative)
5	Implementation of Association Rule Mining algorithm (Apriori)
6	Implementation of prediction algorithm (Linear regression)
7	Perform data Pre-processing task and Demonstrate Classification algorithm on data sets using data mining tool (WEKA, R tool, XL Miner, Orange etc.)
8	Perform data Pre-processing task and Demonstrate Clustering algorithm on data sets using data mining tool (WEKA, R tool, XL Miner, Orange etc.).
9	Perform data Pre-processing task and Demonstrate Association algorithm on data sets using data mining tool (WEKA, R tool, XL Miner, Orange etc.).
10	Demo on any cloud-based data warehousing process (an end to end process) which gives a holistic view of Data Warehouse

Text Books:

1. Oracle database SQL reference
2. Oracle warehouse builder
3. Weka tutorial
4. Python tutorial for classification and clustering
5. Tutorial on orange "https://orangedatamining.com/getting-started/"

Data sets available for download

1. Datasets for data mining "http://www.inf.ed.ac.uk/teaching/courses/dme/html/datasets0405.html"
2. Datasets for data mining "https://www.kdnuggets.com/datasets/index.html"
3. Datasets from UCI repository
4. Kaggle datasets

Web References

1. https://www.coursera.org/specializations/data-mining
2. https://www.udemy.com/course/data-mining-python/
3. https://onlinecourses.nptel.ac.in/noc21_cs06/preview

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL604	Skill base Lab: Linux Server Administration Lab	--	2*+ 2 Hours (Batch-wise)	--	--	02	--	02
*Theory class to be conducted for full class								

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical/ Oral	Oral	Total
		Internal assessment			End Sem Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL604	Skill base Lab: Linux Server Administration Lab	--	--	--	--	--	50	--	--	50

Course Pre-requisites: Familiarity to computer systems, Computer Networks

Course Objectives:

1. To introduce the concept of Open-Source Software.
2. To impart knowledge and skills on various practical and theoretical aspects of Linux operating system (OS) basics and Linux OS based server configuration, management and administration.
3. To provide a comprehensive introduction to SHELL programming, services and utilities.
4. To Introduce the Linux system Security and Virtualization technologies concepts like Hypervisor, emulation, and application

Course Outcomes:

At the end of the course the student should be able to:

1. Understand the concept of Open-source technology and basics of Linux operating system
2. Learn various Linux Command Line administration tasks and perform file, user, group and process management tasks
3. Learn various Linux Command Line utilities to perform storage and network management tasks
4. Learn Linux Server administration tasks and configure servers for front and backend services.
5. Analyse a given problem and apply requisite facets of SHELL programming in order to devise a SHELL script to solve the problem
6. Apply security measures to protect the operating environment and explain virtualization and their role in elastic computing.

Module No		Topics	Hours
1		**Introduction to Open-Source Software**	06
	1.1	Need of Open Sources, Advantages and applications of Open sources, FOSS – FOSS usage, Free Software Movement, Open-Source Software Development Model, comparison with close source / Proprietary software, widely used open-source software license: Apache License 2.0, BSD license, GNU General Public License, MIT License, Mozilla Public License 2.0	
	1.2	**Installation of Linux (Redhat-CentOS-Fedora-Ubuntu):** Linux Architecture, Kernel and shells, Boot Process, bootloader, understanding FHS of Linux, Understanding the different types of run-levels, understanding different types of shutdown commands,	
2		**Open-Source Operating System: System Administration Task**	08
	2.1	**Basic Command Line:** Working with the Bash Shell, Getting the Best of Bash, Useful Bash Key Sequences, Working with Bash History, Performing Basic File System Management Tasks, Working with Files and Directories, Piping and Redirection, Finding Files, Working with Links	
	2.2	**Process management Task:** Performing Job Management Tasks, System and Process Monitoring and Management, Managing Process Niceness, Scheduling Jobs using CRON, Creating Backups,	
	2.3	**Users, Groups, and Permissions:** Managing Users and Groups, Commands for User Management, Managing Passwords, Modifying and Deleting User Accounts, Configuration Files, Creating Groups, Managing Permissions, the Role of Ownership, Basic Permissions: Read, Write, and Execute, Advanced Permissions, Working with Access Control Lists, Setting Default Permissions with umask, Working with Attributes	
3		**Open-Source Operating System: Storage and Network Management**	08
	3.1	**Storage Configuration and Management:** Understanding Partitions and Logical Volumes, Creating Partitions, File Systems Overview, Creating File Systems, Mounting and Unmounting File systems, Mounting File Systems Automatically Through fstab, Working with Logical Volumes, Creating Logical Volumes, Resizing Logical Volumes, Creating Swap Space, Working with Encrypted Volumes	
	3.2	**Network Management:** Understanding Network Manager, Network Manager Configuration Files, Network Service Scripts, Networking from the Command Line, Troubleshooting Networking, Setting Up IPv4 and IPv6, Configuring SSH, Enabling the SSH Server, Using the SSH Client, Using PuTTY on Windows Machines, Configuring Key- Based SSH Authentication, Using Graphical Applications with SSH, Using SSH Port Forwarding, Configuring VNC Server Access	
4		**Open-Source Operating System: Server Administration Task**	08
	4.1	**Configuring Server for File Sharing:** What is NFS? Advantages and Disadvantages of NFS, Configuring NFS4, Setting Up NFSv4, Mounting an NFS Share, Making NFS Mounts Persistent, Configuring Automount, Configuring Samba, Setting Up a Samba File Server, Samba Advanced Authentication Options, Accessing Samba Shares, Understanding the features and advantages of FTP server, Configuring FTP server and FTP clients, Understanding FTP Basic Commands	

	4.2	**Configuring LAMP stack:** Configuring the Apache Web Server, creating a Basic Website, Understanding the Apache Configuration Files, Apache Log Files, Working with Virtual Hosts, Securing the Web Server with TLS Certificates, Setting Up MySQL and PhpMyAdmin.	
5		**Bash Shell Scripting**	**10**
	5.1	**Introducing Bash Shell Scripting:** Introduction to Shells, Executing the Script, Working with Variables and Input, Understanding Variables, Working with Script Arguments, reading user input, Using Command Substitution, Substitution Operators, Changing Variable Content with Pattern Matching, Performing Calculations, Using Control Structures, using if…then…else, using case, using while, using until, using for.	
	5.2	**Advanced Shell Scripting:** Using I/O Redirections, Functions, Arrays, Process substitution, Commands Chaining, AWK, GAWK, SED, CUT and REGEX. Working with web using shell script: Downloading web page as formatted text file and parsing for data, working CURL etc.	
6		**Open-Source Operating System: Advanced security & Virtualization**	**08**
	6.1	**SELinux and FirewallD:** SELinux Overview, SELinux Tools, SELinux Contexts, SELinux Booleans, Use SELinux port labeling to allow services to use non-standard ports, Diagnose and address SELinux policy violations, Configure FirewallD, Understand Firewalld Components, Setting Default Firewalld Zone, Creating Own Services in Firewalld, Assigning Services to Firewalld Zones, Adding Rich Rules for Network Range	
	6.2	**Virtualization:** Introduction to virtualization and its types, need of virtualization, Benefits of Virtualization, Virtualization Implementation, Kernel based Virtual Machines (KVM) and XE	

Text Books:

1. Linux: The Complete Reference, Sixth Edition by Richard Petersen, McGraw Hill Education; 6th edition (1 July 2017)
2. Linux Command Line and Shell Scripting Bible by Richard Blum Wiley; 3rd edition (17 March 2015)
3. Red hat Linux Networking and System Administration, by Terry Collings and Kurt Wall, Wiley 3rd edition 2005

Reference Books:

1. Linux Administration: A Beginner's Guide by Wale Soyinka, McGraw-Hill Education; 8th edition (28 April 2020)
2. Red Hat Enterprise Linux 6 Administration, Real World Skills for Red Hat Administrators by Sander van Vugt, John Wiley and Sons 2013
3. Rhcsa Red Hat Enterprise Linux 8: Training and Exam Preparation Guide, Asghar Ghori, Endeavor Technologies (10 January 2020)

Software Resources:

1. **https://www.virtualbox.org/wiki/Downloads**
2. **https://getfedora.org/**
3. **https://www.centos.org/download/**
4. **https://ubuntu.com/download/desktop**
5. **https://developers.redhat.com/products/rhel/download**

Online Resources: (browser-based terminals)

1. **https://distrotest.net/**
2. **https://bellard.org/jslinux/**
3. **http://www.webminal.org/terminal/**
4. **https://www.tutorialspoint.com/unix_terminal_online.php**

Online Resources: (Study Resources)

1. **https://training.linuxfoundation.org/training/introduction-to-linux/**
2. **https://www.netacad.com/courses/os-it/ndg-linux-unhatched**
3. **https://www.netacad.com/courses/os-it/ndg-linux-essentials**
4. **https://www.edx.org/course/fundamentals-of-red-hat-enterprise-linux**
5. **https://linuxhandbook.com/tag/bash-beginner/**
6. **https://www.learnshell.org/**
7. **https://itsfoss.com/shell-scripting-resources/**

Suggested List of Experiments

Sr. No	Experiment Title
1	Installation of Red HAT/Centos/Fedora Linux operating system. a. Partitioning drives b. Configuring boot loader (GRUB/LILO) c. Updating and upgrading the system d. Shutting down and reboot
2	Learning and executing Linux commands for a. Interacting with BASH shell and built-in shell variables b. Navigation c. File and directory management d. Working with links e. Searching files
3	Learning and executing Linux commands for Process management tasks like a. Executing a process b. Getting process info c. Killing a process d. Changing process attributes e. Managing foreground and background processes f. Scheduling automated jobs using CRON jobs
4	Learning and executing Linux commands for managing Users, Groups, and Permissions

	a. Creating, modifying and deleting users b. Creating, modifying and deleting groups c. Managing file permissions, attributes and ownerships d. Setting Default Permissions with umask e. Setting up access control list for files and directories
5	Learning and executing Linux commands for managing Storage drives in Linux environment a. Create partitions b. Install file system c. Mount and unmount partitions manually from CLI d. Automated mounting using fstab e. Encrypt volumes
6	Learning and executing Linux commands for managing networking in Linux environment a. Enable networking services from command line b. Configure IP and other network settings from command line. c. Configure IP and other network settings from configuration files. d. Configure SSH based services for CLI and GUI access on remote machines.
7	Install and configure an NFS server and mount NFS shares on Linux Environment
8	Install and configure files sharing services using FTP server
9	Install and configure Samba file server and share files across local network.
10	Install and configure a LAMP stack and deploy a full stack web application on it with SSL/TLS security.
11	Shell Scripting: **a.** Write a shell script program to display list of user currently logged in. **b.** Write a shell script program to display “HELLO WORLD”. **c.** Write a shell script program to develop a scientific calculator. **d.** Write a shell Script program to check whether the given number is even or odd. **e.** Shell script Program to search whether element is present is in the list or no **f.** Shell script program to check whether given file is a directory or not. **g.** Shell script program to count number of files in a Directory. **h.** Shell script program to copy contents of one file to another. **i.** Create directory, write contents on that and Copy to a suitable location in your home directory. **j.** Use a pipeline and command substitution to set the length of a line in file to a variable. **k.** Write a program using sed command to print duplicated lines of

	Input. **l.** Write a grep/egrep script to find the number of words character, words and lines in a file. **m.** Write an awk script to develop a Fibonacci series. **n.** Write an awk script to display the pattern of given string or number. **o.** Write a shell script program to check variable attributes of file and processes. **p.** Write a shell script program to check and list attributes of processes. **q.** Shell Script program to implement read, write, and execute permissions. **r.** Shell Script program for changing process priority.
12	Configuring security for the Linux Server environment using SELinux and FirewallD
13	Install and set up KVM to run isolated instances of other operating systems inside a Linux host system

Subject Code	Subject Name	Credits Assigned
ECM601	Mini project – 2B	02

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal Assessment			End Sem Exam	Exam duration Hours			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECM601	Mini project – 2B	--	--	--	--	--	25	25	50

Objectives

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcomes:

Learner will be able to;

1. Identify problems based on societal /research needs.
2. Apply knowledge and skill to solve societal problems in a group.
3. Develop interpersonal skills to work as member of a group or leader.
4. Draw the proper inferences from available results through theoretical/experimental/simulations.
5. Analyze the impact of solutions in societal and environmental context for sustainable development.
6. Use standard norms of engineering practices.
7. Excel in written and oral communication.
8. Demonstrate capabilities of self-learning in a group, which leads to life-long learning.
9. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Major focus of Mini-project 2 shall be towards exploration and applicability of knowledge acquired in the domain areas of DLOs available for the year.
- Student shall give special consideration to identify and provide solutions to the burning societal and/or environmental issues which may affect the mankind to larger extend.

- Students shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.

A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on
  self- learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.
- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case-to-case basis.

Guidelines for Assessment of Mini Project:

The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester. In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

Distribution of Term work marks for both semesters shall be as below;

Marks awarded by guide/supervisor based on logbook: 10
Marks awarded by review committee : 10
Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

In **first semester** entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.

- First on identification and finalization of problem
- Second on proposed solution for the problem.

In **second semester** expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.

- First review shall base on readiness of building working prototype.
- Second review shall be based on poster presentation-cum-demonstration of working model in last month of the said semester.

Half-year project:

In this case students' group shall complete project in all aspects, in a semester, including;

- Identification of need/problem
- Proposed acceptable solution for the identified problem
- Procurement of components/systems, if any,
- Building a working prototype and testing

The group shall be evaluated twice during the semester by review committee, mainly look for the progress as;

- First review focus shall be towards identification & selection of problem and probable solution proposal.
- Second review shall be for implementation and testing of solution. (Innovative/out of box solution)

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria:

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Innovativeness and out of box thinking
6. Cost effectiveness and Societal impact
7. Functional working model as per stated requirements
8. Effective use of skillsets acquired through curriculum including DLOs
9. Effective use of standard engineering practices & norms
10. Contribution of an individual as team member/Leader
11. Feasibility to deploy the solution on large scale
12. Clarity in written and oral communication

In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini-project.

In case of **half year project** all criteria's in generic may be considered for performance evaluation of students in mini-project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

Report should be prepared as per the guidelines issued by the University of Mumbai. Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations, having experience of more than five years approved by head of the Institute.

Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed by team of external & internal examiner at the end of semester/year. Performance shall be evaluated based on;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Implementation of working model
5. Effective use of diversified skill-set
6. Effective use of standard engineering practices & norms
7. Contribution of an individuals as a member/Leader
8. Clarity in written and oral communication

University of Mumbai

No. AAMS_UGS/ICC/2022-23/121

CIRCULAR :-

Attention of the Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology is invited to this office circular No.UG/96 of 2021 dated 1st April, 2021 relating to the revised syllabus of B.E. Degree Course has been amended by incorporating Electronics and Computer Science Branch.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Electronics Engineering at its meeting held on 16th June, 2022 and subsequently passed in the Faculty and then by the Board of Deans at its meeting held on 5th July, 2022 vide item No. 6.33 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.33 (R) and that in accordance therewith, the revised syllabus of B.E. (Electronics & Computer Science) (Sem.– VII & VIII) (CBCS) (REV-2019 'C' Scheme) has been brought into force with effect from the academic year 2022-23.(The circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
20th October, 2022

(Dr. Shailendra Deolankar)
I/c Registrar

To

The Principals of the Affiliated Colleges and Directors of the recognized Institutions in Faculty of Science & Technology.

A.C/6.33(R)/11/07/2022

****

No. AAMS_UGS/ICC/ 2022-23/121 — 20th October, 2022

Copy forwarded with Compliments for information to:-

1) The Dean, Faculty of Science & Technology,
2) The Chairman, Ad-hoc Board of Studies in Electronics Engineering,
3) The Director, Board of Examinations and Evaluation,
4) The Director, Board of Students Development,
5) The Director, Department of Information & Communication Technology,
6) The Co-ordinator, MKCL.

(Dr. Shailendra Deolankar)
I/c Registrar

Desktop/Circular of Engineering/Priya

Copy to :-

1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),
2. The Deputy Registrar, College Affiliations & Development Department (CAD),
3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),
4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),
5. The Deputy Registrar, Executive Authorities Section (EA),
6. The Deputy Registrar, PRO, Fort, (Publications Section),
7. The Deputy Registrar (Special Cell),
8. The Deputy Registrar, Fort/Vidyanagari Administration Department (FAD) (VAD), Record Section,
10. The Professor-cum- Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,

They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.

1. P.A. to Hon'ble Vice-Chancellor,
2. P.A. to Pro-Vice-Chancellor,
3. P.A. to Registrar,
4. All Deans of all Faculties,
5. P.A. to Finance & Account Officer, (F. &. A.O.),
6. P.A. to Director, Board of Examination & Evaluation,
7. P.A. to Director, Innovation, Incubation and Linkages,
8. P.A. to Director, Board of Lifelong Learning and Extension (BLLE),
9. The Director, Dept. Of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,
10. The Director of Board of Student Development,
11. The Director, Department of Students Welfare (DSD),
12. All Deputy Registrar, Examination House,
13. The Deputy Registrars, Finance & Accounts Section,
14. The Assistant Registrar, Administrative sub-campus Thane,
15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,
16. The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri,
17. The Assistant Registrar, Constituent Colleges Unit,
18. BUCTU,
19. The Receptionist,
20. The Telephone Operator,
21. The Secretary MUASA,

for information.

AC – 11 July, 2022
Item No. – 6.33 (R)

University of Mumbai

Revised Syllabus for

B.E. (Electronics & Computer Science)

(Sem. - VII to VIII)

(Choice Based Credit System)

(With effect from the academic year 2022-23)

University of Mumbai

Syllabus for Approval

O: ____________ **Title of Course**	B.E. (Electronics & Computer Science)
O: ____________ **Eligibility**	Passing Third Year Engineering as per the Ordinance 0.6242
R: ____________ **Passing Marks**	40%
No. of years/Semesters:	4 Years / 8 Semester
Level:	~~P.G.~~ / U.G./ ~~Diploma / Certificate~~
Pattern:	~~Yearly~~ / Semester
Status:	~~New~~ / Revised 2019 'C'
To be implemented from Academic Year:	With effect from Academic Year : 2022-23

Dr. R N Awale
Chairman
of Ad-hoc Board of Studies in Electronics Engineering

Dr. Suresh K. Ukarande
Associate Dean,
Faculty of Science and Technology

Dr Anuradha Majumdar
Dean,
Faculty of Science and Technology

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc. There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C‘scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr. Anuradha Muzumdar
Dean
Faculty of Science and Technology
University of Mumbai

Preface

Technical education in the country is undergoing a paradigm shift in current days. Think tank at national level are deliberating on the issues, which are of utmost importance and posed challenge to all the spheres of technical education. Eventually, impact of these developments was visible and as well adopted on bigger scale by almost all universities across the country. These are primarily an adoption of CBCS (Choice base Credit System) and OBE (Outcome based Education) with student centric and learning centric approach. Education sector in the country, as well, facing critical challenges, such as, the quality of graduates, employability, basic skills, ability to take challenges, work ability in the fields, adoption to the situation, leadership qualities, communication skills and ethical behaviour. On other hand, the aspirants for admission to engineering programs are on decline over the years. An overall admission status across the country is almost 50%; posing threat with more than half the vacancies in various colleges and make their survival difficult. In light of these, an All India Council for Technical Education (AICTE), the national regulator, took initiatives and enforced certain policies for betterment, in timely manner. Few of them are highlighted here, these are design of model curriculum for all prevailing streams, mandatory induction program for new entrants, introduction of skill based and inter/cross discipline courses, mandatory industry internships, creation of digital contents, mandate for use of ICT in teaching learning, virtual laboratory and so on.

To keep the pace with these developments in technical education, it is mandatory for the Institutes & Universities to adopt these initiatives in phased manner, either partially or in toto. Hence, the ongoing curriculum revision process has a crucial role to play. The BoS of Electronics Engineering under the faculty of Science & Technology, under the gamut of Mumbai University has initiated a step towards adoption of these initiatives. We, the members of Electronics Engineering Board of Studies of Mumbai University feel privileged to present the revised version of curriculum for Electronics Engineering program to be implemented from academic year 2020-21. Some of the highlights of the revision are;

i. Curriculum has been framed with reduced credits and weekly contact hours, thereby providing free slots to the students to brain storm, debate, explore and apply the engineering principles. The leisure provided through this revision shall favour to inculcate innovation and research attitude amongst the students.
ii. New skill-based courses have been incorporated in curriculum keeping in view AICTE model curriculum.
iii. Skill based Lab courses have been introduced, which shall change the thought process and enhance the programming skills and logical thinking of the students
iv. Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the group dynamics, develop leadership qualities, facilitate decision making and enhance problem solving ability with focus towards socio-economic development of the country. In addition, it shall be direct application of theoretical knowledge in practice, thereby, nurture learners to become industry ready and enlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystem with better means.
v. An usage of ICT through NPTEL/SWAYAM and other Digital initiatives of Govt. of India shall be encouraged, facilitating the students for self-learning and achieve the Graduate Attribute (GA) specified by National Board of accreditation (NBA) i.e. lifelong learning.

Thus, this revision of curriculum aimed at creating deep impact on the teaching learning methodology to be adopted by affiliated Institutes, thereby nurturing the student fraternity in multifaceted directions and create competent technical manpower with legitimate skills. In times to come, these graduates shall shoulder the responsibilities of proliferation of future technologies and support in a big way for 'Make in India' initiative, a reality. In the process,

BoS, Electronics Engineering got whole hearted support from all stakeholders including faculty, Heads of department of affiliating institutes, experts faculty who detailed out the course contents, alumni, industry experts and university official providing all procedural support time to time. We put on record their involvement and sincerely thank one and all for contribution and support extended for this noble cause.

Boards of Studies in Electronics Engineering

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. R. N. Awale	Chairman	5	Dr. Rajani Mangala	Member
2	Dr. Jyothi Digge	Member	6	Dr. Vikas Gupta	Member
3	Dr. V. A. Vyawahare	Member	7	Dr. D. J. Pete	Member
4	Dr. Srija Unnikrishnan	Member	8	Dr. Vivek Agarwal	Member

Program Structure for Final Year Electronics and Computer Science

UNIVERSITY OF MUMBAI

(With Effect from 2022-2023)

Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ECC 701	VLSI Design	3	-	-	3	-	-	**3**
ECC 702	Internet of Things	3	-	-	3	-	-	**3**
ECC DO701	Department Level Optional Course - III	3	-	-	3	-	-	**3**
ECC DO702	Department Level Optional Course - IV	3	-	-	3	-	-	**3**
ECC IO701	Institute Level Optional Course - I	3	-	-	3	-	-	**3**
ECL701	VLSI Design Lab	-	2			1		**1**
ECL702	Internet of Things Lab	-	2	-	-	1	-	**1**
ECL703	Department Level Optional Course - III Lab	-	2	-	-	1	-	**1**
ECP701	Major Project - I	-	6	-	-	3	-	**3**
Total		**15**	**12**	**-**	**15**	**6**	**-**	**21**

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Av					
ECC 701	VLSI Design	20	20	20	80	03	-	-	**100**
ECC 702	Internet of Things	20	20	20	80	03	-	-	**100**
ECC DO701	Department Level Optional Course - III	20	20	20	80	03	-	-	**100**
ECC DO702	Department Level Optional Course - IV	20	20	20	80	03	-	-	**100**
ECC IO701	Institute Level Optional Course - I	20	20	20	80	03	-	-	**100**
ECL701	VLSI Design Lab	-	-	-	-	-	25	25	**50**
ECL702	Internet of Things Lab	-	-	-	-	-	25	25	**50**
ECL703	Department Level Optional Course - III Lab	-	-	-	-	-	25	25	**50**
ECP701	Major Project - I	-	-	-	-	-	50	-	**50**
Total				**100**	**400**	-	**125**	**75**	**700**

Department Level Optional Courses:

Department Level Optional Course -III (DO701)	Department Level Optional Course -IV (DO702)
1. Deep Learning	1. Cloud Computing
2. Image Processing	2. Mobile Communication
3. Big Data Analytics	3. Cyber Security
4. Advanced Database Management Systems	4. Blockchain Technology

Program Structure for Final Year Electronics and Computer Science

UNIVERSITY OF MUMBAI

(With Effect from 2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ECC 801	Robotics	3	-	-	3	-	-	**3**
ECC DO801	Department Level Optional Course -V	3	-	-	3	-	-	**3**
ECC DO802	Department Level Optional Course -VI	3	-	-	3	-	-	**3**
ECC IO801	Institute Level Optional Course - II	3	-	-	3	-	-	**3**
ECL 801	Robotics Lab	-	2	-	-	1	-	**1**
ECL 802	Department Level Optional Course - V Lab	-	2		-	1		**1**
ECP 801	Major Project II	-	12	-	-	6	-	**6**
Total		**12**	**16**	**-**	**12**	**8**	**-**	**20**

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Av					
ECC 801	Robotics	20	20	20	80	03	-	-	**100**
ECC DO801	Department Level Optional Course -V	20	20	20	80	03	-	-	**100**
ECC DO802	Department Level Optional Course -VI	20	20	20	80	03	-	-	**100**
ECC IO801	Institute Level Optional Course - II	20	20	20	80	03	-	-	**100**
ECL 801	Robotics Lab	-	-	-	-	03	25	25	**50**
ECL 802	Department Level Optional Course - V Lab	-	-	-	-	-	25	25	**50**
ECP 801	Major Project II	-	-	-	-	-	50	100	**150**
	Total			**80**	**320**	**-**	**100**	**150**	**650**

Department Level Optional Courses:

Department Level Optional Course -V (DO801)	**Department Level Optional Course -VI (DO802)**
1. MEMS Technology	1. Advanced Networking Technologies
2. Natural Language Processing	2. Multimedia and Virtual Reality
3. 3-D Printing and Design	3. Quantum Computing
4. Advanced Algorithms	4. System Security

Note:

1. Students group and load of faculty per week.

   Mini Project 1 and 2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load: 1 hour per week per four groups

   Major Project 1 and 2:
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   Faculty Load: In Semester VII– ½ hour per week per project group
   In Semester VIII – 1 hour per week per project group

2. Out of 4 hours/week allotted for the mini-projects 1-A and 1-B, an expert lecture of at least one hour per week from industry/institute or a field visit to nearby domain specific industry should be arranged.

3. Mini-projects 2-A and 2-B should be based on DLOs.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 701	VLSI Design	03	02	--	03	01	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC 701	VLSI Design	20	20	20	80	03	25	25	--	150

Course Pre-requisite: Electronic Devices (ECC 302)
Electronic Circuits (ECC402)
Digital Electronics (ECC 303)

Course Objectives:

1. To understand VLSI Design flow and technology trends.
2. To realise MOS based circuits using different design styles.
3. To study semiconductor memories using MOS logic.
4. To study adder, multiplier and shifter circuits for realizing data path design.
5. Understand the Backend flow of the IC Fabrication

Course Outcomes:

After successful completion of the course students will be able to:

1. Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models.
2. Design and analyse MOS based inverters.
3. Realise MOS based circuits using different design styles.
4. Realise semiconductor memories, adder, multiplier and shifter circuits using CMOS logic.
5. Understand the flow of IC Fabrication

Module No.	Unit No.	Contents	Hrs.
1		**VLSI Design flow and Technology Trends**	05
	1.1	VLSI Design Flow: Full custom and Semicustom IC design flow	
	1.2	Semiconductor Manufacturing: Semiconductor technology trend,clean rooms, Wafer cleaning and Gettering. Fabrication flowchart for steps in IC fabrication	
	1.3	Scaling: Types of scaling, comparison of MOSFET Model levels	
	1.4	Technology Comparison: Comparison of BJT and MOS technologies, long channel and short channel MOS devices	
2		**MOSFET Inverters**	08
	2.1	Introduction to MOS inverters: Active and passive load nMOS inverters, CMOS inverter and their comparison	
	2.2	Circuit Analysis of MOS InvertersStatic Analysis of Resistive nMOS and CMOS Inverters: Calculation of critical voltages and noise margins	
	2.3	Design of symmetric CMOS inverter	
	2.4	Analysis of CMOS inverter: Calculation of rise time, fall time and propagation delay	
	2.5	Various components of power dissipation in CMOS circuits	
3		**MOS Circuit Design Styles**	07
	3.1	Static CMOS	
	3.2	Pseudo NMOS design styles	
	3.3	Pass transistor, Transmission gate	
	3.4	Dynamic: C^2MOS	
	3.5	Significance of Stick diagram and Design rules, Layout of CMOS NAND, CMOS NOR	
4		**Combinational and Sequential Circuit Realization**	07
	4.1	Analysis and design of 2-I/P NAND, 2-I/P NOR and complex Boolean function realization using equivalent CMOS inverter for simultaneous switching, Complex Boolean function realization using various design stylesand Basic gates and MUX realization using pass transistor and transmission gate logic	
	4.2	SR Latch, JK FF, D FF, 1 Bit Shift Register realization using CMOS logic	
5		**Semiconductor Memories**	06
	5.1	SRAM: 6T SRAM operation, design strategy, read/write circuits, sense amplifier,	
	5.2	DRAM: 1TDRAM, operation modes, leakage currents, refresh operation, physical design	
	5.3	ROM Array: NAND and NOR based ROM array	
	5.4	Flash memory: F-N tunnelling	
6		**Data Path Design**	06
	6.1	Adder: CLA adder, MODL, Manchester carry chain, High-speed adders: carry skip, carry select and carry save	
	6.2	Multipliers and shifter: Array multiplier and barrel shifter	
		Total	**39**

Text Books:

1. CMOS Digital Integrated Circuits Analysis and Design, Sung-Mo Kang and Yusuf Leblebici, Tata McGraw Hill, Revised 4thEdition.
2. Introduction to VLSI Circuits and Systems, John P. Uyemura, Wiley India Pvt. Ltd.
3. Sorab K. Gandhi, “VLSI Fabrication Principles”, Wiley, Student Edition.

Reference Books:

1. Digital Integrated Circuits: A Design Perspective, Jan M. Rabaey, Anantha ChandrakasanBorivoje Nikolic, Pearson Education, 2nd Edition
2. Basic VLSI Design, Douglas A Pucknell, Kamran Eshraghian, Prentice Hall of India Private Ltd.
3. Logical Effort: Designing Fast CMOS Circuits, Ivan Sutherlan and Bob Sproull
4. Basics of CMOS Cell Design, Etienne Sicard and Sonia Delmas Bendhia, Tata McGraw Hill
5. CMOS VLSI Design: A Circuits and Systems Perspective, Neil H. E. Weste, David Harris and Ayan Banerjee, Pearson Education
6. Analysis and Design of Digital Integrated Circuits, David Hodges, Horace Jackson, Resve Saleh, McGraw-Hill, Inc.
7. Advanced Semiconductor Memories: Architectures, Designs, and Applications, Ashok K. Sharma, Wiley Publication
8. Magnetic Memory Technology: Spin- Transfer- Torque MRAM and Beyond, Denny D.Tang, Chi-Feng Pai, Wiley online Library
9. Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications, Daniele Ielmini , Rainer Waser, Wiley online Library

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 702	Internet of Things	03	02	--	03	01	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC 702	Internet of Things	20	20	20	80	03	25	-----	25	150

Course Pre-requisite: Computer Networks, Embedded Systems, Web Technologies

Course Objectives:

1. To understand the basic building blocks of IoT
2. To understand various IoT protocols.
3. To introduce data handling in IoT
4. To understand the Design Methodology in IoT through case studies.

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand concepts, functional blocks and communication methodology relevant to IoT.
2. Identify various components of IoT
3. Compare various communication protocols for IoT.
4. Understand various methods for data handling in IoT-based systems.
5. Design basic applications based on IoT using specific components.
6. Introduce various security issues in IoT

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to IoT**	5
	1.1	Definition and Characteristics of IoT	
	1.2	IoT Protocols	
	1.3	IoT Functional Blocks	
	1.4	IoT Communication Models	
	1.5	IoT Communication APIs :- REST and WebSockets	
	1.6	IoT Enabling Technologies	
	1.7	Introduction to M2M and Difference between IoT and M2M	
2		**Components(Things) in IoT**	5
	2.1	Sensor Technology, Examples of Sensors	
	2.2	Actuators	
	2.3	Applications of RFID and WSN in IoT	
	2.4	Exemplary Device: - R–Pi and its Interfaces, PCDuino, BeagleBone	
3		**Data Handling in IoT**	9
	3.1	Data Acquiring and Storage, Organizing the Data, Transactions and Business Processes, Analytics	
	3.2	Data Collection, Storage and Computing Using Cloud Platform,	
		Introduction to Cloud Computing, Virtualization, Cloud Models	
		Cloud Services	
		IoT Cloud-based Data Collection, Storage, Computing using Xively	
4		**Design Principles for Web Connectivity**	10
	4.1	Communication Technologies – A comparison	
	4.2	Web Communication Protocols for connected devices:- CoRE Environment, CoAP, LWM2M, MQTT, XMPP, HTTP, SOAP Protocols	
	4.3	LPWAN Fundamentals: LORA and NBIoT	
5		**IoT Design Methodology**	6
	5.1	Defining Specifications About**:** **-** Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration: - Case Studies of Home automation, Weather Monitoring	
	5.2	IoT Levels and Deployment Templates	
	5.3	Supply Chain Management	
6		**IoT Security and Vulnerabilities Solutions**	4
	6.1	Iot Security Tomography and Layered Attacker Model	
	6.2	Identity Management, Establishment, Access Control and Secure Message Communication	
	6.3	Security Protocols	
		Total	**39**

Text Books:

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press.
2. Raj Kamal, " Internet of Things: Architecture and Design Principles", McGraw Hill Education ,First edition
3. David Hanes ,Gonzalo salgueiro"IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, Kindle 2017 Edition
4. Andrew Minteer ,"Analytics for the Internet of Things(IoT)", Kindle Edition

Reference Books:

1. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback, First Edition
2. Yashavant Kanetkar, Shrirang Korde: Paperback "21 Internet of Things (IOT) Experiments", BPB Publications

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
ECC DO701	Department Level Optional Course - III (Deep Learning)	**Theory**	**Practical**	**Tutorial**	**Theory**	**Practical**	**Tutorial**	**Total**
		03	**02**	**--**	**03**	**01**	**--**	**04**

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO701	Department Level Optional Course - III (Deep Learning)	**20**	**20**	**20**	**80**	**03**	**25**	**25**	**--**	**150**

Course Prerequisite: Basic Mathematics, Linear Algebra, Machine Learning

Course Objectives:

1. To develop mathematical concepts required for Deep Learning algorithms
2. To gain an in-depth understanding of training Deep Neural Networks.
3. To acquire knowledge of advanced concepts of Convolution Neural Networks, Autoencoders and Recurrent Neural Networks
4. To get familiarised with the recent trends in Deep Learning.

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand the basic knowledge of Neural Networks
2. Explain the process of training, optimization and Regularization of Deep Neural Networks
3. Design supervised models for DNN
4. Design unsupervised model for DNN
5. Select suitable DNN model for a given application

Module No.	Unit No.	Contents	Hrs.
1		**Introduction**	5
	1.1	Biological neuron, Mc-Culloch Pitts Neuron, Perceptron, Perceptron Learning, Delta learning, Multilayer Perceptron: Linearly separable, linearly non-separable classes.	
	1.2	Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning	
2		**Training, Optimization and Regularization of Deep Neural Network**	
	2.1	**Training Feedforward DNN** Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function	6
	2.2	**Optimization** Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp	
	2.3	**Regularization** Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output.	
3		**Convolutional Neural Networks (CNN): Supervised Learning**	
	3.1	Convolution Operation, Motivation, Basic structure of a convolutional neural network: Padding, strides, pooling, fully connected layers, interleaving between layers	
	3.2	Training a convolutional network: Backpropagation through convolution, Backpropagation as convolution with inverted filter, Convolution/backpropagation as matrix multiplication	
	3.3	Modern Deep Learning Architectures: LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet	
4		**Recurrent Neural Networks (RNN)**	
	4.1	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Back propagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT	
	4.2	Long Short Term Memory: Selective Read, Selective write, Selective Forget, Gated Recurrent Unit	

5		**Autoencoders: Unsupervised Learning**	
	5.1	Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders	
	5.2	Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders	
6		**Recent Trends and Applications**	
	6.1	Generative Adversarial Network (GAN): Architecture	
	6.2	Applications: Image Compression, Brain Tumour Detection, Fraud Detection, Expression identification	
		Total	**39**

Text Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville. Deep Learning. An MIT Press book. 2016.
2. Li Deng and Dong Yu, “Deep Learning Methods and Applications”, now publishers Inc (30 June 2014)
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4. J M Zurada “Introduction to Artificial Neural Systems”, Jaico Publishing House
5. M. J. Kochenderfer, Tim A. Wheeler. “Algorithms for Optimization”, MIt Press.

Reference Books:

1. Jon Krohn, Grant Beyleveld, Aglae Bassens, “Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence”, Pearson Education.
2. Buduma, N. and Locascio, N., “Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.".
3. François Chollet, “Deep Learning with Python”, Manning Publications, 2018.
4. Douwe Osinga. “Deep Learning Cookbook”, O’REILLY, SPD Publishers, Delhi.
5. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Online References:

Sr. No.	Website Links
1	https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
2	http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3	https://nptel.ac.in/courses/106/106/106106184/
4	https://www.deeplearningbook.org/
5	http://introtodeeplearning.com/
6	http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDO701	Image Processing	03	02	--	03	01	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ECCDO 701	Image Processing	20	20	20	80	03	25	25	150

Course Pre-requisite: Engineering Mathematics, Digital Signal Processing

Course Objectives:

1. To learn the fundamental concepts of image processing for image enhancement.
2. To learn image compression, segmentation techniques with practical applications.
3. To provide basic concepts of computer vision and its applications.

Course Outcomes:

After successful completion of the course students will be able to:

1. Represent image in its numerical and graphical form.
2. Perform different image enhancement approaches for improving image quality.
3. Elucidate the mathematical modelling of image segmentation and morphology.
4. Apply the concept of image compression.
5. Understand computer vision system elements.
6. Develop a computer vision system based on requirement.

Module No.	Unit No.	Contents	Hrs.
1		**Fundamentals of Digital Image Processing**	4
	1.1.	Introduction: Background, Representation of a Digital Image, Fundamental steps in Image Processing, Elements of a Digital Image Processing System.	
	1.2.	Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Model, Two-dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Introduction to ColorModel(RGB, CMYK, YIQ, HSI).	
2		**Enhancement in Spatial and Frequency domain**	10
	2.1.	Enhancement in the spatial domain: Intensity Transformations, Histogram Processing, Arithmetic and logical operations.	
	2.2.	Spatial domain filters: Smoothing Filters, Sharpening Filters, High boost Filter.	
	2.3.	Image Transforms: 2D-DFT, FFT, DCT and Haar Transform. Frequency domain enhancement, Homomorphic filtering.	
3		**Image Segmentation and Morphology**	6
	3.1.	Image Segmentation: Detection of discontinuities, Edge linking and Boundary detection, Thresholding, Region based segmentation.	
	3.2	Image Morphology: Dilation, Erosion, Opening, Closing, Hit-Or-Miss Transformation, Boundary Detection, Thinning, Thickening.	
4		**Image Compression**	6
	4.1	Need of compression, Redundancy, Objective and subjective fidelity criteria. Lossless compression: Run Length Coding, VLC (Huffman coding), Arithmetic coding, LZW Coding, Vector Quantization. Lossy compression: Bit plane coding, Predictive Coding, Transform Coding, JPEG Compression standard.	
5		**Computer Vision Basics**	9
	5.1	Introduction, definition, Computer vision components, Boundary Pre-processing: Chain code, Boundary approximation, Signatures, Skeletonization.	
	5.2	Image Feature Extraction: Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, Gabor Filters and DWT. Boundary feature descriptors: Basic descriptors, Shape descriptor, Fourier descriptors, Statistical moments. Region feature descriptors: color, intensity and texture.	
6		**Computer Vision Applications**	4
	6.1	Computer Vision applications: Visual inspection of equipments, object detection like locating pedestrians, face detection and recognition, counting vehicles, content-based image retrieval, applications of computer vision in agriculture, health care, industry, sports etc.	
		Total	**39**

Text Books:

1. Rafael C. Gonzalez and Richard E.Woods, "Digital Image Processing," Pearson Education, edition 4, 2018.
2. Anil K.Jain, "Fundamentals of Digital Image Processing," Pearson Education, 2010.
3. S. Jayaraman, T. Veerakumar, A. Esakkirajan, "Digital Image Processing," First Edition, McGraw Hill Education, 2017
4. Robert J. Schallkoff , "Digital Image Processing and Computer Vision", John Wiley and Sons, 1989.
5. J. R. Parker , "Algorithms for Image Processing and Computer Vision" John Wiley and Sons, 1997.

Reference Books:

1. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003
2. B.Chanda and D.Dutta Majumder, "Digital Image Processing and Analysis," Prentice Hall of India, 2002
3. William K. Pratt, "Digital Image Processing," John Wiley & Sons, 2nd edition, 2004
4. Alan C. Bovik, "Handbook of Image and Video Processing," Elsevier Science Publishing Co Inc, 2009
5. Richard Szeliski, "Computer Vision: Algorithms and Applications," 2nd edition, The University of Washington, 2022
6. Kenneth R. Castleman, "Digital Image Processing," Pearson Education, 2006.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7014	Big Data Analytics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 7014	Big Data Analytics	20	20	20	80	03	--	--	100

Course Prerequisite:

Basic knowledge of Database Management System

Course Objectives:

1. To Provide an Overview of an exciting growing field of Big Data Analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql, Map Reduce.
3. To teach the fundamental techniques in achieving big data analytics with scalability and streaming capability

Course Outcomes:

After successful completion of the course student will be able to:

1. Understand the key issues in big data management and its associated applications in intelligent business andscientific computing.
2. Acquire fundamental enabling techniques and scalable algorithms like Hadoop, MapReduce & NoSQL in big data analytics.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.
5. Develop applications for Big Data analysis using Hadoop and NoSQL etc.

Module No.	Unit No.	Topics	Hrs
1		**Introduction to Big Data Analytics**	03
	1.1	Introduction to Big Data, Big Data characteristics, Types of Big Data, Traditional vs. Big Data a business approach	
	1.2	Technologies Available for Big Data, Infrastructure for Big Data, Big Data Challenges, Case Study of Big Data Solutions.	
2		**Hadoop**	05
	2.1	Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem-Apache HBase, Hive, HCatalog, Pig, Mahout, Oozie, Zookeeper, Sqoop, Physical Architecture, Hadoop limitations.	
3		**NoSQL**	06
	3.1	Introduction to NoSQL, NoSQL business drivers, NoSQL database case studies.	
	3.2	NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns	
	3.3	Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems, Managing MongoDB database with CRUD operations.	
4		**MapReduce**	06
	4.1	MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization.	
	4.2	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures	
	4.3	Algorithms Using MapReduce: MapReduce WordCount Program, Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations by MapReduce, Matrix Operations, Matrix Multiplication by MapReduce.	
5		**Techniques in Big Data Analytics**	13
	5.1	Finding Similar Item: Nearest Neighbor Search, Similarity of Documents, Distance Measures: Euclidean, Jaccard , Cosine , Edit and Hamming Distance with its Examples	
	5.2	Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis Filtering streams: The Blooms filter.	
	5.3	Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a	

		search engine, Efficient computation of Page Rank: Page Rank Implementation Using MapReduce	
	5.4	Frequent Itemset Mining: Market-Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu	
6		**Big Data Analytics Applications**	**06**
	6.1	Recommendation Systems: Introduction, A Model for Recommendation Systems: Collaborative-Filtering System, Content based system and its Examples.	
	6.2	Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Network. Clustering of Social Graphs: Applying Standard Clustering Techniques, Counting triangles using MapReduce.	
		Total	**39**

Textbooks:

1. Radha Shankarmani and M Vijayalakshmi ―Big Data Analytics‖, Wiley
2. Alex Holmes ―Hadoop in Practice‖, Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly ―Making Sense of NoSQL – A guide for managers and the rest of us,Manning Press.

Reference Books:

1. Bill Franks, ―Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics‖, Wiley
2. Chuck Lam, ―Hadoop in Action‖, Dreamtech Press

E-Resources:

1. https://www.analyticsvidhya.com/blog/2014/05/hadoop-simplified
2. https://www.analyticsvidhya.com/blog/2014/05/introduction-mapreduce/
3. https://www.pdfdrive.com/big-data-analytics-a-hands-on-approach-e158549112.html
4. https://www.pdfdrive.com/data-science-and-big-data-analytics-e58447171.html

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO701	Advanced Database Management Systems	03	02	--	03	01	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO 701	Advanced Database Management Systems	20	20	20	80	03	25	–	25	125

Course Prerequisite: Database Management System.

Course Objectives:

1. To impart knowledge related to query processing and query optimizer phases of a database management system
2. To introduce concepts of advanced access control techniques like role based and discretionary methods
3. To impart knowledge related to indexing in database management system
4. To introduce advanced database models like parallel and distributed databases
5. To impart an overview of emerging data models like temporal, mobile and spatial databases.
6. To introduce concepts of Big data

Course Outcomes:

After successful completion of the course students will be able to

1. Measure query costs and design alternate efficient paths for query execution.
2. Apply sophisticated access protocols to control access to the database.
3. Implement alternate models like Parallel and Distributed databases and Design applications using advanced models like mobile, spatial databases
4. Apply indexing techniques on large data in database
5. Apply Big data concepts in real world applications

Module No.	Unit No.	Contents	Hrs.
1		**Query Processing and Optimization**	6
	1.1	Query Optimization Overview, Measures of Query Cost Selection Operation	
	1.2	Sorting, Join Operation, Other Operations, Evaluation of Expressions	
	1.3	Transformation of Relational Expressions Estimating Statistics of Expression Results, Choice of Evaluation Plans	
2		**Advanced Data Management Techniques**	6
	2.1	Advanced Database Access protocols: Discretionary Access Control Based on Granting and Revoking Privileges;	
	2.2	Mandatory Access Control and Role- Based Access Control.	
	2.3	Overview of Advanced Database models like Mobile databases, Temporal databases, Spatial databases.	
3		**Indexing**	7
	3.1	Indexed Sequential Access Method (ISAM) B+ Trees: A Dynamic Index Structure, Format of a Node	
	3.2	Search, insert, delete operations in B+ Tree	
	3.3	Hashing Techniques; Types of Indexes: Single Level Ordered Indexes; Multilevel Indexes; Overview of B-Trees and B+-Trees	
4		**Parallel Databases**	6
	4.1	Architectures for Parallel Databases, Parallel Query Evaluation and Optimization,	
	4.2	Data Partitioning, Parallelizing Sequential Operator Evaluation Code	
	4.3	Parallelizing Individual Operations: Bulk Loading and Scanning, sorting, joins	
5		**Distributed Databases**	6
	5.1	Introduction: Distributed Data Processing, What is a Distributed Database System?	
	5.2	Design Issues, Distributed DBMS Architecture.	
	5.3	Distributed Database Design: Top-Down Design Process, Distribution Design Issues, Fragmentation, Allocation.	
	5.4	Overview of Query Processing: Query Processing Problem, Objectives of Query Processing	
	5.5	Characterization of Query Processors, Layers of Query Processing, Query Optimization in Distributed Databases;	
6		**Introduction to Big Data**	8
	5.1	Sources and Uses of Big Data, Querying Big Data	
	6.2	Big Data Storage Systems: Distributed File Systems, Key-Value Storage Systems	
	6.3	The MapReduce Paradigm: MapReduce in Hadoop with the example of word count	
	6.4	Streaming Data: Querying Streaming Data Introduction to Graph Databases	
		Total	**39**

Text Books:

1. Korth, Slberchatz,Sudarshan, :"Database System Concepts", 6th Edition, McGraw – Hill
2. Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education.
3. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems" 3rd Edition McGraw Hill

Reference Books:

1. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom "Database System Implementation", Pearson Ltd. 1/e
2. Thomas M. Connolly Carolyn Begg, Database Systems: A Practical Approach to Design Implementation and Management, 4/e, Pearson Ltd.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDO702	Cloud Computing	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECCDO702	Cloud Computing	20	20	20	80	03	--	--	--	100

Course Pre-requisites: Computer networks, Basics of operating system (O.S.)

Course Objectives:

1. To provide an overview of cloud computing fundamentals.
2. To make students familiar with thekey concepts of virtualization.
3. To explore various cloud computing services.
4. To create an opensource cloud.
5. To identify risks and provide cloud security.
6. To analyze several cloud applications and recent trends in cloud computing.

Course Outcomes:
After successful completion of the course students will be able to:

1. Define cloud computing and understand different cloud services and deployment models.
2. Implement different types of virtualization.
3. Use several cloud computing services.
4. Design of opensource cloud.
5. Identification of threats and cloud-based risks for cloud security.
6. Understand cloud applications and recent trends.

Module No.	Unit No.	Contents	Hrs.
0		**Pre-requisites:** Basics of operating system (O.S.), ISO-OSI model and its layers	2
1		**Introduction to Cloud Computing**	4
	1.1	Definitionofcloudcomputing and cloud data centre, NIST model and cloud cube model, andcharacteristics of cloud computing.	
	1.2	Cloud deployment models (private, public, hybrid, and community) and service models (SaaS, PaaS, and IaaS).	
	1.3	Impact of cloud computing on business,key drivers for cloud computing.	
	1.4	Advantages and disadvantages of cloud computing.	
		Self-learning topics: Comparison between cloud service providers with traditional IT service providers.	
2		**Virtualization**	8
	2.1	Introduction and benefits of virtualization, implementation levels of virtualization, VMM.	
	2.2	Virtualization at O.S.level, middleware support for virtualization, virtualization structure/tools and mechanisms, hypervisor and xen architecture, binary translation with full virtualization, para virtualization with compiler support.	
	2.3	CPU virtualization, memory virtualization and I/O virtualization, virtualization in multicore processors,demonstration of virtualization usingtype II hypervisor.	
		Self-learning topics: Comparison between virtualization and containerization (docker).	
3		**Cloud Computing Services**	5
	3.1	Exploring different cloud computingservices: Software-as-a-Service (SaaS) (e.g., Dropbox, Google Workspace, Salesforce, etc.), Platform-as-a-Service(PaaS) (e.g., AWS Elastic Beanstalk, Windows Azure, Heroku, Google App Engine, etc.), Infrastructure-as-a-Service (IaaS) (e.g., DigitalOcean, AWS, Microsoft Azure, Google Compute Engine (GCE), etc.).	
	3.2	Anything-as-a-Service or Everything-as-a-Service (XaaS), Security-as-a-Service, Identity Management-as-a-Service, and Database-as-a-Service.	
	3.3	Storage-as-a-Service, Collaboration-as-a-Service, Compliance-as-a-Service,Monitoring-as-a-Service, Communication-as-a-Service,Network-as-a-Service Disaster Recovery-as-a-Service, Analytics-as-a-Service, and Backup-as-a-Service	
		Self-learning topics: Explore any 10 services offered by AWS/Microsoft Azure.	
4		**Open Source Cloud Implementation of OpenStack and Eucalyptus**	7
	4.1	OpenStack Cloud Architecture, Features of OpenStack, Components of OpenStack, Mode of Operations of OpenStack	
	4.2	Eucalyptus Architecture, Features of Eucalyptus, Components of Eucalyptus, Mode of Operations of Eucalyptus	
	4.3	Installation and configuration process of OpenStack and Eucalyptus	
		Self-learning topics: Exploreopen source cloud and edge computing platform for an enterprise: OpenNebula.	
5		**Cloud Security**	7
	5.1	Security overview, cloud security challenges and risks, SaaS security, cloud computing security architecture, architectural considerations.	
	5.2	General issues in securing cloud, securing data, application, and virtual machine security.	
	5.3	AAA model, automatic security establishing trusted cloud computing, secure execution environments and communications, access control, disaster recovery in clouds.	

		Self-learning topics: Cloud security in AWS/Microsoft Azure/Google Cloud Platform.	
6		**Cloud Applications and Recent Trends**	6
	6.1	**Cloud Applications:**	
		Scientific Applications: **Healthcare:** ECG analysis in cloud **IoT-enabled Cloud Applications:** Smart Agriculture	
		Business and Consumer Applications: CRM and ERP, Productivity, networking, media applications, multiplayer online gaming.	
	6.2	**Recent Trends:**	
		Mobile cloud computing, autonomic cloud computing, multimedia cloud, energy aware cloud computing.	
		Self-learning topics: Jungle computing, Fog computing, Quantum computing	
			39

Text Books:

1) Mastering Cloud Computing by Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, McGraw Hill Education
2) Cloud Computing and Services by Arup Vithal, Bhushan Jadhav, StarEdu Solutions, SYBGEN Learning India Pvt. Ltd.
3) Cloud Computing: A Practical Approach forLearning and Implementation by A. Srinivasan, J.Suresh, Pearson.
4) Cloud Security: A Comprehensive Guide to Secure Cloud Computing by Ronald L. Krutz,Russell Dean Vines, Wiley & Sons.
5) Cloud Computing Bible by Barrie Sosinsky, Wiley Publishing.

Reference Books:

1) Cloud Computing Black Book by Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Deven Shah, Dreamtech Press.
2) Amazon Web Services in Action by Michael Wittig, Andreas Wittig, Manning Publisher.
3) To the cloud: cloud powering an Enterprise, Arora Pankaj, Tata Mc Graw Hill Education.
4) Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Morgan Kaufmann.

Useful Digital Links:

1) NPTEL:https://onlinecourses.nptel.ac.in/noc22_cs20/preview
2) OpenStack Installation Guide: https://docs.openstack.org/install-guide/
3) Eucalyptus Installation: https://docs.eucalyptuscloud.org/eucalyptus/4.4.4/install-guide-4.4.4.pdf
4) AWS Management Console: https://aws.amazon.com/console/
5) https://ndl.iitkgp.ac.in NOC: Cloud Computing https://rb.gy/wyjtjx
6) https://ndl.iitkgp.ac.in NOC :Cloud Computing and Distributed Computing –Virtualization https://rb.gy/uuyzq3

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO702	Mobile Communication	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Prac tical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO702	Mobile Communication	20	20	20	80	03	--	--	--	100

Course Pre-requisite:

1. Analog and Digital Communication
2. Communication Networks
3. Digital Electronics

Course Objectives:

1. To introduce the concepts and design fundamentals of Cellular communication systems.
2. To understand the architecture and services of 2G cellular technologies.
3. To study the evolution of cellular technology from 2G to 5G.
4. To understand the services provided by network, transport and application layer in mobile communication.

Course Outcomes:

After successful completion of the course students will be able to:

1. Analyse the design parameters of cellular communication system
2. Examine various multiple access techniques and design PN-sequence generator.
3. Describe and compare GSM and IS-95 CDMA technologies.
4. Summarize the underlying fundamentals of cellular technologies from 2G to 4G.
5. Explain services provided by network, transport and application layer in mobile communication

Module No.	Unit No.	Contents	Hrs.
1		**Concept of Cellular Communication**	07
	1.1	Introduction to cellular communications, basic propagation mechanisms and multipath fading	
	1.2	**Cellular System design fundamentals :** Cluster, frequenc y reuse, Call setup, Handoff strategies, interference and system capacity, cluster size and system capacity and Channel assignment strategies	
	1.3	**Traffic Theory:** Trunking and Grade of service, Improving Coverage and capacity	
2		**Multiple Access Techniques**	06
	2.1	Multiplexing and Multiple Access: Time Division Multiple Access, Frequency Division Multiple Access, Space division multiple access technique	
	2.2	Spread spectrum Multiple Access: Need for and concept of spread spectrum (SS) modulation, PN-sequence generation, properties of PN-sequence, Gold-sequence generation, Direct-sequence SS, Frequency-hopping SS	
3		**2G Technologies**	10
	3.1	**GSM:** Services and features, GSM air specifications, GSM network architecture, Physical andLogical Channels, Frame structure, Identifiers, Authentication and security, call procedure, Hand-off procedure	
	3.2	**IS-95 (CDMA):** Air specifications of IS-95, Forward and Reverse CDMA channels, Forward and Reverse CDMA channel modulation process block diagram, power control subchannel, Handoffs in IS 95 CDMA and RAKE receiver.	
4		**Evolution from 2G to 5G**	06
	4.1	GPRS, EDGE technologies, W-CDMA (UMTS), CDMA2000: features and network architectures	
	4.2	**LTE:** LTE System Overview, Evolution from UMTS to LTE, LTE/SAE Requirements, SAE Architecture, EPS: Evolved Packet System, E-UTRAN, Voice over LTE (VoLTE), Introduction to 5G	
5		**Mobile Network Layer**	05
	5.1	**Mobile IP**: IP Packet Delivery, Agent Advertisement and Discovery, Registration, Tunneling and Encapsulation	
	5.2	**Mobility Management:** Introduction, IP Mobility, Optimization, IPv6, Micro Mobility: CellularIP	
6		**Mobile Transport and Application Layer**	05
	6.1	Mobile TCP: Traditional TCP, Classical TCP Improvements like Indirect TCP, Snooping TCP & Mobile TCP, Selective Retransmission	
	6.2	WAP: Architecture, WDP, WTLS, WTP, WSP, WAE, WML	
		Total	**39**

Text Books:

1. Theodore Rappaport, “Wireless Communications: Principles and Practice, 2nd Edition, Pearson Publication
2. Jochen Schiller, “Mobile Communications”, 3e, Pearson Publication.
3. William Stallings, “Wireless Communication and Networking”, PHI Publication.
4. Vijay Garg, “IS-95 CDMA and CDMA 2000: Cellular/PCS System Implementation”, Pearson Publication.

Reference Books:

1. T.L Singal, “Wireless Communication”, Tata McGraw Hill ,2010.
2. Upena Dalal, “Wireless Communication”, Oxford University Press, 2009.
3. Andreas F Molisch, "Wireless Communication", John Wiley, India 2006.
4. Vijay Garg, “Wireless communication and Networking”, Pearson Publication.
5. Christopher Cox, “An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications”, Wiley publications.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO702	Cyber Security	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
		20	20	20	80	03	----	--	--	100

Course Prerequisite:

Course Objectives:

1. To understand the need for Cyber Security Awareness.
2. To understand the flow and methodology of an attack
3. To learn and explore various static and web vulnerability analysis tools.
4. To understand the various IPR, privacy and security compliances.

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand the need of Cyber Security and its aspects.
2. Illustrate the various tools and techniques used by attackers to launch their attacks.
3. Identify cyber attacks and its countermeasures.
4. Identify various web application and Network vulnerability scanning techniques and defence methodologies.
5. Describe the various Privacy and standard compliances with the help of real world application.

Module No.	Unit No.	Contents	Hrs.	CO
0		**Prerequisite**	2	
		Computer Networks		
1		**Introduction to Cyber space**	8	CO 1
	1	**Cyber Crime:** Cybercrime definition, Types of Cybercrime. Classifications of cybercrime, Cyber Hygiene, Types of Hackers - Hackers and Crackers - Cyber-Attacks and Vulnerabilities - Malware threats - Sniffing - Gaining Access - Escalating Privileges - Executing Applications - Hiding Files - Covering Tracks - Worms - Trojans - Viruses - Backdoors		
	2	**Cyber Attacks**:Cyber attack Lifecycle,social engineering, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Attacks on Wireless and mobile Networks.		
2		**Cyber crime Attacks and Techniques**	8	CO 2
	3.	**Attacks Techniques**:Password Cracking, Key loggers and Spywares Steganography,Identity Theft (ID Theft),, Banner Grabbing Techniques, ransom wares,Crypto wares		
		network information gathering, vulnerability scanning, Virtual Private Networks (VPN), Open Port Identification, Social engineering, Types of social engineering, How cyber criminal works?, Prevention from being victim of social engineering.		
3		**Cyber Attacks and Preventions**	6	CO 3
	4	attacks on WIFI and prevention, traditional techniques, theft of internet hours, Wi-Fi measures		
		attacks on Mobile phone and prevention, mobile phone theft,mobile virus ,mishing,vishing,smishing,hacking bluetooth		
4		**Web and Network Security**	8	CO 4
	5	Web Security:OWASP, Web Security Considerations, Management, Cookies, Privacy on Web, Web Browser Attacks,Web Bugs, Clickjacking, Session Hijacking and Management, Phishing and Pharming Techniques, Web Service Security		
	6.	Network security:Syn-DOS:,DDOS,defences against Denial of Service Attacks.Virtual Private Networks(VPN)		
5		**Cyber Laws**	4	
	7.	**Information Security Privacy and Standard Compliances (WR)** HIPPA,FISMA, PCI DSS, GDPR, Intellectual Property Aspect of Cyber Law, Creative Commons Library, Data Protection Laws in India.		CO 5
6		**Cyber Security Initiatives-(case studies)**	3	CO 5
	8.	Online Banking, Mobile Banking Security , Security of Debit and Credit Card,UPI Security		
		Role of AI/ML in Cyber Security		
		Total	**39**	

Text Books:

1. **Nina Godbole,Sunit Belapure, "Cyber Security-Understanding Cyber Crimes,Computer Forensics and Legal Perspective",Wiley-India,2011.**
2. **The Complete Cyber Security Course -Volume 1- Nathan House**
3. **Network Security Bible, Eric Cole, Second Edition, Wiley**

Reference Books:

1. **The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi**
2. **James Graham,Richard Howard ,Ryan Olson. " Cyber Security Essentials,CRC Press,2018 print.**
3. **Build your own Security Lab, Michael Gregg, Wiley India**
4. **Computer Security, Dieter Gollman, Third Edition, Wiley**

Web References:

- **Virtual Penetration Testing Labs- https://pentesterlab.com**
- **OWASP- https://owasp.org/**
- **DVWA- https://dvwa.co.uk**
- **FISMA - https://csrc.nist.gov/projects/risk-management/fisma-background**
- **PCI DSS ttps://www.itgovernance.eu/blog/en/a-guide-to-the-4-pci-dss-compliance-levels**
- **GDPR -https://gdpr.eu/what-is-gdpr/**

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO702	Block Chain Technologies	03	02	---	03	---	---	03

Subject Code	Subject Name	Examination Scheme									
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg. of Test 1 and Test 2						
ECC DO702	Block Chain Technologies	20	20	20	80	03	---	---	---	100

Course Prerequisite: Computer Network, Operating System, Cryptography

Course Objectives:

1. To learn the fundamentals of Blockchain
2. To obtain knowledge about technologies of Blockchain
3. To incorporate the models of Blockchain- Ethereum
4. To learn the models of Hyperledger Fabric
5. To explore various applications of Blockchain.

Course Outcomes:

After successful completion of the course students will be able to:

1. Describe the primitives of the cryptography related to blockchain.
2. Understand and explore the working of Blockchain technology
3. Illustrate the concepts of Bitcoin and their usage.
4. Implement Ethereum block chain contract.
5. Explore Hyperledger Fabric and its working.
6. Investigate security features in blockchain technologies

Module No.	Unit No.	Contents	Hrs.
1		**Introduction of Cryptography**	4
		Basic Cryptographic primitives used in Blockchain - Public Key cryptosystem, Cryptographic Hash functions: Properties of Hash, MD5, SHA 256, Hash Pointers and Data Structures, Digital Signatures: ECDSA, Public Keys as Identities, Cryptocurrencies: Goofycoin	
2		**Introduction to Blockchain**	7
		Centralization vs. Decentralization, What is Blockchain, History of Blockchain, Blockchain defined- peer to peer, Distributed Ledger, Cryptographically Secure, Append-only, Updatable via consensus, How Blockchain Works, Benefits and Limitations of Blockchain, Types of Blockchain, The Structure of a Block, Block header, Genesis block, Mining , Rewards, Consensus, Types of Consensus Mechanisms, Consensus in Blockchain.	
3		**Bitcoin and Cryptocurrency**	6
		What is Bitcoin, Private keys in Bitcoin, Public Keys in Bitcoin, Addresses in Bitcoin, Transactions, The Bitcoin Network,Bitcoin Wallets, Scripting language in Bitcoin, Bitcoin Mining- task of Bitcoin miners, Mining Hardware, Crypto Currencies, Anonymity and Pseudonymity in Bitcoin	
		Self Study - Alt Coins	
4		**Introduction to Ethereum**	10
		Introduction to Ethereum, Ethereum's Consensus Mechanisms, MetaMask Setup, Ethereum Accounts, Ethers, Gas, Introduction to Smart Contracts, Remix IDE, Writing smart contracts using Solidity	
		Self Study- Geth, Ganache-Creating Wallets	
5		**Introduction to Hyperledger**	6
		What is Hyperledger? Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer, Transaction Flow.	
		Self study: Case Study of Supply Chain Management using Hyperledger	
6		**Privacy, Security issues in Blockchain**	6
		Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains (Sybil attacks, selfish mining, 51% attacks), prevention of attacks	

		Self Study: Corda, Ripple, Quorum platforms and its security	
		Total	**39**

Text Books:

1. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.
2. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.

Reference Books:

1. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas M Antonopoulos 2018
2. D. Drescher, Blockchain Basics. Apress, 2017.
3. Merunas Grinčelaitis, "Mastering Ethereum: Implement Advanced Blockchain Applications Using Ethereum-supported Tools, Services, and Protocols", Packt Publishing.
4. Blockchain with Hyperledger Fabric,Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing.

OTHER ONLINE REFERENCES

1. http://www.coursera.org/learn/ibm-blockchain-essentials-for-developers
2. https://www.nptel.ac.in/courses/106105184/
3. https://www.tutorialspoint.com/blockchain/index.htm
4. https://www.udemy.com/course/build-your-blockchain-az/
5. https://www.ibm.com/downloads/cas/3EGWKGX7.
6. https://www.hyperledger.org/use/fabric
7. https://onlinecourses.nptel.ac.in/noc19_cs63/preview
8. https://andersbrownworth.com/blockchain/blockchain

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of the syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

- Question paper will comprise 6 questions, each of 20 marks.
- Total 4 questions need to be solved.
- Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
- Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL701	VLSI Design Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL701	VLSI Design Lab	--	--	--	--	--	25	25	--	50

Laboratory Outcomes:

After successful completion of the course students will be able to:

1. Demonstrate transfer, dynamic characteristics of various digital circuits.
2. Understand the circuit design using various simulation tools
3. Demonstrate layouts for various circuits and doing simulations.
4. Understand the variation in the behaviour after extraction.

Term Work:

At least 10 experiments covering entire syllabus of VLSI **Design ECC 701** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr.No.	Experiment Name
1	Plot Transfer and output characteristics of NMOS and PMOS
2	For NMOS as well as PMOS devices use the ITRS technology node 32nm, 45nm, 65nm and 90nm. Simulate the device and download the customized nominal model cards
3	Design CMOS inverter. Carry out static as well as transient simulation with different aspect ratio of pull up and pull-down devices
4	Comparative analysis of the NMOS Inverter with different types of loads.
5	Find the equivalent CMOS inverter for the given 2-input NAND and NOR gates
6	Implement the given equation using various logic design style
7	Implementation of any Flip- Flop using various logic design styles
8	Simulate Minimum Sized CMOS INVERTER circuit to calculate τ_{PHL} and τ_{PLH}
9	Design and Simulate 4:1 multiplexer using NMOS pass transistor
10	Design and simulate 4-bit adder/subtractor
11	Design CMOS transmission gate and perform all the analysis to verify its Characteristics.
12	Design and Simulate 4-bit multiplier
13	Simulate and carry out comparative analysis for 6T SRAM cell with a) β= 1.5 and α=1, and b) β= 1 and α=1
14	Draw the CMOS schematic and Layout of the inverter circuit, simulate layout
15	Extraction of CMOS layout and simulation of the extracted Inverter
16	Draw and simulate layout for CMOS NAND and CMOS NOR gate

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 702	Internet of Things	--	02	--	--	01	--	01

Subject Code	Subject Name	Theory Marks					Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ECL 702	Internet of Things	--	--	--	--	--	25	25	50

Prerequisites: 1. Programming Using Arduino IDE
2. Python programming

Laboratory Outcomes:

After successful completion of the course students will be able to:

1. Interface various sensors to any IoT device and push data onto cloud.
2. Remotely control various devices using Blynk App and Node-red environment.
3. Implement IoT protocols to control devices remotely.
4. Implement services like Google Assistance, Adafruit I/O, IFTTT, Firebase etc in IoT.
5. Configure AWS Cloud and its Application in IoT

Term Work:

At least 10 experiments covering entire syllabus of **Internet of Things ECC702** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr.No.	Experiment Name
1	Interfacing Various Sensors like LDR, ultrasonic, DHT etc (data collection) and pushing data on to Thingspeak Cloud
2	Controlling IoT devices/sensors remotely using Node-red and rpi.
3	Application of MQTT in node red
4	Control a LED Remotely & Monitor Temperature values with a Raspberry Pi using Node-RED
5	Controlling IoT devices using Blynk App.
6	Temperature and Humidity monitor using Blynk
7	ESP8266 Voice Control with Google Assistant and Adafruit IO and IFTTT.
8	Implementing Publish-Subscribe model using MQTT protocol and DHT11 sensor
9	Google Firebase: - controlling LED using Android App
10	Publishing sensor data from ESP32 to AWS IoT Cloud.
11	Device controlling over cloud on android mobile app :- Monitoring sensor and different data on mobile phone
12	Creating an emergency push button to upload status on Facebook
13	To send Push notification to IoT device (R-pi to smart phone)
14	Google Assistant Controlled Switch Using NodeMCU
15	AWS and SNS service

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 703	Department Level Optional Course - III Lab (Deep Learning)	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL703	Department Level Optional Course – III Lab (Deep Learning)	--	--	--	--	--	25	25	--	50

Course Pre-requisite: Python Programming, Engineering Mathematics

Laboratory Outcomes:

After successful completion of the laboratory, students will be able to:

1. Implement basic neural network models to learn logic functions.
2. Design and train feed-forward neural networks using various learning algorithms.
3. Build and train deep learning models such as Auto-encoders, CNNs, RNN, LSTM etc.

Term Work:

At least 10 experiments covering entire syllabus should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

Suggested List of Experiments

Sr.No.	Experiment Name
1	**Based on Module 1 (Any two) using Virtual Lab**
	Implement Mc-Culloch Pitts model for binary logic functions.
	Implement Perceptron algorithm to simulate any logic gate.
	Implement Multilayer Perceptron algorithm to simulate XOR gate.
	To explore python libraries for deep learning e.g. Theano, TensorFlow etc.
2	**Module 2 (Any Two)**
	Apply any of the following learning algorithms to learn the parameters of the supervised single layer feed-forward neural network. a. Stochastic Gradient Descent b. Mini Batch Gradient Descent c. Momentum GD d. Nestorev GD e. Adagrad GD Adam Learning GD
3	**Module 3 (Any One)**
	Implement a back-propagation algorithm to train a DNN with at least 2 hidden layers.
	Design and implement a fully connected deep neural network with at least 2 hidden layers for a classification application. Use appropriate Learning Algorithm, output function and loss function
4	**Module 4 (Any One)**
	Design and implement a CNN model for digit recognition application.
	Design and implement a CNN model for image classification.
5	**Module 5 (Any One)**
	Design the architecture and implement the auto-encoder model for Image Compression.
	Design the architecture and implement the auto-encoder model for Image denoising.
6	**Module 6 (Any One)**
	Design and implement LSTM for Text / Image / Audio / Video / etc.
	Design and implement GRU for Text / Image / Audio / Video / etc.
	Design and implement RNN for Text / Image / Audio / Video / etc.

Online References:

Sr. No.	Website Links
1	https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
2	http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3	https://nptel.ac.in/courses/106/106/106106184/
4	https://www.deeplearningbook.org/
5	http://introtodeeplearning.com/
6	http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL703	Image Processing Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme							
		Theory Marks					Term Work	Practical /Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ECL703	Image Processing Lab	--	--	--	--	--	25	25 --	50

Laboratory Outcomes;

After successful completion of the laboratory, students will be able to:

1. Enhance the quality of image in spatial and frequency domain.
2. Apply lossless or lossy compression techniques to reduce the size of an image.
3. Segment image components based on discontinuity and similarity criteria.
4. Extract various features from the scene for specified computer vision application.

Term Work:

At least **8** experiments covering entire syllabus of should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Experiments must be graded from time to time. One presentation on a **case-study or mini project** based on the topic in Digital Image Processing need to be submitted. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested List of Experiments

Sr.No.	Experiment Name
1	Gray level transformation: Negative, Log, Power law, gray level slicing, Contrast stretching.
2	Histogram Equalization.
3	Neighborhood Processing.
4	Filtering in Frequency domain - Smoothing and sharpening.
5	2D-DFT and DCT spectrum analysis.
6	Compression using Transform Coding (JPEG Baseline coding) with parameter evaluation (CR, MSE, PSNR etc.).
7	Morphological Operations: erosion, dilation, opening, closing, boundary detection
8	Segmentation based on discontinuity and similarity.
9	Use of transforms for face recognition.
10	Object detection using statistical moment.
11	CBIR using color, shape and texture (as an application).
12	Feature Extraction using HOG.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 703	Big Data Analytics	--	02	--	--	01	--	01

Subject Code	Subject Name	Theory Marks					Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ECL 703	Big Data Analytics	--	--	--	--	--	25	25	50

Laboratory outcomes:

After successful completion of the laboratory, students will be able to:

1. Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop, Mapreduce and NoSQL in big data analytics.
2. Collect, manage, store, query and analyze various forms of Big Data.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

Term Work:

At least 8 experiments covering entire syllabus of **Big Data Analytics (ECC DO701)** should be set to have well predefined inference and conclusion. Additionally, a Mini Project on a real-life large data application to be implemented (Use standard Datasets available on the web). The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Hadoop HDFS Practical: -HDFS Basics, Hadoop Ecosystem Tools Overview. -Installing Hadoop. -Copying File to Hadoop. -Copy from Hadoop File system and deleting file. -Moving and displaying files in HDFS.
2	To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands.
3	Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc.
4	Write a program to implement word count program using MapReduce.
5	Implement PageRank using Map-Reduce.
6	Implementing any one Clustering algorithm (K-Means/CURE) using Map-Reduce.
7	Implement Bloom Filter using any programming language
8	Perform CRUD operations in MongoDB
9	To demonstrate use of recommendation system for movie rating prediction
10	To find common friends in social network graph using Map-Reduce.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 703	Advanced Database Management Systems Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 703	Advanced Database Manageme-nt Systems Lab	--	--	--	--	--	25	--	25	50

Prerequisite: Database Management System

Laboratory Outcomes:

After successful completion of the course students will be able to:

1. Build index on database.
2. Analyze time series data using open source tools.
3. Perform partitioning tasks on the database.
4. Write codes using map-reduce technique.

Term Work:

At least 10 experiments covering entire syllabus of **Advanced Database Systems (ECL 703)** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempts should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiments must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Create an index on the given tables, observe execution time of queries and record your observations.
2	Demonstrate use of grant and revoke access
3	Find the cost of queries using DBMS tools (Postgresql, MySQL, Oracle etc)
4	Data distribution and partitioning using Apache Ignite
5	Collocating computations with data using Apache Ignite
6	Time series data analysis using Temporal database like TimescaleDB
7	Count number of words in a large file using map reduce
8	Compare the cost required for query execution and obtain the optimized query
9	Develop a distributed database application. (FileServer Implementation using RMI)
10	Create a node and relationships using neo4j
11	Select and display data using neo4j
12	Create index and add constraints using neo4j

References:

1. https://docs.timescale.com/timescaledb/latest/tutorials/nyc-taxi-cab/#introduction-to-iot-new-york-city-taxicabs
2. https://neo4j.com/developer/get-started/
3. https://docs.timescale.com/install/latest/
4. https://hadoop.apache.org/

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Course Code	Course Name	Credits
ILO7011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09

03	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper.Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. John Stark, “Product Lifecycle Management: Paradigm for 21st Century Product Realisation”, Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, “Product Design for the environment-A life cycle approach”, Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, Immonen Anselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, TataMcGrawHill,2006,ISBN:0070636265

Course Code	Course Name	Credits
ILO7012	**Reliability Engineering**	**03**

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.	08

	System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. L.S. Srinath, “Reliability Engineering”, Affiliated East-Wast Press (P) Ltd., 1985.
2. Charles E. Ebeling, “Reliability and Maintainability Engineering”, Tata McGraw Hill.
3. B.S. Dhillion, C. Singh, “Engineering Reliability”, John Wiley & Sons, 1980.
4. P.D.T. Conor, “Practical Reliability Engg.”, John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”, John Wiley & Sons.
6. Murray R. Spiegel, “Probability and Statistics”, Tata McGraw-Hill Publishing Co. Ltd.

Course Code	Course Name	Credits
ILO7013	**Management Information System**	**03**

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud	6

	computing model.	
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Kelly Rainer, Brad Prince,Management Information Systems, Wiley
2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm, 10th Ed., Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

Course Code	Course Name	Credits
ILO7014	Design of Experiments	03

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08

03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition,John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, “Taguchi Technique for Quality Engineering,” McGrawHill
7. Madhav S Phadke, “ Quality Engineering using Robust Design,” Prentice Hall

Course Code	Course Name	Credits
ILO7015	Operations Research	03

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem,	14

	Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Taha, H.A. "Operations Research - An Introduction", Prentice Hall, (7th Edition), 2002.
2. Ravindran, A, Phillips, D. T and Solberg, J. J. "Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F. S. and Liebermann, G. J. "Introduction to Operations Research", Tata McGraw Hill, 2002.
4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut.
5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons.

Course Code	Course Name	Credits
ILO7016	Cyber Security and Laws	03

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law	8

	,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination.

In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.

1. Question paper will comprise of total six question
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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, *Information Systems Security*, Wiley India, New Delhi
6. Kennetch J. Knapp, *Cyber Security &Global Information Assurance* Information Science Publishing.
7. William Stallings, *Cryptography and Network Security*, Pearson Publication

8. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO7017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.	06

	3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
04	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in the past on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

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4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic web sites)

Course Code	Course Name	Credits
ILO 7018	**Energy Audit and Management**	**03**

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control;	10

	Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISP701	Major Project – I	--	6#	--	--	3	--	3

# Indicates workload of Learner (Not Faculty)

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISP701	Major Project – I	--	--	--	--	50	--	50	100

Subject Code	Subject Name	Credits
ISP701	Major Project – I	3
Course Objectives	**The course is aimed** 1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1 Identify problems based on societal /research needs. 2 Apply Knowledge and skill to solve societal problems in a group. 3 Develop interpersonal skills to work as member of a group or leader. 4 Draw the proper inferences from available results through theoretical/ experimental/simulations. 5 Analyze the impact of solutions in societal and environmental context for sustainable development. 6 Use standard norms of engineering practices 7 Excel in written and oral communication. 8 Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. 9 Demonstrate project management principles during project work.	

Guidelines for Major Project

- Students should form groups with minimum 2(two) and not more than 4 (four)

- Students should do survey and identify needs, which shall be converted into problem statement for major project in consultation with faculty supervisor/head of department/internal committee of faculties.

- Student shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project.

- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during major project activity; however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the major Projects.

Guidelines for Assessment of Major Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments. The progress of major project to be evaluated on continuous basis, minimum two reviews in the semester.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

- Distribution of Term work marks for both semesters shall be as below;

	Marks awarded by guide/supervisor based on log book	: 15
	Marks awarded by review committee	: 15
	Quality of Project report	: 20

Review/progress monitoring committee may consider following points for assessment.

- In VII semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalization of problem
    - Second shall be on finalization of proposed solution of problem.

Assessment criteria of Major Project-I
Major Project-I shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Major Project-I shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

Program Structure for Final Year Electronics and Computer Science

UNIVERSITY OF MUMBAI

(With Effect from 2022-2023)

Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ECC 801	Robotics	3	-	-	3	-	-	**3**
ECC DO801	Department Level Optional Course -V	3	-	-	3	-	-	**3**
ECC DO802	Department Level Optional Course -VI	3	-	-	3	-	-	**3**
ECC IO801	Institute Level Optional Course - II	3	-	-	3	-	-	**3**
ECL 801	Robotics Lab	-	2	-	-	1	-	**1**
ECL 802	Department Level Optional Course - V Lab	-	2		-	1		**1**
ECP 801	Major Project II	-	12	-	-	6	-	**6**
Total		**12**	**16**	-	**12**	**8**	-	**20**

Course Code	Course Name	Examination Scheme							
		Internal Assessment			End Sem Exam	Exam Duration (in Hrs)	TW	Pract/ Oral	Total
		Test 1	Test 2	Av					
ECC 801	Robotics	20	20	20	80	03	-	-	**100**
ECC DO801	Department Level Optional Course -V	20	20	20	80	03	-	-	**100**
ECC DO802	Department Level Optional Course -VI	20	20	20	80	03	-	-	**100**
ECC IO801	Institute Level Optional Course - II	20	20	20	80	03	-	-	**100**
ECL 801	Robotics Lab	-	-	-	-	03	25	25	**50**
ECL 802	Department Level Optional Course - V Lab	-	-	-	-	-	25	25	**50**
ECP 801	Major Project II	-	-	-	-	-	50	100	**150**
	Total			**80**	**320**	-	**100**	**150**	**650**

Department Level Optional Courses:

Department Level Optional Course -V (DO801)	Department Level Optional Course -VI (DO802)
1. MEMS Technology	1. Advanced Networking Technologies
2. Natural Language Processing	2. Multimedia and Virtual Reality
3. 3-D Printing and Design	3. Quantum Computing
4. Advanced Algorithms	4. System Security

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC 801	Robotics	03	02	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC 801	Robotics	20	20	20	80	03	--	--	--	100

Course Pre-requisite: Applied Mathematics III, Applied Mathematics IV, Controls and Instrumentation

Course Objectives:

1. To get acquainted with the basics of robotics
2. To familiarize students with kinematics & dynamics of robots
3. To familiarize students with Trajectory & task planning of robots.
4. To familiarize students with robot vision

Course Outcomes:

After successful completion of the course students will be able to:

1. Describe the basics of Robotics
2. Describe and derive kinematics and dynamics of stationary and mobile robots.
3. Apply trajectory planning algorithms
4. Describe concepts of robot motion planning algorithms
5. Apply image processing in robotic vision
6. Identify suitable Robot language based on applications

Module No.	Unit No.	Contents	Hrs.
1		**Fundamentals of Robotics**	04
	1.1	Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Specification Notations, Applications.	
2		**Direct Kinematics**	08
	2.1	Dot and Cross Products, Co-ordinate frames, Rotations, Homogeneous Co-ordinates, Link Co-ordinates, Arm Equation (3 axis and 4 axis Robots)	
3		**Inverse Kinematics and Work Space Analysis**	07
	3.1	General properties of solutions, Tool Configuration, Inverse kinematics of 3 axis, 4 axis and 5 axis Robots, Work Space Analysis of 3 axis and 4 axis Robots, Work Envelope.	
4		**Trajectory planning**	04
	4.1	Basics of Trajectory planning , Joint-space trajectory planning, Pick and place operations, Continuous path motion, Interpolated motion, Straight line motion	
5		**Task Planning**	07
	5.1	Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, BUG 1, BUG 2 and Tangent Bug Algorithms	
6		**Robot Vision and Robot Languages**	09
	6.1	Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform.	
	6.2	Robot language, Classification of Robot languages, Computer control and Robot software, Variable Assembly Language system and language	
		Total	**39**

Text Books:

1. Robert Shilling, "Fundamentals of Robotics - Analysis and control, Prentice Hall of India, 2009
2. Saeed Benjamin Niku, "Introduction to Robotics – Analysis, Control, Applications", Wiley India Pvt. Ltd., Second Edition, 2011

Reference Books:

1. John J. Craig, "Introduction to Robotics – Mechanics & Control", Third Edition, Pearson Education, India, 2009
2. Mark W. Spong , Seth Hutchinson, M. Vidyasagar, "Robot Modeling & Control ",
3. Wiley India Pvt. Ltd., 2006
4. Mikell P. Groover et.al, "Industrial Robots-Technology, Programming & applications", McGraw Hill , New York, 2008
5. S. R. Deb and Sankha Deb, "Robotics Technology and Flexible Automation" , Second Edition. TMH

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO801	MEMS Technology	03	02	--	03	01	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Prac tical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO801	MEMS Technology	20	20	20	80	03	25	25	--	150

Course Pre-requisite: 1. Controls and Instrumentation
2. Embedded Systems and RTOS

Course Objectives:

1. To provide knowledge of MEMS fabrication steps.
2. To provide knowledge of MEMS Materials with respect to applications.
3. To demonstrate the use of semiconductor-based fabrication processes for sensors and actuators
4. To provide an understanding of basic design and operation of MEMS sensors, actuators and passive structures.

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand the different MEMS devices, working principles, materials and their properties.
2. Design and simulate MEMS devices using standard simulation tools.
3. Develop different concepts of MEMS sensors and actuators for real-world applications.
4. Understand the rudiments of Micro-fabrication techniques.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to MEMS**	**04**
	1.1	Introduction to MEMS and Micro Electronics Technologies.	
	1.2	MEMS in Real world applications such as Air-Bag, DMD, Pressure Sensors, MEMS Challenges, MEMS Sensors in Internet of Things (IoT), Bio-medical applications.	
2		**MEMS Materials and Their Properties**	**07**
	2.1	Use of Si, SiO_2, SiN, SiC, Cr, Au, Al, Ti, SU8, PMMA, Pt in building MEMS applications.	
	2.2	Material properties such as Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Thermoelectricity.	
3		**MEMS Sensors and Actuators**	**08**
	3.1	Types MEMS Sensing (Capacitive, Piezo electric Piezo resistive)	
	3.2	Micro Actuation Techniques (Thermal, Piezo electric, Electro static), Shape Memory Alloys, Micro Grippers, Micro Gears, Micro Motors, Micro Valves, Micro Pumps**.**	
4		**MEMS Fabrication Processes**	**08**
	4.1	MEMS Processes & Process parameters: Bulk & Surface Micromachining, High Aspect Ratio MEMS (LIGA) .	
	4.2	X-Ray Lithography, Photolithography, PVD, Wet etching, Dry etching, Plasma etching, DRIE, Etch Stop Techniques, Die, Wire & Wafer Bonding, Dicing, Packaging.	
5		**MEMS Devices**	**09**
	5.1	Construction and working and applications of basic Cantilever structure, Micro heaters, Accelerometers, Pressure Sensor , Micromirrors in DMD, Inkjet printer ,Steps involved in fabrication of above devices.	
6		**MEMS Reliability**	**03**
	6.1	Reliability and various failure mechanisms for MEMS.	
	6.2	Reliability curve.	
		Total	**39**

Text Books:

1. An Introduction to Micro-electromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc.

2. Micro-system Design - by S. Senturia; Publisher: Springer.

3. Introduction to Electromechanical system design –by James J Allen. Taylor & Francis Group, LLC publication

Reference Books:

1. Fundamentals of Micro-fabrication - by M. Madou; Publisher: CRC Press; 2nd edition.

2. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8012	Natural Language Processing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 8012	Natural Language Processing	20	20	20	80	03	--	--	100

Course Pre-requisite:

Course Objectives:

1. To understand natural language processing and to learn how to apply basic algorithms in this field.
2. To get acquainted with the basic concepts and algorithmic description of the main language levels:morphology, syntax, semantics, and pragmatics.
3. To design and implement applications based on natural language processing

Course Outcomes:

After successful completion of the course student will be able to:

1. Have a broad understanding of the field of natural language processing.
2. Understand the mathematical and linguistic preliminaries necessary for various processes in NLP
3. Be able to Design, implement and test algorithms for NLP problems
4. Perform Word-Level, Syntax-Level and Semantic-Level Analysis
5. Develop basic understanding of Pragmatics in NLP
6. Be able to apply NLP techniques to design real world NLP applications

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Natural Language Processing**	**06**
	1.1	The need of NLP. Generic NLP system, Levels of NLP	02
	1.2	Stages in building a Natural Language Processing System. Challenges and ambiguities in NLP Design	04
2.0		**Mathematical and Linguistic Preliminaries**	**06**
	2.1	Probability Theory, Conditional Probability and Independence, Bayes Rule, Random Variables, Probability Distributions, Statistics, Counting, Frequency, Mean and Variance	04
	2.2	English Grammar, Parts of Speech, Phrase Structures	02
3.0		**Word Level Analysis**	**06**
	3.1	Tokenization, Segmentation, Lemmatization, Edit Distance, Collocations, Porter Stemmer, N-gram Language Model	04
	3.2	Morphological Analysis, Derivational and Reflectional Morphology	02
4.0		**Syntax-Analysis**	**08**
	4.1	Tag set for English, Penn Tree bank, Introduction to Parts of Speech Tagging (POST)	02
	4.2	Markov Processes, Hidden Markov Models (HMM)	02
	4.2	Parts of Speech Tagging using Hidden Markov Models, Viterbi Algorithm	04
5.0		**Semantic Analysis**	**08**
	4.1	Lexical Semantics, ambiguous words, word senses, Relations between senses: synonym, antonym, reversives, hyponym, hypernym, meronym, structured polysemy, metonymy, zeugma	04
	4.2	Introduction to WordNet, gloss, synset, sense relations in WordNet. Cosine distance between documents. Word sense disambiguation.	04
6.0		**Pragmatics and applications of NLP**	**05**
	6.1	Reference resolution: Discourse model, Reference Phenomenon, Syntactic and Semantic Constraints on co reference	03
	6.2	Applications of NLP: Categorization, Summarization, Sentiment Analysis, Named Entity Recognition, Machine Translation, Information Retrieval, Question Answer System	02
		Total	**39**

Text Books:

1. Daniel Jurafsky, James H. Martin, Speech and Language Processing‖ Second Edition, Prentice Hall.
2. Christopher D. Manning & Hinrich Schutze, Foundations of Statistical Natural Language Processing, MIT Press.

Reference Books:

1. Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
2. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor), The Handbook of Computational Linguisticsand Natural Language Processing

NPTEL / Swayam Course:

1. Course: Natural Language Processing By Prof. Pawan Goyal, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc21_cs102/preview
2. Course: Applied Natural Language Processing By Prof. Ramaseshan R, CMI
   https://onlinecourses.nptel.ac.in/noc20_cs87/preview

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questionswill be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO801	3D Printing and Design	03	02	--	03	01	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO801	3D Printing and Design	20	20	20	80	03	25	25	--	150

Course Pre-requisite: None

Course Objectives:

1. To Understand the concept of Additive Manufacturing
2. To Classify the Various different AM Processes
3. To Demonstrate the concept of Direct Digital Manufacturing
4. To Implement the Concept of Design for Additive Manufacturing
5. To Understand RE Technologies

Course Outcomes:

After successful completion of the course students will be able to:

1. Repeat the concept of Additive Manufacturing
2. Describe the Various different AM Processes
3. Demonstrate the concept of Direct Digital Manufacturing
4. Demonstrate the Concept of Design for Additive Manufacturing
5. Implement RE Technologies

Module No.	Unit No.	Contents	Hrs.
1		**Introduction**	5
		Additive Manufacturing Fundamentals, Historical Development, Commonly Used Terms, Definitions, AM Manufacturing Process, Classification of AM processes (As per ASTM F42 and ISO TC 261). Subtractive Manufacturing vs Additive manufacturing. Benefits of Additive Manufacturing. AM technology in Product Development Applications of AM : Engineering, Planning, Aerospace, Automotive, Jewellery, Architecture, Arts, Medical, Bio Engineering	
2		**Additive Manufacturing systems**	10
		Vat Polymerisation, Powder Bed Fusion Based AM, Material Extrusion based, Material Jetting Based, Binder Jetting Based, Sheet Lamination based, Direct Energy Deposition based	
3		**Direct Digital Manufacturing**	6
		Direct Digital Manufacturing(DDM) : Concept of DDM, Applications with Case Studies, DDM Drivers, Cost estimation: Cost Model, Build Time Model, Life-cycle costing, Future of DDM	
4		**Design for Additive Manufacturing**	6
		Design for Additive Manufacturing AM unique Capabilities : Shape Complexity, Heirarchical Complexity, Functional Complexity and Material Complexity. Core DFAM Concepts and Objective : Complex Geometry, Integrated Assemblies, Customised Geometry, Multi-functional Design, Eliminnaaton of Conventional Design for Manufacturing Constraints	
5		**Rapid Proto-typing**	6
		Rapid Prototyping Data Formats : STL, File Format Problems and Limitations, Consequence of Building valid and Invalid Tessellated model, STL File repair, Newly Proposed File Formats. RapidProto-typing software Features of various Software.	
6		**Reverse Engineering**	6
		Reverse Engineering (RE): Introduction to Generic RE Process, RE Hadware and Software. Integration of RE and RP for Layer Based Model Generaion, Application and Case Studies of RE in Automotive, Aerospace, Medical, Architectural industry, Barriers for adopting RE Other Related technologies: Reverse Engineering , Computer Aided Engineering, Haptic Feedback Based CAD	
		Total	**39**

Text Books:

1. Fundamentals of Digital Manufacturing science, Zude Zhou, Shane (Shengquan) Xie, Dejun Chen, Springer 2012
2. Additive Manufacturing Technologies, Ian Gibson, David Rosen, Brent Stucker, Spinger

Reference Books:

1. Understanding Additive Manufacturing, Andreas Gebhardt, Hanser Publication, ISBN-13:978-1-56990-507-4
2. Rapid Manufacturing : An Industrial Revolution fo the digital Age, N. Hopkins, R.J.M. Hague and P.M. Dickens (Eds.), John Wiley and Sons, 2006
3. Rapid Proto-typing Principles and Applications, Chua C. K., Leong K. F., and Lim C.S. , 2nd edition , World Scientific, 2003
4. Rapid Proto-typing Theory and Practice, Ali Kamrani and EmadAbouel Nasr (Eds.), Springer, 2006

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO801	Advanced Algorithms	03	02	--	03	01	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO801	Advanced Algorithms	20	20	20	80	03	25	25	--	150

Course Pre-requisite: Data structure concepts, Discrete structures

Course Objectives:

1. To provide mathematical approaches for Analysis of Algorithms
2. To understand and solve problems using various algorithmic approaches
3. To analyse algorithms using various methods

Course Outcomes:

At the end of the course learner will be able to

1. Analyze the running time and space complexity of algorithms.
2. Describe, apply and analyze the complexity of divide and conquer, greedy and dynamic programming strategy.
3. Identify appropriate data structures and design techniques for different problems
4. Differentiate polynomial and non-deterministic polynomial algorithms.
5. Analyze various algorithms.

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to analysis of algorithm**	08
	1.1	Mathematical background for algorithm analysis, Growth of function – Big – Oh, Omega, Theta notation, Complexity derivations,	
	1.2	Solving recurrences using Substitution Method, Recursion tree method and Master method	
	1.3	Complexity Classes: P, NP, NP Hard, NP Complete	
	1.4	Amortised Analysis -Aggregate Method, Accounting Method, Potential Method	
2		**Divide and Conquer approach**	04
	2.1	General method,Binary Search, Merge Sort, Quick Sort, Randomized quick sort, and Min-max algorithm	
3		**Greedy Algorithms**	06
	3.1	General Method, Knapsack Problem, Huffman's Codes , Minimum Spanning Tree, Kruskal's Algorithm , Prim's Algorithm , Dijkstra's Algorithm.	
4		**Dynamic Programming Approach**	08
	4.1	General Method, Making coin change, Principle of optimality, Knapsack Problem, Matrix Chain Multiplication, Activity Selection Problem, Longest common subsequence, All pair shortest path algorithm	
5		**Maximum Flow**	07
	5.1	Flow networks, Ford Fulkerson method, Max bipartite matching , Push relabel algorithm , The relabel to front algorithm	
6		**Classical Problems in Algorithms**	06
	6.1	Travelling Salesman problem, Subset Sum Problem, Matrix Multiplication, 15 puzzle , N-queens problem	
		Total	**39**

Text Books:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Third Edition, The MIT Press, 2009.
2. Michael T Goodrich and Roberto Tamassia, "Algorithm Design: Foundations, Analysis and Internet Examples", John Wiley and Sons, 2002.
3. Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani, "Algorithms", Tata McGraw-Hill, 2009
4. R.K. Ahuja, TL Magnanti and JB Orlin, "Network flows: Theory, Algorithms, and Applications", Prentice Hall Englewood Cliffs, NJ 1993.

Reference Books:

1. M.R. Garey and D.S. Johnson, Computers and Intractability: A Guide to the Theory of NP-Completeness, Freeman, 1979.
2. E. Horowitz and S. Sahni, Fundamentals of Computer Algorithms, Computer Science Press,1978.

Online References:

1. NPTEL course: https://nptel.ac.in/courses/106105164
2. Coursera link: https://www.coursera.org/specializations/algorithms

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO8021	Advanced Networking Technologies	03	-	--	03	-	--	04

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO8021	Advanced Networking Technologies	20	20	20	80	03	-	--	-	100

Course Pre-requisite: Computer Networks

Course Objectives:

1. Understand the characteristic features of Various Wireless networks.
2. Understand the characteristic features of Various Wireless networks.
3. Introduce the need for network security and safeguards

Course Outcomes:

After successful completion of the course students will be able to:

1. Appreciate the need for Wireless networks and study the IEEE 802.11 Standards
2. Comprehend the significance of Asynchronous Transfer Mode(ATM).
3. Analyze the importance of Optical networking
4. Demonstrate knowledge of network design and security and management
5. Understand the concept of multimedia networks..

Module No.	Unit No.	Contents	Hrs.
1		**Wireless LAN and WAN Technologies**	08
	1.1	Introduction to Wireless networks : Infrastructure networks, Ad-hoc networks	
	1.2	IEEE 802.11 architecture and services	
	1.3	Medium Access Control sub-layers	
	1.4	CSMA/CA, Physical Layer, 802.11 Security considerations	
	1.5	Asynchronous Transfer Mode (ATM): Architecture, ATM logical connections, ATM cells , ATM Functional Layers, Congestion control and Quality of service	
2		**Optical Networking**	06
	2.1	SONET : SONET/SDH, Architecture, Signal, SONET devices, connections, SONET layers, SONET frames, STS Multiplexing, SONET Networks	
	2.2	WDM, DWDM: Frame format, DWDM architecture ,Optical Amplifier , Optical cross connect Performance and design considerations.	
3		**Routing in the Internet**	08
	3.1	Intra and inter domain Routing, Unicast Routing Protocols: RIP, OSPF, BGP	
	3.2	Multicast Routing Protocols ,Drawbacks of traditional Routing methods	
4		**Network Security**	08
	4.1	Security goal, Security threats, security safeguards, firewall types and design, IPTABLES	
	4.2	Internet Security: Network Layer Security, Transport Layer Security, Application Layer Security	
5		**Multimedia Information and Networking**	06
	5.1	Compression Fundamentals, Digital Representation, Compression techniques	
	5.2	Multimedia Communication across networks, RTP, RTSP, SIP,H..323	
6		**Network Design**	03
	6.1	3 tier Network design layers: Application layer, Access layer	
	6.2	Backbone layers, Ubiquitous computing and Hierarchical computing	
		Total	**39**

Text Books:

1. Behrouz A. Forouzan, “Data communication and networking “, McGraw Hill Education, Fourth Edition.
2. J F. Kurose & KW. Ross: Computer Networking- A Top-down Approach featuring the Internet, 3rd edition,
3. Darren L. Spohn , “Data Network Design” , McGraw Hill Education ,Third edition
4. William Stallings, “Data and Computer communications”, Pearson Education, 10th Edition

Reference Books:

1. K. R. Rao et al: Multimedia Communication Systems, Prentice-Hall of India,.
2. Deven Shah , Ambavade, “Advanced Communication Networking”
3. Beherouz A Forouzan , “TCP /IP Protocol Suite” , Tata McGraw Hill Education ,4th edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO802	Multimedia System and Virtual reality	03	-	--	03	-	--	03

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO802	Multimedia System and Virtual reality	20	20	20	80	03	-	-	--	100

Course Pre-requisites: Computer Fundamentals, Graphics, Communication Theory, ISO-OSI Model, Java Classes

Course Objectives:

1. To introduce students about basic fundamentals and key aspects of the multimedia system.
2. To provide knowledge of compression techniques of different multimedia components.
3. To discuss the multimedia authoring tools and security in multimedia systems.
4. To comprehend and analyse the fundamentals of virtual reality system.
5. To learn different pipeline and modelling techniques in virtual reality.
6. To understand various programming languages in virtual reality.

Course Outcomes:
After successful completion of the course students will be able to:

1. Understand the basics of multimedia and multimedia system architecture.
2. Analyse file formats and compression algorithms for different multimedia components.
3. Understand multimedia authoring system and apply different security techniques in multimedia environment.
4. Define the fundamentals of virtual reality and its related technologies.
5. Understand typical rendering pipeline and modelling techniques.
6. Design an application with the principles of virtual reality.

Module No.	Unit No.	Contents	Hrs.
		Pre-requisites	
0		Computer Fundamentals, Graphics, Communication Theory, ISO-OSI Model, Java Class	2
1		**Introduction to Multimedia**	5
	1.1	Definition of Multimedia, Characteristics of Multimedia System, History of Multimedia System, Difference between Multimedia and Hypermedia, Objects and Elements of Multimedia, Applications of Multimedia.	
	1.2	Multimedia System Architecture: Workstation Architecture, IMA Architectural Framework, Network Architecture for Multimedia Systems, Types of Medium (Perception Media, Representation Media, Presentation Media, Storage Media, Transmission Media, Information Exchange Media), Interaction Techniques.	
2		**Multimedia Types, File Formats and Compression Techniques**	10
	2.1	**Digital Image:** Representation (2D format, resolution), Types of Images (monochrome, gray, color), File formats like BMP, JPG, Compression Techniques: fundamentals (coding, interpixel and psychovisual redundancies), Types –lossless and lossy, Lossless Compression; Algorithms– Shannon-Fano, CCITT Group 4 2D, Lossy Compression Algorithm – JPEG	
	2.2	**Digital Audio:** Computer representation of sound, File Formats – WAV, MPEG Audio, Compression: PCM, DM, DPCM	
	2.3	**Digital Video**: Digitization of Video, types of video signals (component, composite and S-video), File Formats: MPEG Video, H.261, Compression: MPEG	
3		**Multimedia Authoring and Security**	6
	3.1	**Authoring System**: Overview, Introduction to Authoring Tools, Features of Authoring Tools, Design Issue of Multimedia Authoring, Types of Authoring Systems.	
	3.2	**Digital Watermarking**: Concept, Visible and Invisible Watermarks, Watermarking Classification (Spatial Domain, Transform Domain, Feature Domain), Digital Watermarking Applications	
	3.2	**Steganography**: Concept and Types	
	3.3	**Image Authentication**: Issues and Digital Signature Based Image Authentication	
4		**Introduction to Virtual Reality**	4
	4.1	Definition of Virtual Reality (VR), Classical Components of VR System, Important factors in a VR System, Types of VR Systems, VR Advantages, VR Input Output Devices, Applications of VR System	

5		**VR Rendering Pipeline and Modelling**	6
	5.1	Graphical Rendering Pipeline, Haptic Rendering Pipeline, OpenGL Rendering Pipeline, Geometric Modelling, Kinematic Modelling, Physical Modelling, BehaviourModelling	
6		**VR Programming**	6
	6.1	VRML, Extensible 3D (X3D), Java 3D, OpenGL	
		Total	**39**

Text Books:

1. Prabhat K. Andleigh&KiranThakrar, "Multimedia System Design", Pearson, 2015
2. Rajesh K. Maurya, "Computer Graphics with Virtual Reality Systems", 3rd Edition, Wiley, 2018
3. K.R.Rao,D.Milovanovic, Multimedia Communication Systems: Techniques, Standards and Networks, Pearson, 2012.
4. Koegel Buford, "Multimedia Systems", Pearson, 2002.

Reference Books:

1. Steinmetz Ralf and NahrstedtKlara, "Multimedia: Computing, Communications and Applications", Pearson, 2008
2. AtulPuri, "Multimedia Systems, Standards, and Networks", 1st Edition, CRC Press, 2000.
3. Frank Y. Shih, "Multimedia Security: Watermarking, Steganography and Forensics", CRC Press, 2013.
4. Grigore C. Burdea, Philippe Coiffet, "Virtual Reality Technology", 2nd Edition, Wiley, 2003.
5. John Vince, "Virtual Reality Systems", Pearson, 2002.

Online References:

1. Multimedia Systems: https://nptel.ac.in/courses/117105083
2. Virtual Reality: https://nptel.ac.in/courses/106106138
3. Virtual Reality Specialization: https://www.coursera.org/specializations/virtual-reality

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7025	Quantum Computing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 7025	Quantum Computing	20	20	20	80	03	--	--	100

Course pre-requisite:

ECC303- Digital System Design
ECC301-Engineering Mathematics-III
ECCDLO5014- Data Structures and Algorithm
ECL404-Skill Lab: Python Programming

Course Objectives:

1. To understand basics of quantum computing
2. To understand mathematics required for quantum computing.
3. To understand building blocks of quantum computing.
4. To understand quantum algorithms.
5. To understand quantum hardware principles.
6. To understand tools for quantum computing.

Course Outcome:

After successful completion of the course student will be able to :-

1. Explain basic concepts of quantum computing
2. Explain mathematical fundamentals required for quantum computing.
3. Explain building blocks of quantum computing through architecture and programming models.
4. Explain quantum algorithms.
5. Explain quantum hardware building principles.
6. Explain usage of tools for quantum computing.

Module No.	Unit No.	Topics	Hrs.
1.0		Introduction to Quantum Computing	**07**
	1.1	Motivation for studying Quantum Computing	
	1.2	Origin of Quantum Computing	
	1.3	Quantum Computer vs. Classical Computer	
	1.4	Introduction to Quantum mechanics	
	1.5	Overview of major concepts in Quantum Computing Qubits and multi-qubits states Bloch Sphere representation Quantum Superposition Quantum Entanglement	
	1.6	Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.)	
2.0		Mathematical Foundations for Quantum Computing	**05**
	2.1	Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors.	
3.0		Building Blocks for Quantum Program	**08**
	3.1	Architecture of a Quantum Computing platform	
	3.2	Details of q-bit system of information representation: Block Sphere Multi-qubpits Stateys Quantum -superposAition of qpubits (vralid aind linvalid superposition) Quantum Entanglement Useful states from quantum algorithmic perceptive e.g. Bell State Operation on qubits: Measuring and transforming using gates. Quantum Logic gates and Circuit No Cloning Theorem and Teleportation	
	3.3	Programming model for a Quantum Computing Program Steps performed on classical computer Steps performed on Quantum Computer Moving data between bits and qubits.	
4.0		Quantum Algorithms and Error correction	**06**
	4.1	Quantum Algorithms Shor's Algorithm Grover's Algorithm Deutsch's Algorithm Deutsch -Jozsa Algorithm	
	4.2	Quantum error correction using repetition codes 3 qubit codes Shor's 9 qubit error correction Code	
5.0		Quantum Hardware	**10**
	5.1	Ion Trap Qubits The DiVincenzo Criteria Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating Rotor	
	5.2	Quantum Mechanics of a Free Rotor: A Poor Person's Atomic Model: Rotor Dynamics and the Hadamard Gate, Two-Qubit Gates The Cirac-Zoller Mechanism: Quantum Theory of Simple Harmonic Motion, A Phonon-Qubit Pair Hamiltonian, Light-Induced Rotor-Phonon Interactions,	

		Trapped Ion Qubits, Mølmer-Sørenson Coupling ..	
	5.3	Cavity Quantum Electrodynamics (cQED): Eigenstates of the Jaynes-Cummings Hamiltonian Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms, Superconducting Qubits	
	5.4	Quantum computing with spins: Quantum inverter realized with two exchange coupled spins in quantum dots, A 2-qubit spintronic universal quantum gate.	
6.0		OSS Toolkits for implementing Quantum program	**03**
	6.1	IBM quantum experience	
	6.2	Microsoft Q Rigetti PyQuil (QPU/QVM)	
		Total	**39**

Text books:

1. Michael A. Nielsen, “Quantum Computation and Quantum Information”, Cambridge University Press.
2. David McMahon, “Quantum Computing Explained”, Wiley ,2008
3. Qiskit textbook https://qiskit.org/textbook-beta/
4. Vladimir Silva, Practical Quantum Computing for Developers,2018
5. Bernard Zygelman, A First Introduction to Quantum Computing and Information,2018
6. Supriyo Bandopadhyay and Marc Cahy, “Introduction to Spintronics”, CRC Press, 2008.

Reference books:

1. The Second Quantum Revolution: From Entanglement to Quantum Computing and OtherSuper-Technologies, Lars Jaeger
2. La Guardia**,** Giuliano Gladioli “Quantum Error correction codes” Springer,2021

Internal Assessment (20-Marks):

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

End Semester Examination (80-Marks):

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC DO802	System Security	03	02	--	03		--	3

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Prac tical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECC DO802	System Security	20	20	20	80	03			--	100

Course Pre-requisite: Computer Networks

Course Objectives:

1. To understand the fundamentals of system security.
2. To explore the working principles and utilities of various crypto algorithms including Secret key Cryptography and public key algorithms
3. To understand the various controls available for protection against internet attacks, including integrity check, firewalls, intruder detection systems.
4. To understand, and evaluate different attacks on Open Web Applications and Web services
5. To describe the mechanisms used to provide security in different infrastructure and networks.
6. To perform Security Auditing and Analysis

Course Outcomes:

After successful completion of the course students will be able to:

1. Understand the concept of vulnerabilities, attacks and protection mechanisms.
2. Understand theworkingof various crypto algorithms.
3. Analyzevarious controls available for protection against internet attacks.
4. Evaluate different attacks on Open Web Applications and Web services
5. Analyze mechanisms used to provide security in different infrastructure and networks
6. Perform security monitoring and testing of system

Module No.	Unit No.	Contents	Hrs.
1		**The Need for System Security**	4
	1.1	Risks, Threats, and Vulnerabilities,**Tenets of Information Systems Security** **(**Confidentiality,Integrity ,Availability)	
	1.2	**Malicious Attack** Birthday Attacks ,Brute-Force Password Attacks , Dictionary Password Attacks, IP Address Spoofing Hijacking ,Replay Attacks ,Man-in-the-Middle Attacks Masquerading ,Eavesdropping ,Social Engineering, Phreaking ,Phishing ,Pharming .	
2		**Cryptography**	6
	2.1	Cryptography : Overview of Cryptography : What is cryptography , encryption and decryption techniques ,Symmetric and asymmetric key cryptography : AES, DES, RSA, Knapsack cryptosystem.	
3		Network Security	9
	3.1	Firewall: Need of Firewall, types of firewall- Packet Filters, Stateful Packet Filters, Application Gateways, Circuit gateways. Firewall Policies, Configuration, limitations, DMZ, VPN.	
	3.2	Intrusion Detection System Vulnerability Assessment, Misuse detection, Anomaly Detection, Network Based IDS, Host-Based IDS, Honeypots	
	3.3	Kerberos: Working, AS, TGS, SS	
	3.4	IP Security- Overview, Protocols- AH, ESP, Modes- transport and Tunnel.	
	3.5	Public key infrastructure Introduction, Certificates, (PKI): Certificate Authority, authority, Registration	
	3.6	X.509/PKIX certificate format.	
	3.7	Basic concepts of SNMP, SNMPv1 Community facility and SNMPv3	
4		**Web Security**	7
	4.1	Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Privacy on Web, Web Browser Attacks, Account Harvesting, Web Bugs, Clickjacking, CrossSite Request Forgery, Session Hijacking and Management, Secure Electronic Transaction, Email Attacks, DNS Attacks, Web Service Security.	

5		**Infrastructure Security**	9
	5.1	**Physical Security**: Managerial, Technical And Physical Controls, Environmental Exposures And Controls, Physical Access Controls	
	5.2	**Wireless network Security:** IEEE 802.11xWireless LAN Security, Wireless Intrusion Detection System (WIDS)	
	5.3	**Mobile Security:** Security Threats, Device Security, **Cloud Security:** Cloud Security Risks and Countermeasures, Cloud Identity and Access Management, Cloud Security as a Service, SAML, OAuth	
	5.4	**IOT Security:** IoT Concepts, IoT Attacks, IoT Hacking Methodology, IoT Hacking Tools, IoT Countermeasures	
6		**Security Auditing and Analysis**	4
	6.1	How to define your audit plan? What auditing benchmarks are ? How to collect audit data? Which post-audit activities you need to perform? How to perform security monitoring? Which types of log information you should capture? How to verify security controls ? • How to monitor and test your security systems?	
		Total	**39**

Text Books:

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education .
3. Fundamentals of Information system security, Third Edition, David Kim,Michael G. Solomon
1. Jones & Bartlett Learning
4. Network Security and Cryptography, Bernard Menezes, Cengage Learning
5. Network Security Bible, Eric Cole, Second Edition, Wiley

Reference Books:

1. Web Application Hackers Handbook by Wiley.
2. Information Security The Complete Reference, 2nd Edition ,**Mark Rhodes-Ousley,**McGraw Hill Education
3. Computer Security, Dieter Gollman, Third Edition, Wiley
4. CCNA Security Study Guide, Tim Boyle, Wiley
5. Introduction to Computer Security, Matt Bishop, Pearson.
6. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, Shahed Latif ,O'Reilly

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 801	Robotics lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 801	Robotics lab	--	--	--	--	--	25	--	25	50

Laboratory outcomes:

After successful completion of the laboratory, students will be able to:

1. Use the acquired knowledge in solving direct and inverse kinematics problems
2. Select and Implement suitable task and trajectory planning algorithms.
3. Develop suitable programming tools for Robotic applications
4. Construct Robots/Robotic arms for automation applications

Term Work:

Term work consists of performing minimum 6 experiments covering entire syllabus of Robotics, one mini project and two assignments. The experiments should be student centric and attempt should be made to make experiments more meaningful and interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and/or Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr.No.	Experiment Name
1	Study/Demo of 4 axis robotic arm
2	Study/Demo of 5 axis robotic arm
3	Forward kinematics
4	Inverse kinematic
5	Joint-space trajectory
6	Cartesian-space trajectory
7	Template matching
8	Iterative processing
9	Segmentation
10	Mini project

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 802	MEMS Technology	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 802	MEMS Technology	--	--	--	--	--	25	25	--	50

Laboratory outcomes:

After completing laboratory sessions, students will be able to

1. Determine various parameters for MEMS devices.
2. Plot characteristics of MEMS devices.
3. Select particular device for specific application.
4. Observe effect of device parameters variation on its performance.

Term Work:

At least 10 experiments covering entire syllabus of **MEMS Technology ECC DO801** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Case study experiment can be given to cover advance development in the subject. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Modeling and simulation of cantilever .
2	Modeling and simulation of pressure sensor .
3	Modeling and simulation of accelerometer .
4	Modeling and simulation of thermal actuator. .
5	Modeling and simulation of SMA .
6	Modeling and simulation of Piezoelectric sensor. .
7	Hardware experiment on MEMS devices.
8	Hardware experiment on MEMS devices
9	Case study on advance topic.
10	Case study of recent development in the subject.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 802	Natural Language processing	--	02	--	--	01	--	01

Subject Code	Subject Name	Theory Marks					Term Work	Practical/ Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours			
		Test 1	Test 2	Avg of Test 1 and Test 2					
ECL 802	Natural Language processing	--	--	--	--	--	25	25	50

Laboratory outcomes:

After successful completion of the laboratory, students will be able to:

1. Design, implement and test algorithms for NLP problems.
2. Understand the mathematical and linguistic foundations underlying approaches to the various areas in NLP.
3. Apply NLP techniques to design real world NLP applications such as machine translation, text categorization, text summarization, information extraction...etc.

Term Work:

At least 8 experiments covering entire syllabus of **Natural Language processing ECC DO801** should be set to have well predefined inference and conclusion. Additionally, **a Case Study/ Mini Project** based on any Application is mandatory. The experiments should be student centric and attempt should be made to make experiments more meaningful and interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr. No.	Experiment Name
1	Preprocessing of text (Tokenization, Filtration)
2	Preprocessing of text (Script Validation)
3	Preprocessing of text (Stop Word Removal, Stemming)
4	Understanding the morphology of a word by the use of Add-Delete table.
5	N-gram model
6	POS tagging
7	Calculation of emission and transition matrix which will be helpful for tagging Parts of Speech using Hidden Markov Model.
8	Find POS tags of words in a sentence using Viterbi decoding.
9	Chunking
10	Named Entity Recognition

Note:
1. Possible tools / language: R tool/ Python programming Language
2. Although it is not mandatory, the experiments can be conducted with reference to any Indian regional language.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 802	3D printing and Design Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 802	3D Printing and Design Lab	--	--	--	--	--	25	25	--	50

Term Work:

At least 10 experiments covering entire syllabus of **3D Printing and Design ECC DO801** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr.No.	Experiment Name
1	Study of Specifications & Processes for 3d Printing Machines
2	2D Modeling Using CAD Software
3	Assembly Modeling Involving 2 or 3 Components
4	Creation of STL Files and Slicing Files as Preprocessing for 3D printing
5	Study of Meshing and its Influence on the accuracy of component
6	Reverse Engineering using a 3 D scanner / CMM
7	Design of Supports For Thin Section / Overhang Features of a Component
8	Study workflow, Material Requirements, Design Considerations, Post Processing of Fused Deposition Modeling FDM 3D printer
9	Design for additive Manufacturing : one or Two experiments
10	Mini Project on New Product Design

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL 802	Advanced Algorithms Lab	--	02	--	--	01	--	01

Subject Code	Subject Name	Examination Scheme								
		Theory Marks					Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 1	Test 2	Avg of Test 1 and Test 2						
ECL 802	Advanced Algorithms Lab	20	20	20	80	3	25	25	--	50

Laboratory Outcomes:

After completing laboratory sessions, students will be able to

1. Understand the methods of designing and analyzing algorithms.
2. Design and implement efficient algorithms for a specified application.
3. Strengthen the ability to identify and apply the suitable algorithm for the given real-world problem.
4. Analyze worst-case running time of algorithms and understand fundamental algorithmic problems.

Term Work:

At least 10 experiments covering entire syllabus should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

Sr.No.	Experiment Name
1.	Implementation of Merge and Quick sort using divide and conquer approach
2.	Implementation of Fractional Knapsack
3.	Implementation of Djikstras's algorithms
4.	Implementation of 0/1 Knapsack using dynamic programming
5	Implementation of Longest Common Subsequence
6.	Implementation of Floyd's Warshall's algorithm
7.	Implementation of Ford Fulkerson algorithm
8.	Implementation of Maximum Bipartite matching algorithm
9.	Implementation of n-queen using backtracking
10.	Implementation of sum of subsets algorithm
11.	Implementation of 15 puzzle problem
12.	Implementation of Travelling salesman's problem.

Note: Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

e Code	Course Name	Credits
ILO8021	**Project Management**	**03**

Objectives:

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

Outcomes: Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

Module	Detailed Contents	Hrs
01	**Project Management Foundation:** Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	5
02	**Initiating Projects:** How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	6
03	**Project Planning and Scheduling:** Work Breakdown structure (WBS) and linear responsibility chart, Interface Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM,	8

	GANTT chart. Introduction to Project Management Information System (PMIS).	
04	**Planning Projects:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	6
05	**5.1 Executing Projects:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.	6

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Credits
ILO8022	Finance Management	03

Objectives:

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

Outcomes: Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

Module	Detailed Contents	Hrs
01	**Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges	06
02	**Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.	06
03	**Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis;	09

	Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.	
04	**Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.	10
05	**Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. **Capital Structure:** Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure	05
06	**Dividend Policy:** Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	03

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

Course Code	Course Name	Credits
ILO8023	**Enterprepreneurship Development and Management**	**03**

Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Outcomes: Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Module	Detailed Contents	Hrs
01	**Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	04
02	**Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur **Entrepreneurship And Business Development:** Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	09
03	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	05
04	**Indian Environment for Entrepreneurship:** key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc.,	08

	Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	
05	**Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	08
06	**Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	05

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
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4. Only Four question need to be solved.

REFERENCES:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Course Code	Course Name	Credits
ILO8024	Human Resource Management	03

Objectives:

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

Outcomes: Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers.

Module	Detailed Contents	Hrs
01	**Introduction to HR** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	5
02	**Organizational Behavior (OB)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-	7

	making, Attitude and Behavior. • Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); • Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team. • Case study	
03	**Organizational Structure &Design** • Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress. • Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership. • Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	6
04	**Human resource Planning** • Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale. • Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning. • Training & Development: Identification of Training Needs, Training Methods	5
05	**Emerging Trends in HR** • Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment • Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	6
06	**HR & MIS** Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries **Strategic HRM** Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals	10

	Labor Laws & Industrial Relations Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act	

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

Course Code	Course Name	Credits
ILO8025	**Professional Ethics and Corporat Social Responsibility (CSR)**	**03**

Objectives:

1. To understand professional ethics in business
2. To recognized corporate social responsibility

Outcomes: Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

Module	Detailed Contents	Hrs
01	**Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	04
02	**Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	08
03	**Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy **Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	06
04	**Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	05
05	**Corporate Social Responsibility:** Articulation of Gandhian Trusteeship	08

	Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	
06	**Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	08

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi.

Course Code	Course Name	Credits
ILO8026	Research Methodology	03

Objectives:

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

Outcomes: Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

Module	Detailed Contents	Hrs
01	**Introduction and Basic Research Concepts** **1.1** Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology **1.2** Need of Research in Business and Social Sciences **1.3** Objectives of Research **1.4 Issues** and Problems in Research **1.5** Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	09
02	**Types of Research** **2.1.** Basic Research **2.2.** Applied Research **2.3.** Descriptive Research **2.4.** Analytical Research **2.5.** Empirical Research **2.6** Qualitative and Quantitative Approaches	07

03	**Research Design and Sample Design** **3.1** Research Design – Meaning, Types and Significance **3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors	**07**
04	**Research Methodology** **4.1** Meaning of Research Methodology **4.2**. Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f.** Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report	**08**
05	**Formulating Research Problem** **5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	**04**
06	**Outcome of Research** **6.1** Preparation of the report on conclusion reached **6.2** Validity Testing & Ethical Issues **6.3** Suggestions and Recommendation	**04**

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

Course Code	Course Name	Credits
ILO8027	**IPR and Patenting**	**03**

Objectives:

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

Outcomes: Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

Module	Detailed Contents	Hr
01	**Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plantvariety protection, Geographical indications, Transfer of technology etc. **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	05
02	**Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement **Indian Scenario of IPR:** Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.	07
03	**Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc.	05
04	**Basics of Patents:** Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method	07

	of getting a patent	
05	**Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	08
06	**Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignments on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books

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13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Credits
ILO8028	**Digital Business Management**	**03**

Objectives:

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

Outcomes: The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

Module	Detailed content	Hours
1	**Introduction to Digital Business-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business-** Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC	06

3	**Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system **Application Development:** Building Digital business Applications and Infrastructure	06
4	**Managing E-Business-**Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications	06
5	**E-Business Strategy-**E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization-**Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignment on complete syllabus or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

References:

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-enOECD Publishing

Course Code	Course Name	Credits
ILO8029	**Environmental Management**	**03**

Objectives:

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

Outcomes: Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

Module	Detailed Contents	Hrs
01	Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario.	10
02	Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man-made disasters, Atomic/Biomedical hazards, etc.	06
03	Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc.	05
04	Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility	10
05	Total Quality Environmental Management, ISO-14000, EMS certification.	05
06	General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc.	03

<u>Assessment</u>:

Internal:

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

End Semester Theory Examination:

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ISP801	Major Project – II	--	12#	--	--	6	--	6

# Indicates workload of Learner (Not Faculty)

Sub Code	Subject Name	Examination scheme							
		Theory (out of 100)				Term work	Pract. and Oral	Oral	Total
		Internal Assessment			End sem Exam				
		Test1	Test2	Avg.					
ISP801	Major Project – II	--	--	--	--	100	--	50	150

Subject Code	Subject Name	Credits
ISP801	Major Project – II	3
Course Objectives	**The course is aimed** 1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1 Identify problems based on societal /research needs. 2 Apply Knowledge and skill to solve societal problems in a group. 3 Develop interpersonal skills to work as member of a group or leader. 4 Draw the proper inferences from available results through theoretical/ experimental/simulations. 5 Analyze the impact of solutions in societal and environmental context for sustainable development. 6 Use standard norms of engineering practices 7 Excel in written and oral communication. 8 Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. 9 Demonstrate project management principles during project work.	

Guidelines for Major Project

- Students should form groups with minimum 2(two) and not more than 4 (four)

- Students should do survey and identify needs, which shall be converted into problem statement for major project in consultation with faculty supervisor/head of department/internal committee of faculties.

- Student shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project.

- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during major project activity; however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.

- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.

- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the major Projects.

Guidelines for Assessment of Major Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in the semester.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

- Distribution of Term work marks for both semesters shall be as below;

    - Marks awarded by guide/supervisor based on log book 30
    - Marks awarded by review committee 30
    - Quality of Project report 40

Review/progress monitoring committee may consider following points for assessment.

- In VIII semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.

- First review is based on readiness of building working prototype to be conducted.
- Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Assessment criteria of Major Project-II

Major Project-II shall be assessed based on following criteria;

1. Cost effectiveness and Societal impact
2. Full functioning of working model as per stated requirements
3. Effective use of skill sets
4. Effective use of standard engineering norms
5. Contribution of an individual's as member or leader
6. Clarity in written and oral communication

Guidelines for Assessment of Major Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Major Project shall be assessed based on following points:

1 Quality of problem and Clarity

2 Innovativeness in solutions

3 Cost effectiveness and Societal impact

4 Full functioning of working model as per stated requirements

5 Effective use of skill sets

6 Effective use of standard engineering norms

7 Contribution of an individuals as member or leader

8 Clarity in written and oral communication

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