Item No. 145
AC – 23/07/2020

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Electronics and Telecommunication Engineering

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)

Item No. 145
AC – 23/07/2020

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Second Year B.E. Electronics and Telecommunication Engineering**
2	Eligibility for Admission	**After Passing First Year Engineering as per 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	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ / **Semester** (Strike out which is not applicable)
8	Status	**New** / ~~Revised~~ (Strike out which is not applicable)
9	To be implemented from Academic Year	**With effect from Academic Year: 2020-2021**

Date 02-07-2020

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 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 13 weeks and remaining 2 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 171, 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.

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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 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.

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Preface By BoS

Technological developments in the field of electronics and telecommunication engineering have revolutionized the way people see the world today. Hence, there is a need for continuously enriching the quality of education by a regular revision in the curriculum, which will help our students achieve better employability, start-ups, and other avenues of higher studies. The current revision in the Bachelor of Engineering program (REV- 2019 'C' Scheme) aims at providing a strong foundation with required analytical concepts in the field of electronics and telecommunication engineering.

Some of the salient features of this revised curriculum are as below and they fall in line with the features in AICTE Model Curriculum.

1. The curriculum is designed in such a way that it encourages innovation and research as the total number of credits has been reduced from around 200 credits in an earlier curriculum to 171 credits in the current revision.
2. In the second and third-year curriculum, skill-based laboratories and mini-projects are introduced.
3. It will result in the students developing a problem-solving approach and will be able to meet the challenges of the future.
4. The University of Mumbai and BoS – Electronics and Telecommunication Engineering will ensure the revision of the curriculum on regular basis in the future as well and this update will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

The BoS would like to thank all the subject experts, industry representatives, alumni, and various other stakeholders for their sincere efforts and valuable time in the preparation of course contents, reviewing the contents, giving valuable suggestions, and critically analyzing the contents.

Board of Studies in Electronics and Telecommunication Engineering

Dr. Faruk Kazi: Chairman

Dr. V. N. Pawar: Member

Dr. Ravindra Duche: Member

Dr. Milind Shah: Member

Dr. R. K. Kulkarni: Member

Dr. Baban U. Rindhe: Member

Dr. Mrs. Nair: Member

Dr. Nalbarwar: Member

Dr. Sudhakar Mande: Member

Dr. S. D. Deshmukh: Member

Program Structure for Second Year Engineering
Semester III & IV
UNIVERSITY OF MUMBAI
(With Effect from 2020-2021)
Semester III

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC301	Engineering Mathematics-III	3	--	1*	3	--	1	4
ECC302	Electronic Devices & Circuits	3	--	--	3	--	--	3
ECC303	Digital System Design	3	--	--	3	--	--	3
ECC304	Network Theory	3	--	1	3	--	1	4
ECC305	Electronic Instrumentation & Control Systems	3	--	--	3	--	--	3
ECL301	Electronic Devices & Circuits Lab	--	2	--	--	1	--	1
ECL302	Digital System Design Lab	--	2	--	--	1	--	1
ECL303	Electronic Instrumentation & Control Systems Lab	--	2	--	--	1	--	1
ECL304	Skill Lab: C++ and Java Programming	--	4	--	--	2	--	2
ECM301	Mini Project 1A	--	4$	--	--	2	--	2
Total		**15**	**14**	**2**	**15**	**07**	**2**	**24**

*** Should be conducted batch wise.**
$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC301	Engineering Mathematics-III	20	20	20	80	3	25	--	125
ECC302	Electronic Devices & Circuits	20	20	20	80	3	--	--	100
ECC303	Digital System Design	20	20	20	80	3	--	--	100
ECC304	Network Theory	20	20	20	80	3	25	--	125
ECC305	Electronic Instrumentation & Control Systems	20	20	20	80	3	--	--	100
ECL301	Electronic Devices & Circuits Lab	--	--	--	--	--	25	25	50
ECL302	Digital System Design Lab	--	--	--	--	--	25	--	25
ECL303	Electronic Instrumentation & Control Systems Lab	--	--	--	--	--	25	--	25
ECL304	Skill Lab: C++ and Java Programming	--	--	--	--	--	25	25	50
ECM301	Mini Project 1A	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**75**	**750**

Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC401	Engineering Mathematics-IV	3	--	1*	3	--	1	4
ECC402	Microcontrollers	3	--	--	3	--	--	3
ECC403	Linear Integrated Circuits	3	--	--	3	--	--	3
ECC404	Signals & Systems	3	--	1	3	--	1	4
ECC405	Principles of Communication Engineering	3	--	--	3	--	--	3
ECL401	Microcontrollers Lab	--	2	--	--	1	--	1
ECL402	Linear Integrated Circuits Lab	--	2	--	--	1	--	1
ECL403	Principles of Communication Engineering Lab	--	2	--	--	1	--	1
ECL404	Skill Lab: Python Programming	--	4	--	--	2	--	2
ECM401	Mini Project 1B	--	4$	--	--	2	--	2
Total		**15**	**14**	**2**	**15**	**7**	**2**	**24**

*** Should be conducted batch wise.**

$ Indicates work load of a learner (Not Faculty) for Mini Project 1B. Faculty Load: 1 hour per week per four groups.

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. & oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
ECC401	Engineering Mathematics-IV	20	20	20	80	3	25	--	125
ECC402	Microcontrollers	20	20	20	80	3	--	--	100
ECC403	Linear Integrated Circuits	20	20	20	80	3	--	--	100
ECC404	Signals & Systems	20	20	20	80	3	25	--	125
ECC405	Principles of Communication Engineering	20	20	20	80	3	--	--	100
ECL401	Microcontrollers Lab	--	--	--	--	--	25	--	25
ECL402	Linear Integrated Circuits Lab	--	--	--	--	--	25	25	50
ECL403	Principles of Communication Engineering Lab	--	--	--	--	--	25	25	50
ECL404	Skill Lab: Python Programming	--	--	--	--	--	25	25	50
ECM401	Mini Project 1B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	**--**	**175**	**100**	**775**

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

Course Code	Course Name	Examination Scheme							
		Theory				Exam Dura-tion (in Hrs.)	Term Work	Pract & Oral	Total
		Internal Assessment			End Sem Exam				
		Test1	Test2	Avg of Test 1 & 2					
ECC301	Engineering Mathematics-III	20	20	20	80	03	25	-	125

*** Should be conducted batch wise.**

Pre-requisite:

1. FEC101-Engineering Mathematics-I
2. FEC201-Engineering Mathematics-II
3. Scalar and Vector Product: Scalar and vector product of three and four vectors

Course Objectives: The course is aimed

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

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

1. Understand the concept of Laplace transform and its application to solve the real integrals in engineering problems.
2. Understand the concept of inverse Laplace transform of various functions and its applications in engineering problems.
3. Expand the periodic function by using Fourier series for real life problems and complex engineering problems.
4. Understand complex variable theory, application of harmonic conjugate to get orthogonal trajectories and analytic function.
5. Use matrix algebra to solve the engineering problems.
6. Apply the concepts of vector calculus in real life problems.

Module	Detailed Contents	Hrs.
01	**Module: Laplace Transform** Definition of Laplace transform, Condition of Existence of Laplace transform. Laplace Transform (L) of Standard Functions like e^{at}, $sin(at)$, $cos(at)$, $sinh(at)$, $cosh(at)$ and $t^n, n \geq 0$. 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). 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	**Module: 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	**Module: 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	**Module: 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	**Module: 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 on verification 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	**Module: 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	6

	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.	
Total		39

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 Hill Publication
8. Higher Engineering Mathematics, Dr. B. S. Grewal, Khanna Publication

Term Work:

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. 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

Internal Assessment Test (20-Marks):

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 second class test (Internal Assessment II) will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory 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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. Total 04 questions need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC302	Electronic Devices & Circuits	3	-	--	3	--	--	3

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC302	Electronic Devices & Circuits	20	20	20	80	03	--	--	100

Course pre-requisite:

FEC: 102 - Engineering Physics-I
FEC: 201 - Engineering Physics-II
FEC:105 - Basic Electrical Engineering

Course Objectives:

1. To explain functionality different electronic devices.
2. To perform DC and AC analysis of small signal amplifier circuits.
3. To analyze frequency response of small signal amplifiers.
4. To compare small signal and large signal amplifiers.
5. To explain working of differential amplifiers and it's applications in Operational Amplifiers

Course Outcomes:

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

1. Know functionality and applications of various electronic devices.
2. Explain working of various electronics devices with the help of V-I characteristics.
3. Derive expressions for performance parameters of BJT and MOSFET circuits.
4. Evaluate performance of Electronic circuits (BJT and MOSFET based).
5. Select appropriate circuit for given application.
6. Design electronic circuit (BJT, MOSFET based) circuits for given specifications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction of Electronic Devices**	**05**
	1.1	Study of pn junction diode characteristics & diode current equation. Application of zener diode as a voltage regulator.	
	1.2	Construction, working and characteristics of BJT, JFET, and E-MOSFET	
2.0		**Biasing Circuits of BJTs and MOSFETs**	**06**
	2.1	Concept of DC load line, Q point and regions of operations, Analysis and design of biasing circuits for BJT (Fixed bias & Voltage divider Bias)	
	2.2	DC load line and region of operation for MOSFETs. Analysis and design of biasing circuits for JFET (self bias and voltage divider bias), E-MOSFET (Drain to Gate bias & voltage divider bias).	
3.0		**Small Signal Amplifiers**	**06**
	3.1	Concept of AC load line and Amplification, Small signal analysis (Zi, Zo, Av and Ai) of CE amplifier using hybrid pi model.	
	3.2	Small signal analysis (Zi, Zo, Av) of CS (for EMOSFET) amplifiers.	
	3.3	Introduction to multistage amplifiers.(Concept, advantages & disadvantages)	
4.0		**Frequency response of Small signal Amplifiers:**	**08**
	4.1	Effects of coupling, bypass capacitors and parasitic capacitors on frequency response of single stage amplifier, Miller effect and Miller capacitance.	
	4.2	High and low frequency analysis of CE amplifier.	
	4.3	High and low frequency analysis of CS (E-MOSFET) amplifier.	
5.0		**Large Signal Amplifiers:**	**06**
	5.1	Difference between small signal & large signal amplifiers. Classification and working of Power amplifier	
	5.2	Analysis of Class A power amplifier (Series fed and transformer coupled).	
	5.3	Transformer less Amplifier: Class B power amplifier. Class AB output stage with diode biasing	
	5.4	Thermal considerations and heat sinks.	
6.0		**Introduction to Differential Amplifiers**	**08**
	6.1	E-MOSFET Differential Amplifier, DC transfer characteristics, operation with common mode signal and differential mode signal	
	6.2	Differential and common mode gain, CMRR, differential and common mode Input impedance.	
	6.3	Two transistor (E-MOSFET) constant current source	
		Total	**39**

Text books:

1. D. A. Neamen, “Electronic Circuit Analysis and Design,” Tata McGraw Hill, 2ndEdition.
2. A. S. Sedra, K. C. Smith, and A. N. Chandorkar, “Microelectronic Circuits Theory and Applications,” International Version, OXFORD International Students, 6thEdition
3. Franco, Sergio. Design with operational amplifiers and analog integrated circuits. Vol. 1988. New York: McGraw-Hill, 2002.

References:

1. Boylestad and Nashelesky, “Electronic Devices and Circuits Theory,” Pearson Education, 11th Edition.
2. A. K. Maini, “Electronic Devices and Circuits,” Wiley.
3. T. L. Floyd, “Electronic Devices,”Prentice Hall, 9th Edition, 2012.
4. S. Salivahanan, N. Suresh Kumar, “Electronic Devices and Circuits”, Tata Mc-Graw Hill, 3rd Edition
5. Bell, David A. Electronic devices and circuits. Prentice-Hall of India, 1999.

NPTEL/ Swayam Course:

1. Course: Analog Electronic Circuit By Prof. Shouribrata chatterjee (IIT Delhi); https://swayam.gov.in/nd1_noc20_ee89/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 completed 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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC303	Digital System Design	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.					
ECC303	Digital System Design	20	20	20	80	03	--	--	100

Course Pre-requisite:

FEC105 – Basic Electrical Engineering

Course Objectives:

1. To understand number system representations and their inter-conversions used in digital electronic circuits.
2. To analyze digital logic processes and to implement logical operations using various combinational logic circuits.
3. To analyze, design and implement logical operations using various sequential logic circuits.
4. To study the characteristics of memory and their classification.
5. To learn basic concepts in VHDL and implement combinational and sequential circuits using VHDL.

Course Outcomes:

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

1. Understand types of digital logic, digital circuits and logic families.
2. Analyze, design and implement combinational logic circuits.
3. Analyze, design and implement sequential logic circuits.
4. Develop a digital logic and apply it to solve real life problems.
5. Classify different types of memories and PLDs.
6. Simulate and implement basic combinational and sequential circuits using VHDL/Verilog.

Module No.	Unit No.	Topics	Hrs.
1.0		**Number Systems and Codes**	**04**
	1.1	Review of Binary, Octal and Hexadecimal Number Systems, their inter-conversion, Binary code, Gray code and BCD code, Binary Arithmetic, Addition, Subtraction using 1's and 2's Complement	04
2.0		**Logic Family and Logic Gates**	**05**
	2.1	Difference between Analog and Digital signals, Logic levels, TTL and CMOS Logic families and their characteristics	03
	2.2	Digital logic gates, Universal gates, Realization using NAND and NOR gates, Boolean Algebra, De Morgan's Theorem	02
3.0		**Combinational Logic Circuits**	**12**
	3.1	SOP and POS representation, K-Map up to four variables and Quine-McClusky method for minimization of logic expressions	04
	3.2	Arithmetic Circuits: Half adder, Full adder, Half Subtractor, Full Subtractor, Carry Look ahead adder and BCD adder, Magnitude Comparator	04
	3.3	Multiplexer and De-Multiplexer: Multiplexer operations, cascading of Multiplexer, Boolean function implementation using MUX, DEMUX and basic gates, Encoder and Decoder	04
4.0		**Sequential Logic Circuits**	**12**
	4.1	Flip flops: RS, JK, Master slave flip flops; T & D flip flops with various triggering methods, Conversion of flip flops, Registers: SISO, SIPO, PISO, PIPO, Universal Shift Register	04
	4.2	Counters: Asynchronous and Synchronous counters with State transition diagram, Up/Down, MOD N, BCD Counter	04
	4.3	Applications of Sequential Circuits: Frequency division, Ring counter, Johnson counter, Introduction to design of Moore and Mealy circuits	04
5.0		**Different Types of Memories and Programmable Logic Devices**	**04**
	5.1	Classification and Characteristics of memory, SRAM, DRAM, ROM, PROM, EPROM and Flash memories	02
	5.2	Introduction: Programmable Logic Devices (PLD), Programmable Logic Array (PLA), Programmable Array Logic (PAL)	02
6.0		**Introduction to VHDL**	**02**
	6.1	Basics of VHDL/Verilog Programming, Design and implementation of adder, subtractor, multiplexer and flip flop using VHDL/Verilog	02
		Total	**39**

Text Books:

1. John F. Warkerly, “Digital Design Principles and Practices”, Pearson Education, Fifth Edition (2018).
2. Morris Mano, Michael D. Ciletti, “Digital Design”, Pearson Education, Fifth Edition (2013).
3. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill Education, Forth Edition (2010).
4. A. Anand Kumar, “Fundamentals of Digital Circuits”, PHI, Fourth Edition (2016).
5. Volnei A. Pedroni, “Digital Electronics and Design with VHDL” Morgan Kaufmann Publisher, First Edition (2008).
6. Stephen Brown & Zvonko Vranesic, “Fundamentals of Digital Logic with Verilog Design”, Third Edition, MGH (2014).

Reference Books:

1. Thomas L. Floyd, “Digital Fundamentals”, Pearson Prentice Hall, Eleventh Global Edition (2015).
2. Mandal, “Digital Electronics Principles and Applications”, McGraw Hill Education, First Edition (2010).
3. Ronald J. Tocci, Neal S. Widmer, Gregory L. Moss “Digital Systems Principles and Applications”, Ninth Edition, PHI (2009).
4. Donald P. Leach / Albert Paul Malvino/Gautam Saha, “Digital Principles and Applications”, The McGraw Hill, Eight Edition (2015).
5. Stephen Brown & Zvonko Vranesic, “Fundamentals of Digital Logic Design with VHDL”, Second Edition, TMH (2009).
6. J. Bhasker, “A Verilog HDL Primer”, Star Galaxy Press, Third Edition (1997).

NPTEL / Swayam Course:

1. Course: Digital Circuits By Prof. Santanu Chattopadhyay (IIT Kharagpur); https://swayam.gov.in/nd1_noc20_ee70/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 completed 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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC304	Network Theory	03	--	01	03	--	01	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. of Test 1 and Test 2					
ECC304	Network Theory	20	20	20	80	03	25	--	125

Course Pre-requisite:

1. FEC105 - Basic Electrical Engineering
2. FEC201 - Engineerring Mathematics II

Course Objectives:

1. To evaluate the Circuits using network theorems.
2. To analyze the Circuits in time and frequency domain.
3. To study network Topology, network Functions and two port networks.
4. To synthesize passive network by various methods.

Course Outcomes:

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

1. Apply their knowledge in analyzing Circuits by using network theorems.
2. Apply the time and frequency method of analysis.
3. Evaluate circuit using graph theory.
4. Find the various parameters of two port network.
5. Apply network topology for analyzing the circuit.
6. Synthesize the network using passive elements.

Module No.	Unit No.	Topics	Hrs.
1.0		**Electrical circuit analysis**	**08**
	1.1	Circuit Analysis: Analysis of Circuits with and without dependent sources using generalized loop and node analysis, super mesh and super node analysis technique Circuit Theorems: Superposition, Thevenin's, Norton's and Maximum Power Transfer Theorems (Use only DC source).	
	1.2	Magnetic circuits: Concept of Self and mutual inductances, coefficient of coupling, dot convention, equivalent circuit, solution using mesh analysis (for Two Loops only).	
2.0		**Graph Theory**	**06**
	2.1	Objectives of graph theory, Linear Oriented Graphs, graph terminologies Matrix representation of a graph: Incidence matrix, Circuit matrix, Cut-set matrix, reduced Incident matrix, Tieset matrix, f-cutset matrix.	
	2.2	Relationship between sub matrices A, B & Q. KVL & KCL using matrix.	
3.0		**Time and frequency domain analysis**	**07**
3.0	**3.1**	Time domain analysis of R-L and R-C Circuits: Forced and natural response, initial and final values. Solution using first order and second order differential equation with step signals.	
	3.2	Frequency domain analysis of R-L-C Circuits: Forced and natural response, effect of damping factor. Solution using second order equation for step signal.	
4.0		**Network functions**	**06**
	4.1	Network functions for the one port and two port networks, driving point and transfer functions, Poles and Zeros of Network functions, necessary condition for driving point functions, necessary condition for transfer functions, calculation of residues by graphical methods, testing for Hurwitz polynomial.	
	4.2	Analysis of ladder & symmetrical lattice network (Up to two nodes or loops)	
5.0		**Two port Networks**	**05**
	5.1	Parameters: Open Circuits, short Circuit, Transmission and Hybrid parameters, relationship among parameters, conditions for reciprocity and symmetry.	
	5.2	Interconnections of Two-Port networks T & π representation.	
6.0		**Synthesis of RLC circuits**	**07**
	6.1	Positive Real Functions: Concept of positive real function, necessary and sufficient conditions for Positive real Functions.	
	6.2	Synthesis of LC, RC & RL Circuits: properties of LC, RC & RL driving point functions, LC, RC & RL network Synthesis in Cauer-I & Cauer-II , Foster-I & Foster-II forms (Up to Two Loops only).	
		Total	**39**

Textbooks:

1. Franklin F Kuo, “Network Analysis and Synthesis”, Wiley Toppan, 2nd ed. ,1966.
2. M E Van Valkenburg, “Network Analysis”, Prentice-Hall of India Pvt Ltd, New Delhi, 26th Indian Reprint, 2000.

Reference Books:

1. A. Chakrabarti*, “Circuit Theory”,* Dhanpat Rai & Co., Delhi, 6th Edition.
2. A. Sudhakar, Shyammohan S. Palli “Circuits and Networks”, Tata McGraw-Hill education.
3. Smarajit Ghosh “Network Theory Analysis & Synthesis”, PHI learning.
4. K.S. Suresh Kumar, “Electric Circuit Analysis” Pearson, 2013.
5. D. Roy Choudhury, “Networks and Systems” , New Age International, 1998.

NPTEL / Swayam Course:

1. Course: Basic Electrical Circuits By Prof. Nagendra Krishnapura (IIT Madras); https://swayam.gov.in/nd1_noc20_ee64/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 completed 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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Term Work (25-Marks):

At least **10 assignments** covering entire syllabus must be given during the **“Class Wise Tutorial”**. The assignments should be students’ centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment 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.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC305	Electronic Instrumentation & Control Systems	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC305	Electronic Instrumen-tation & Control Systems	20	20	20	80	03	--	--	100

Course pre-requisites:

1. FEC105 – Basic Electrical Engineering

Course Objectives:

1. To provide basic knowledge about the various sensors and transducers
2. To provide fundamental concepts of control system such as mathematical modeling, time response and Frequency response.
3. To develop concepts of stability and its assessment criteria.

Course Outcomes:

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

1. Identify various sensors, transducers and their brief performance specification.
2. Understand the principle of working of various transducer used to measure temperature, displacement, level, pressure and their application in industry
3. Determine the models of physical systems in forms suitable for use in the analysis and design of control systems.
4. Obtain the transfer functions for a given Control system.
5. Understand the analysis of systems in time domain and frequency domain.
6. Predict stability of given system using appropriate criteria.

Module No.	Unit No.	Topics	Hrs.
1		**Principle of Measurement, Testing and Measuring instruments**	04
	1.1	Introduction to Basic instruments: Components of generalized measurement system Concept of accuracy, precision, linearity, sensitivity, resolution, hysteresis, calibration.	
	1.2	Measurement of Resistance: Kelvin's double bridge, Wheatstone bridge and Mega ohm bridge Measurement of Inductance: Maxwell bridge and Hey bridge Measurement of Capacitance: Schering bridge	
2		**Sensors and Transducers**	06
	2.1	Basics of sensors and Transducers-Active and passive transducers, characteristics and selection criteria of transducers	
	2.2	Displacement and pressure- Potentiometers, pressure gauges, linear Variable differential transformers (LVDT) for measurement of pressure and displacement strain gauges	
	2.3	Temperature Transducers- Resistance temperature detectors (RTD). Thermistors and thermocouples, their ranges and applications	
3		**Introduction to control system Analysis**	08
	3.1	Introduction: Open and closed loop systems, example of control systems	
	3.2	Modelling: Modelling, Transfer function model	
	3.3	Block diagram reduction techniques and Signal flow graph	
4		**Response of control system**	04
	4.1	Dynamic Response: Standard test signals, transient and steady state behavior of first and second order systems, steady state errors in feedback control systems and their types	
	4.2	Concept of lag and lead compensator.	
5		**Stability Analysis in Time Domain**	08
	5.1	Concept of stability: Routh and Hurwitz stability criterion	
	5.2	Root locus Analysis: Root locus concept, general rules for constructing root-locus, root locus analysis of control system	
6		**Stability Analysis in frequency domain**	09
	6.1	Introduction: Frequency domain specification, Relationship between time and frequency domain specification of system, stability margins	
	6.2	Bode Plot: Magnitude and phase plot, Method of plotting Bode plot, Stability margins and analysis using bode plot. Frequency response analysis of RC, RL, RLC circuits	
	6.3	Nyquist Criterion: Concept of Polar plot and Nyquist plot, Nyquist stability criterion, gain and phase margin	
Total			39

Textbooks:

1. A.K. Sawhney, "*Electrical & Electronic Measurement & Instrumentation"* – DRS .India
2. B.C Nakra, K.K. Cahudhary, Instrumentation Measurement and Analysis, Tata Mc Graw Hill.
3. W.D. Cooper, "*Electronic Instrumentation And Measuring Techniques"* –PHI
4. Nagrath, M.Gopal, "*Control System Engineering*", Tata McGrawHill.
5. Rangan C. S., Sarma G. R. and Mani V. S. V., "*Instrumentation Devices And Systems*", Tata McGraw-Hill, 2nd Ed.,2004.
6. K.Ogata, "*Modern Control Engineering*, Pearson Education", IIIrd edition.

Reference Books:

1. Helfrick&Copper, "*Modern Electronic Instrumentation & Measuring Techniques"* –PHI
2. M.M.S. Anand, "*Electronic Instruments and instrumentationTechnology"*.
3. Gopal M., "Control Systems Principles and Design", Tata McGraw Hill Publishing Co. Ltd.New Delhi, 1998.
4. Benjamin C.Kuo, "*Automatic Control Systems*, Eearson education", VIIthedition
5. Doeblin E.D., Measurement system, Tata Mc Graw Hill., 4th ed, 2003.Madan Gopal, "Control Systems *Principles and Design"*, Tata McGraw hill, 7th edition,1997.
6. Normon, "*Control System Engineering"*, John Wiley & sons, 3rdedition.

NPTEL/ Swayam Course:

1. Course: Control Systems By Prof. C. S. Shankar Ram (IIT Madras); https://swayam.gov.in/nd1_noc20_ee90/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 completed 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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical/ Oral	Tutorial	Total
ECL301	Electronic Devices & Circuits Lab	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECL301	Electronic Devices & Circuits Lab	--	--	--	--	25	25	50

Course Objectives:

1. To make students familiar with equipments and measuring instruments used to perform Electronics Devices and Circuits laboratory work.
2. To provide hands on experience to develop laboratory setup for performing given experimental using various equipments, electronic devices and measuring instruments.
3. To develop an ability among students to gather appropriate data and analyse the same to relate theory with practical.
4. To develop trouble shooting abilities among students.

Course Outcomes:

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

1. Know various equipments, electronics devices and components, and measuring instruments used to perform laboratory work.
2. Students will be able to explain functionality of various equipments, electronics devices and components and neasu6 instruments used to perform laboratory work.
3. Students will be able connect various equipments, devices, components and measuring devices using bread board as per the circuit diagram for experiment to be performed.
4. Students will able to perform experiment to gather appropriate data.
5. Students will able to analyze data obtained from experiment to relate theory with experiment results.
6. Students will able to prepare laboratory report (Journal) to summarise the outcome each experiment.

Laboratory plan:

Maximum of 10 practicals including minimum 2 to 3 simulations should be conducted. Suggested list of experiments:

1. To study of pn junction diode characteristics.
2. To study zener as a voltage regulator.
3. To study characteristics of CE configuration.
4. To study BJT biasing circuits.
5. To study BJT as CE amplifier.
6. To study frequency response of CE amplifier.
7. To study EMOSFET biasing circuits.
8. Simulation experiment on study of CS amplifier.
9. Simulation experiment on study frequency response of CS amplifier.
10. Simulation experiment on study of differential amplifier.
11. Simulation experiment on multistage amplifier.

Term Work: At least 10 Experiments including not more than 03 simulations covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.
Term work assessment must be based on the overall performance of the student with every experiment and assignments are 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. The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL302	Digital System Design Lab	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL302	Digital System Design Lab	--	--	--	--	25	--	25

Course objectives:

1. To get familiarise with basic building blocks of Digital System Design and verify the operation of various digital ICs.
2. To train students to design and implementation of combinational circuits.
3. To instruct students on how to design and implement sequential circuits.
4. To introduce simulation software like VHDL/Verilog to design basic digital circuits.

Course outcomes:

Learners will be able to …

1. Identify various Digital ICs and basic building blocks of digital system design
2. Design and implement combinational circuits like adder, subtractor, multiplexer, code converters etc.
3. Identify and understand working of various types of flip flops and their inter conversions.
4. Design and implement basic sequential circuits such as counters, registers etc.
5. Acquire basic knowledge of VHDL/Verilog basic programming.

Suggested list of experiments:

1. Simplification of Boolean functions.
2. Design AND, OR, NOT, EXOR, EXNOR gates using Universal gates: NAND and NOR.
3. Implement digital circuits to perform Binary to Gray and Gray to Binary operations.
4. Implement Half adder, Full adder, Half subtractor and Full subtractor circuits.
5. Design and implement BCD adder using 4-bit Binary Adder IC-7483.
6. Implement logic equations using Multiplexer.
7. Verify encoder and decoder operations.

8. Design and implement Magnitude Comparator.
9. Verify truth table of different types of flip flops.
10. Flip flop conversions JK to D, JK to T and D to TFF.
11. Design asynchronous/synchronous MOD N counter using IC7490.
12. Verify different counter operations.
13. Write VHDL/Verilog simulation code for different logic gates.
14. Write VHDL/Verilog simulation code for combinational and sequential circuits.
15. Write VHDL/Verilog simulation code for 4:1 Multiplexer, 2 to 4 line binary decoder.

Term Work:

At least 08 experiments covering the entire syllabus must be given "**Batch Wise"**. Out of these, **06 hardware experiments**, to be done strictly on breadboard and **at least 02 software experiments** using VHDL/Verilog. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments are 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.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Pract.	Tut.	Total
ECL303	Electronic Instrumentation & Control Systems Lab.	--	2	--	--	1	--	1

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam			
ECL303	Electronic Instrumentation & Control Systems Lab.	--	--	--	--	25	--	25

Course Objectives:

1. To experimentally verify the principle and characteristics of various transducers and measurement of resistance and inductance.
2. To make students understand the construction and the working principle of various transducers used for Displacement measurement, Temperature measurement and Level measurement.
3. To examine steady-state and frequency response of the Type 0, 1, and 2 systems.
4. To examine steady-state and frequency response of first and second order electrical systems.
5. To inspect stability analysis of system using Root locus, Bode plot, polar plot and Nyquist plot.

Course Outcomes:

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

1. Plot and validate the performance characteristics of transducers.
2. Validate the characteristics of various temperature, pressure and level transducers.
3. Plot frequency response of first-order electrical system.
4. Plot time response of second-order electrical system and calculate the steady-state error.
5. Validate the effect of damping factor on the response of second order system.
6. Inspect the frequency response specifications of systems by using bode-plot, Polar plot, Nyquist-plot techniques, and comment on the stability of system

List of experiments:

1. Designing DC bridge for Resistance Measurement (Quarter, Half and Full bridge)
2. Designing AC bridge Circuit for capacitance measurement.
3. Study and characteristics of Resistive Temperature Detector (RTD).
4. Study of Linear Variable Differential Transformer (LVDT)
5. To plot the effect of time constant on first-order systems response.
6. To plot the frequency response of first-order System
7. To plot the time response of second-order systems
8. To plot the frequency response of second-order System
9. To Examine Steady State Error for Type 0, 1, 2 System
10. To study the performance of Lead and Lag Compensator
11. To inspect the relative stability of systems by Root-Locus using Simulation Software.
12. To determine the frequency specification from Polar plot of system
13. To inspect the stability of system by Nyquist plot using Simulation software.
14. To inspect the stability of system by Bode plot using Simulation software.
15. Any other experiment based on syllabus which will help students to understand topic/concept.

Term Work:

At least 08 Experiments covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments are 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	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL304	Skill Lab: C++ and Java Programming	--	04	--	--	02	--	02

Course Code	Course Name	Examination Scheme						
		Theory Marks						
		Internal assessment			End Sem. Exam	Term Work	Practical And Oral	Total
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECL304	Skill Lab: C++ and Java Programming	--	--	--	--	25	25	50

Note: Before performing practical **'Necessary Theory'** will be taught by concern faculty

Course Pre-requisites:

1. FEL204 - C-Programming

Course Objectives:

1. Describe the principles of Object Oriented Programming (OOP).
2. To understand object-oriented concepts such as data abstraction, encapsulation, inheritance and polymorphism.
3. Utilize the object-oriented paradigm in program design.
4. To lay a foundation for advanced programming.
5. Develop programming insight using OOP constructs.

Course Outcomes:

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

1. Describe the basic principles of OOP.
2. Design and apply OOP principles for effective programming.
3. Develop programming applications using OOP language.
4. Implement different programming applications using packaging.
5. Analyze the strength of OOP.
6. Percept the Utility and applicability of OOP.

Module No.	Unit No.	Topics	Hrs.
1.0		**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.	
2.0		**C++ Control Structures**	**08**
	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.	
3.0		**Object-Oriented Programming using C++**	**12**
	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.	
4.0		**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.	
5.0		**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 sub classes). **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	**52**

Suggested list of Experiments:

Note: *Before performing practical necessary Theory will be taught by concern faculty*

Sr.No	Write C++ Program to
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.	Write JAVA Program to
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

Textbooks:

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

Reference Books:

1. Herbert Schidt, “The Complete Reference”, Tata McGraw-Hill Publishing Company Limited, Ninth Edition.
2. Java: How to Program, 8/e, Dietal, PHI.
3. Grady Booch, James Rumbaugh, Ivar Jacobson, “The Unified Modeling Languageser Guide”, Pearson Education.
4. Sachin Malhotra, Saurabh Chaudhary “Programming in Java”, Oxford University Press, 2010.

Skill-Enhancement:

1. The students should be trained to code in Eclipse (an industry accepted software tool). Also, for a given problem statement, there is need to include external library files (other than JDK files). Moreover, the students need to be trained on Maven (a build tool).
2. Real-life mini-problem statements from software companies (coming in for placement) to be delegated to groups of 3-4 students each and each group to work on the solution for 8-12 hours (last 2 lab sessions).

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

Term Work:

At least **12** experiments (**06 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 experiments more meaningful, interesting and innovative.
Term work assessment must be based on the overall performance of the student with every Experiments are 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.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam should cover all **12** experiments for examination.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM301	Mini Project 1A	--	04[$]	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM301	Mini Project 1A	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

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.

Outcome: At the end of the course learners 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

NOTE: For Electronics & Telecommunication Engineering we recommend following syllabus for Mini-Project 1A, in case it is half-year project.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM301	Mini Project 1A: Analog & Digital Circuit Design based Projects	--	04[$]	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM301	Mini Project 1A: Analog & Digital Circuit Design based Projects	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

Course Pre-requisite:

1. FEC105 - BEE

Course Objectives:

1. To make students familiar with the basics of electronic devices and circuits, electrical circuits and digital systems
2. To familiarize the students with the designing and making of Printed circuit boards(PCB)
3. To improve the knowledge of electronics hardware among students

Course outcomes:

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

1. Create the electronics circuit for particular application/experiment.
2. Design and simulate the circuits by putting together the analog and digital components
3. Learn the technique of soldering and circuit implementation on general purpose printed circuit board (GPP).
4. Realize the PCB design process and gain up-to-date knowledge of PCB design software.
5. Utilize the basic electronic tools and equipment's (like DMM, CRO, DSO etc.)
6. Analysis of hardware fault (Fault detection and correction)

Module No.	Unit No.	Topics	Hrs.
1.0		**Identification and Designing of Circuit**	**08**
	1.1	Identification of particular application with understanding of its detail operation. Study of necessary components and devices required to implement the application.	
	1.2	Designing the circuit for particular application (either analog , digital, electrical , analog and digital, etc)	
2.0		**Software simulation and Implementation on GPP**	**12**
	2.1	Simulation of circuit for particular application using software's to verify the expected results	
	2.2	Implementation of verified circuit on general purpose printed circuit board (GPP). Now Verify the hardware results by using electronic tools and equipment's like millimeter, CRO, DSO etc.	
3.0		**PCB design and optimization**	**08**
	3.1	Design the circuit by placing components using PCB design software's.	
	3.2	Reduce the size of PCB by varying the position of components or devices for optimize use of copper clad material	
4.0		**Implementation of PCB**	**08**
	4.1	Transfer the designed PCB on Copper clad either by using dark room or taking printout on glossy paper, etc (use available suitable method).	
	4.2	Perform Etching and then Soldering.	
5.0		**Detection of Hardware faults and Result verification**	**08**
	5.1	Identify the hardware faults in designed circuit and subsequently rectify it	
	5.2	Now again verify the hardware results by using electronic tools and equipment's like millimeter, CRO, DSO etc.	
6.0		**Understanding the Troubleshooting**	**08**
	6.1	Understand the trouble shooting by removing some wired connection.	
	6.2	Understand the trouble shooting of track. Troubleshoot the faculty components or devices	
		Total	**52**

NOTE: During 1st week or within 1-month of the beginning of the semester, following topics related to ADC and DAC should be covered as theoretical concepts.

a. **Performance specifications of ADC, single ramp ADC, ADC using DAC, dual slope ADC, successive approximation ADC.**

b. **Performance specifications of DAC, binary weighted resistor DAC, R/2R ladder DAC, inverted R/2R ladder DAC.**

Reference books:

1. Schultz Mitchel E., *"Grob's Basic Electronics",* McGraw-Hill Education; 10th edition, 25 October , 2006.
2. Charles Platt, *"Make Electronics: Learning by discovery",* O'Reilly; 2nd edition, 18 September , 2015.
3. Forrest M Mims III, *"Getting started in Electronics",* Book Renter, Inc.; 3rd edition , 1 January 2000.

4. R S Khandpur, "*Printed circuit board*", McGraw-Hill Education; 1st edition, 24 February , 2005.
5. Kraig Mitzner, "*Complete PCB Design Using OrCAD Capture and PCB Editor",* Academic Press; 2nd edition , 20 June 2019.

Suggested Software tools:

1. LTspice:https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html#
2. Eagle : https://www.autodesk.in/products/eagle/overview
3. OrCAD: https://www.orcad.com/
4. Multisim : https://www.multisim.com/
5. Webbench:http://www.ti.com/design-resources/design-tools-simulation/webench-power-designer.html
6. Tinkercad : https://www.tinkercad.com/

Online Repository:

1. https://www.electronicsforu.com
2. https://circuitdigest.com
3. https://www.electronicshub.org

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	TW/Pract	Tut.	Total
ECC401	Engineering Mathematics-IV	03	-	01*	03	-	01	04

Course Code	Course Name	Examination Scheme							
		Theory				Exam Dura-tion (in Hrs.)	Term Work	Pract & Oral	Total
		Internal Assessment			End Sem exam				
		Test1	Test2	Avg. of Test 1 & 2					
ECC401	Engineering Mathematics-IV	20	20	20	80	03	25	-	125

*** Should be conducted batch wise.**

Pre-requisite:

1. FEC101-Engineering Mathematics-I
2. FEC201-Engineering Mathematics-II
3. ECC301-Engineering Mathematics-III & Binomial Distribution.

Course Objectives: The course is aimed:

1. To understand 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 understand probability distributions and expectations.
4. To understand the concepts of vector spaces used in the field of machine learning and engineering problems.
5. To understand the concepts of Quadratic forms and Singular value decomposition.
6. To understand the concepts of Calculus of Variations.

Course Outcomes:

On successful completion of course learner/student will be able to:

1. Use the concepts of Complex Integration for evaluating integrals, computing residues & evaluate various contour integrals.
2. Apply the concept of Correlation and Regression to the engineering problems in data science, machine learning and AI.
3. Apply 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 which are very useful tools in various Engineering applications.
6. Find the extremals of the functional using the concept of Calculus of variation.

Module	Detailed Contents	Hrs.
01	**Module: 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 real integrations ,Z- Transform.	7
02	**Module: 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	**Module: Probability Distributions** 1.1 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	**Module: Linear Algebra: Vector Spaces:-** 4.1 Vectors in n-dimensional vector space, norm, dot product, The CauchySchwarz 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 and Independence, QR decomposition.	6
05	**Module: 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	**Module: 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

References:

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

Term Work (25-Marks):

General Instructions:

1. Batch wise tutorials are to be conducted. The number of students per batch should be as per University pattern for practicals.
2. Students must be encouraged to write at least 6 class tutorials on entire syllabus.
3. 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

Internal Assessment Test (25-Marks):

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 second class test (Internal Assessment II) will be based on remaining contents (approximately 40% syllabus but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Theory 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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. Total 04 questions need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC402	Micro-controllers	3	-	--	3	-	--	3

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC402	Micro-controllers	20	20	20	80	03	-	-	100

Course Pre-requisites:

1. ECC303 - Digital System Design

Course objectives:

1. To develop background knowledge of Computer and its memory System.
2. To understand architecture of 8051 and ARM7 core.
3. To write programs for 8051 microcontrollers.
4. To understand design of Microcontroller Applications.

Course outcomes:

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

1. Understand Computer and its memory System,
2. Understand the detailed architecture of 8051 and ARM7 Core.
3. Write programs for 8051 microcontrollers.
4. Design an applications using microcontroller.

Module No.	Unit No.	Topics	Hrs
1		**Overview of Microprocessor based System**	5
	1.1	Overview of microcomputer systems and their building blocks, Memory Interfacing, Steps taken by the microprocessor to fetch and executes an instruction from the memory	
	1.2	Concepts of Program counter register, Reset, Stack and stack pointer , Subroutine, Interrupts and Direct Memory Access	
	1.3	Concept of RISC & CISC Architecture	
	1.4	Harvard & Von Neumann Architecture	
2		**The Memory Systems**	4
	2.1	Classification of Memory : Primary and Secondary	
	2.2	Types of Semiconductor memories	
	2.3	Cache Memory	
	2.4	Virtual Memory Concept with Memory Management Unit with Segmentation and Paging (Address Translation Mechanism)	
3		**8051 Microcontroller**	8
	3.1	Comparison between Microprocessor and Microcontroller	
	3.2	Features, architecture and pin configuration	
	3.3	CPU timing and machine cycle	
	3.4	Input / Output ports	
	3.5	Memory organization	
	3.6	Counters and timers	
	3.7	Interrupts	
	3.8	Serial data input and output	
4		**8051 Assembly Language Programming and Interfacing**	9
	4.1	Addressing modes	
	4.2	Instruction set	
	4.3	Need of Assembler & Cross Assemble, Assembler Directives	
	4.4	Programs related to: arithmetic, logical, delay subroutine , input, output, timer, counters, port, serial communication, and interrupts	
	4.5	Interfacing with LEDs, Relay and Keys	
5		**ARM7**	8
	5.1	Introduction & Features of ARM 7	
	5.2	Concept of Cortex-A, Cortex-R and Cortex-M	
	5.3	Architectural inheritance, Pipelining	
	5.4	Programmer’s model	
	5.5	Brief introduction to exceptions and interrupts handling	
	5.6	Instruction set: Data processing, Data Transfer, Control flow	
6		**Study 8 bit microcontroller Applications**	5
	6.1	Understanding features of NXP 89v51RD2, Atmega 328P and PIC16F886	
	6.2	Selecting a microcontroller for an application	
	6.3	Study of 89v51 based Clock Using I2C RTC and Seven Segment Display	
	6.4	PIC16F886 Speed Control of DC Motor.	
	6.5	Atmega 328P based remote temperature monitoring with LCD display	
		Total	39

Text Books:

1. Douglas V Hall, SSSP Rao “Microprocessors & Interfacing”, McGraw Hill
2. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, “Computer Organization”, Fifth Edition, Tata McGraw-Hill
3. Shibu K. V “Introduction to embedded systems” McGraw Hill.
4. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, “The 8051 Microcontroller & Embedded systems”, Pearson Publications, Second Edition 2006.
5. C. Kenneth J. Ayala and D. V. Gadre, “The 8051 Microcontroller & Embedded system using assembly & ‘C’ ”, Cengage Learning, Edition 2010.
6. Steve Furber, “ARM System on chip Architecture”, Pearson,2nd edition.

Reference books:

1. “MCS@51 Microcontroller, Family User’s Manual” Intel
2. “PIC16F882/883/884/886/887 Data Sheet”, Microchip.
3. ATmega328P 8-bit AVR Microcontroller with 32K Bytes In-System Programmable Flash datasheet, Atmel
4. P89V51RB2/RC2/RD2 8-bit 80C51 5 V low power 16/32/64 kB flash microcontroller, Data Sheet NXP founded by Philips
5. James A. Langbridge, “Professional Embedded Arm Development”, Wrox, John Wiley Brand& Sons Inc., Edition 2014

NPTEL/ Swayam Course:

1. Course: Microprocessors and Microcontrollers By Prof. Santanu Chattopadhyay (IIT Kharagpur); **https://swayam.gov.in/nd1_noc20_ee42/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 completed 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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC403	Linear Integrated Circuits	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs)	Term Work	Prac. and Oral	Total
		Internal assessment			End Sem. Exam. (ESE)				
		Test1	Test2	Avg. of Test 1 and Test 2					
ECC403	Linear Integrated Circuits	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. FEC105-Basic Electrical Engineering
2. ECC302-Electronic Devices & Circuits

Course Objectives:

1. To understand the concepts, working principles and key applications of linear integrated circuits.
2. To perform analysis of circuits based on linear integrated circuits.
3. To design circuits and systems for particular applications using linear integrated circuits.

Course Outcome:

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

1. Outline and classify all types of integrated circuits.
2. Understand the fundamentals and areas of applications for the integrated circuits.
3. Develop the ability to design practical circuits that perform the desired operations.
4. Understand the differences between theoretical & practical results in integrated circuits.
5. Identify the appropriate integrated circuit modules for designing engineering application.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Operational Amplifier**	**07**
	1.1	Block diagram of Op-Amp. Ideal and practical characteristics of op-amp.	
	1.2	Configurations of Op-Amp: Open loop and closed loop configurations of Op-amp, Inverting and Non-inverting configuration of Op-amp and buffer.	
	1.3	Summing amplifier, difference amplifiers and Instrumentation amplifier using Op-amp.	
2.0		**Linear Applications of Operational Amplifier**	**08**
	2.1	Voltage to current and current to voltage converter.	
	2.2	Integrator & differentiator (ideal & practical), Active Filters: First and Second order active low pass, high pass, band pass, band reject and Notch filters.	
	2.3	Positive feedback, Barkhausen's criteria, Sine Wave Oscillators: RC phase shift oscillator, Wien bridge oscillator.	
3.0		**Non-Linear Applications of Operational Amplifier**	**07**
3.0	**3.1**	Comparators: Inverting comparator, non-inverting comparator, zero crossing detectors, window detector.	
	3.2	Schmitt Triggers: Inverting Schmitt trigger, non-inverting Schmitt trigger.	
	3.3	Waveform Generators: Square wave generator and triangular wave generator. Basics of Precision Rectifiers: Half wave and full wave precision rectifiers. Peak detector.	
4.0		**Timer IC 555 and it's applications**	**07**
	4.1	Functional block diagram and working of IC 555	
	4.2	Design of Astable and Monostable multivibrator using IC 555	
	4.3	Applications of Astable and Monostable multivibrator as Pulse width modulator and Pulse Position Modulator.	
5.0		**Voltage Regulators.**	**06**
	5.1	Functional block diagram, working and design of three terminal fixed voltage regulators (78XX, 79XX series).	
	5.2	Functional block diagram, working and design of general purpose IC 723 (HVLC and HVHC).	
	5.3	Introduction and block diagram of switching regulator, Introduction of LM 317.	
6.0		**Special Purpose Integrated Circuits**	**04**
	6.1	Functional block diagram and working of VCO IC 566 and application as frequency modulator.	
	6.2	Functional block diagram and working of PLL IC 565 and application as FSK Demodulator.	
		Total	**39**

Textbooks:

1. Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, Pearson Prentice Hall, 4th Edition.
2. D. Roy Choudhury and S. B. Jain, “Linear Integrated Circuits”, New Age International Publishers, 4th Edition.

Reference Books:

1. K. R. Botkar, “Integrated Circuits”, Khanna Publishers (2004)
2. Sergio Franco, “Design with operational amplifiers and analog integrated circuits”, Tata McGraw Hill, 3rd Edition.
3. David A. Bell, “Operation Amplifiers and Linear Integrated Circuits”, Oxford University Press, Indian Edition.
4. R. F. Coughlin and F. F. Driscoll, “Operation Amplifiers and Linear Integrated Circuits”, Prentice Hall, 6th Edition.
5. J. Millman, Christos CHalkias, and Satyabratatajit, Millman’s,“Electronic Devices and Circuits,” McGrawHill, 3rdEdition.

NPTEL/ Swayam Course:

1. Course: ICs MOSFETs Op-Amps & Their Applications By Prof. Hardik Jeetendra Pandya (IISc Bangalore);
   https://swayam.gov.in/nd1_noc20_ee13/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 completed 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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC404	Signals and Systems	03	--	01	03	--	01	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 & Test 2					
ECC404	Signals and Systems	20	20	20	80	03	25	--	125

Course pre-requisite:

1. ECC301 – Engineering Mathematics III

Course objectives:

1. To introduce students to the idea of signal and system analysis and characterization in time and frequency domain.
2. To provide foundation of signal and system concepts to areas like communication, control and comprehend applications of signal processing in communication systems.

Course outcomes:

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

1. Classify and Analyze different types of signals and systems
2. Analyze continuous time LTI signals and systems in transform domain
3. Analyze and realize discrete time LTI signals and systems in transform domain
4. Represent signals using Fourier Series and Analyze the systems using the Fourier Transform.
5. Demonstrate the concepts learnt in Signals and systems Course using the modern engineering tools.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to signals and systems**	**07**
	1.1	**Introduction to Signals:** Definition, Basic Elementary signals - exponential, sine, step, impulse, ramp, rectangular, triangular. Operations on signals. **Classification of Signals:** analog and discrete time signals, even and odd signals, periodic and non-periodic signals , deterministic and non-deterministic signals, energy and power signals.	
	1.2	**Systems and Classification of systems:** System Representation, continuous time and discrete systems, system with and without memory, causal and non-causal system, linear and nonlinear system, time invariant and time variant system, stable system.	
2.0		**Time domain analysis of Continuous Time and Discrete Time systems**	**07**
	2.1	**Linear Time Invariant (LTI) systems:** Representation of systems using differential /difference equation, Impulse, step and exponential response, System Stability and Causality.	
	2.2	Use of convolution integral and convolution sum for analysis of LTI systems, properties of convolution integral/sum, impulse response of interconnected systems.	
	2.3	Correlation and spectral Density: auto-correlation, cross correlation, analogy between correlation and convolution, energy spectral density, power spectral density, relation of ESD and PSD with auto-correlation.	
3.0		**Fourier Analysis of Continuous and Discrete Time Signals and Systems**	**07**
	3.1	Fourier transform of periodic and non-periodic functions, Properties of Fourier Transform, Inverse Fourier Transform, Frequency Response: computation of Magnitude and Phase Response, Limitations of Fourier Transform.	
4.0		**Laplace Transform and Continuous time LTI systems**	**06**
	4.1	Need of Laplace Transform, Concept of Region of Convergence, Properties of Laplace Transform, Relation between continuous time Fourier Transform and Laplace Transform, unilateral Laplace Transform, inverse Laplace Transform.	
	4.2	**Analysis of continuous time LTI systems using Laplace Transform: C**ausality and stability of systems in *s*-domain, Total response of a system.	
5.0		***z*-Transform and Discrete time LTI systems**	**08**
	5.1	Need of *z*-Transform, *z*-Transform of finite and infinite duration sequences, Concept of Region of Convergence, *z*-Transform	

		properties, Standard *z*-transform pairs, relation between *z*-transform and discrete time Fourier Transform, one sided *z*-Transform. Inverse *z*-Transform: Partial Fraction method only.	
	5.2	**Analysis of discrete time LTI systems using *z*-Transform**: Systems characterized by Linear constant coefficient difference equation, Transfer Function, plotting Poles and Zeros of a transfer function , causality and stability of systems, Total response of a system.	
6.0		**FIR and IIR systems**	**04**
	6.1	Concept of finite impulse response systems and infinite impulse response systems, Linear Phase FIR systems.	
	6.2	**Realization structures of LTI system:** Direct form –I and direct form II, Linear Phase FIR structures.	
Total			**39**

Text books:

1. Nagoor Kani, Signals and Systems, Tata McGraw Hill, Third Edition, 2011.
2. Rodger E Ziemer, William H. Tranter and D. Ronald Fannin, Signals and Systems, Pearson Education, Fourth Edition 2009.
3. Alan V. Oppenhiem, Alan S. Willsky and S. Hamid Nawab, Signals and Systems, Prentice-Hall of India, Second Edition, 2002.
4. Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.

Reference books:

1) Hwei. P Hsu, Signals and Systems, Tata McGraw Hill, Third edition, 2010
2) Simon Haykin and Barry Van Veen, Signals and Systems, John Wiley and Sons, Second Edition, 2004.
3) V. Krishnaveni and A. Rajeshwari, Signals and Systems, Wiley-India, First Edition 2012.
4) Michael J Roberts, Fundamentals of Signals and systems, Tata McGraw Hill, special Indian Economy edition, 2009.
5) Luis F. Chaparro, Signals and Systems Using MATLAB, Academic Press
6) Rangaraj M. Rangayyan, “Biomedical Signal Analysis- A Case Study Approach”, Wiley 2002.
7) Signals and Systems Laboratory: Virtual Laboratory http://ssl-iitg.vlabs.ac.in/

NPTEL/ Swayam Course:

1. Course: Principles of Signals & Systems By Prof. Aditya K. Jagannatham (IIT Kanpur); https://swayam.gov.in/nd1_noc20_ee15/preview

Teachers and students are encouraged to use *Signals and Systems Laboratory: Virtual Laboratory* (Reference number 8) for demonstration of concepts such as systems and their properties, Fourier analysis etc.

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 completed 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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Term Work (25-Marks):

At least 06 Tutorials covering entire syllabus and 01 course project must be given during the “Class Wise Tutorial”.

Students can form team of maximum 4 members and work on course project using any software viz. C, Python, Scilab, Matlab, Octave, etc. The course project should be appropriately selected in order to demonstrate any concept learnt in this course.

03-hours (out of the total 12-hours allotted for the tutorials) can be utilized for the course project completion.

Term work assessment must be based on the overall performance of the student with every tutorial and a course project 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.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC405	Principles of Communication Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Prac. & Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECC405	Principles of Communication Engineering	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. ECC301 - Engineering Mathematics- III
2. ECC302 - Electronic Devices and Circuits

Course Objectives:

1. To illustrate the fundamentals of basic communication system.
2. To understand various analog modulation and demodulation techniques.
3. To focus on applications of analog modulation and demodulation techniques.
4. To explain the key concepts of analog and digital pulse modulation and demodulation techniques.

Course Outcomes:

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

1. Understand the basic components and types of noises in communication system.
2. Analyze the concepts of amplitude modulation and demodulation.
3. Analyze the concepts of angle modulation and demodulation.
4. Compare the performance of AM and FM receivers.
5. Describe analog and digital pulse modulation techniques.
6. Illustrate the principles of multiplexing and demultiplexing techniques.

Module No.	Unit No.	Topics	Hours
1		**Basics of Communication System**	**05**
	1.1	Block diagram, electromagnetic spectrum, signal bandwidth and power, types of communication channels, Introduction to time and frequency domain. Basic concepts of wave propagation.	**03**
	1.2	Types of noise, signal to noise ratio, noise figure, noise temperature and Friss formula.	**02**
2		**Amplitude Modulation and Demodulation**	**12**
	2.1	Basic concepts, need for modulation, waveforms (time domain and frequency domain), modulation index, bandwidth, voltage distribution and power calculations.	**04**
	2.2	DSBFC: Principles, low-level and high-level transmitters, DSB suppressed carrier, Balanced modulators with diode (Ring modulator and FET) and SSB systems.	**04**
	2.3	Amplitude demodulation: Diode detector, practical diode detector, Comparison of different AM techniques, Applications of AM and use of VSB in broadcast television.	**04**
3		**Angle Modulation and Demodulation**	**10**
	3.1	Frequency and Phase modulation (FM and PM): Basic concepts, mathematical analysis, FM wave (time and frequency domain), sensitivity, phase and frequency deviation, modulation index, deviation ratio, bandwidth requirement of angle modulated waves, narrowband FM and wideband FM.	**04**
	3.2	Varactor diode modulator, FET reactance modulator, stabilized AFC, Direct FM transmitter, indirect FM Transmitter, noise triangle, pre- emphasis and de-emphasis	**03**
	3.3	FM demodulation: Balanced slope detector, Foster-Seely discriminator, Ratio detector, FM demodulator using Phase lock loop, amplitude limiting and thresholding, Applications of FM and PM.	**03**
4		**Radio Receivers**	**04**
	4.1	Characteristics of radio receivers, TRF, Super - heterodyne receiver block diagram, tracking and choice of IF, AGC and its types and Communication receiver.	**03**
	4.2	FM receiver block diagram, comparison with AM receiver.	**01**
5		**Analog and Digital Pulse Modulation & Demodulation**	**06**
	5.1	Sampling theorem for low pass signal, proof with spectrum, Nyquist criteria, Sampling techniques, aliasing error and aperture effect.	**03**
	5.2	PAM, PWM, PPM generation, detection and applications. Basics of PCM system and differential PCM system. Concepts of Delta modulation (DM) and Adaptive Delta Modulation (ADM).	**03**
6		**Multiplexing & De-multiplexing**	**02**
	6.1	Frequency Division Multiplexing transmitter & receiver block diagram and applications. Time Division Multiplexing transmitter & receiver block diagram and applications.	**02**
		Total	**39**

Textbooks:

1. Kennedy and Davis, "Electronics Communication System", Tata McGraw Hill, Fourth edition.
2. B.P. Lathi, Zhi Ding "Modern Digital and Analog Communication system", Oxford University Press, Fourth edition.
3. Wayne Tomasi, "Electronics Communication Systems", Pearson education, Fifth edition.

Reference Books:

1. Taub, Schilling and Saha, "Taub's Principles of Communication systems", Tata McGraw Hill, Third edition.
2. P. Sing and S.D. Sapre, "Communication Systems: Analog and Digital", Tata McGraw Hill, Third edition.
3. Simon Haykin, Michel Moher, "Introduction to Analog and Digital Communication", Wiley, Second edition.
4. Dennis Roddy and John Coolen, Electronic Communication, Pearson, 4/e, 2011.
5. Louis Frenzel, "Communication Electronics", Tata McGraw Hill, Third Edition.

NPTEL/ Swayam Course:

1. Course: Analog Communication By Prof. Goutam Das (IIT Kharagpur);
   https://swayam.gov.in/nd1_noc20_ee69/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 completed 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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL401	Micro-controllers Lab	-	2	-	-	1	-	1

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					
ECL401	Micro-controllers Lab	-	-	-	-	-	25	--	25

Course Objectives:

1. To understand development tools of microcontroller based systems.
2. To learn programming for different microcontroller operation & interface to I/O devices.
3. To develop microcontroller based applications.

Course Outcomes:

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

1. Understand different development tools required to develop microcontroller based systems.
2. Write assembly language programs for arithmetic and logical operations, code conversion & data transfer operations.
3. Write assembly language programs for general purpose I/O, Timers & Interrupts.
4. Interface & write programs for Input and Output devices
5. Develop microcontroller based Applications.

Suggested Experiment List:

1. Perform Arithmetic and Logical Operations (Using Immediate, Direct and Indirect addressing)
2. Code Conversion
3. Transfer of data bytes between Internal and External Memory
4. Experiments based on General Purpose Input-Output, Timers, Interrupts, Delay, etc
5. Interfacing of Matrix Key board, LED, 7 Segment display, LCD, Stepper Motor, UART

At Least 10 experiment Minimum two from each category of above list must be given during the **Laboratory session batch wise**. Computation/simulation based experiments are also encouraged.

Before starting the experiments there should be one session on Study of development tools like Editor, Assembler-cross Assembler, Compiler-Cross compiler, Linker, Simulator, emulator etc.

Mini project based on 8051 derivatives, PIC, AVR & other 8 bit microcontrollers using Assembly and/or C language. (Readymade of Arduino & raspberry pi are **not recommended here**)

Note: Mini Project can be considered as a part of term-work.

Term Work (25-Marks):

The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are 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	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL402	Linear Integrated Circuits Lab.	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam. Duration (in Hrs)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ECL402	Linear Integrated Circuits Lab.	--	--	--	--	--	25	25	50

Course Outcomes:

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

1. Understand the differences between theoretical, practical and simulated results in integrated circuits.
2. Apply the knowledge to do simple mathematical operations.
3. Apply knowledge of op-amp, timer and voltage regulator ICs to design simple applications.

Laboratory Plan:

Minimum 8 hardware practical (compulsorily based on IC 741, IC 555, IC 723 and remaining on VCO 566 or PLL 565) and 2 simulations should be conducted. At least one experiment from each Module of syllabus.

Suggested list of experiments:

1. Design inverting, non-inverting amplifier and buffer using IC 741.
2. Design summing and difference amplifier using op-amp.
3. Design voltage to current converter with grounded load.
4. Design and analyze Integrator
5. Design and analyze Differentiator
6. Design Schmitt trigger using Op-amp.
7. Design Wein bridge and RC phase shift Oscillator.
8. Design and analyze second order High pass and Low pass filter
9. Design and analyze Band pass and Band reject filter.
10. Design Astable multivibrator using IC 555 for fixed frequency and variable duty cycle.
11. Design Monostable Multivibrator using IC 555.
12. Design Low voltage Low current voltage regulator using IC 723.
13. Design High voltage High current voltage regulator using IC 723.
14. Design Frequency Modulator using IC 566
15. Design FSK Demodulator using IC 565
16. Design Instrumentation amplifier using 3 Op-Amp.
17. Design Precision rectifier
18. Design Square & Triangular wave generator

Term Work (25-Marks):

At least 10 Experiments including 02 simulations covering entire syllabus must be given during the “Laboratory session batch wise”. Computation/simulation based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects are graded from time to time.

The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL403	Principles of Communication Engineering Lab.	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks					Term Work	Practical & Oral	Total
		Internal assessment			End Sem. Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECL403	Principles of Communication Engineering Lab.	--	--	--	--	--	25	25	50

Course Pre-requisites:

1. Usage of basic Electronic instruments and components.
2. Fundamentals of Electronic Devices and circuits

Course Objectives:

1. To give an understanding of Time and Frequency domain representation of signals.
2. To demonstrate continuous wave modulation and demodulation.
3. To demonstrate analog and digital pulse communication.
4. Able to use simulation software to build communication circuits.

Course Outcomes:

After successful performance of the practicals student will be able to:

1. Analyze analog modulation techniques.
2. Analyze the waveforms of Radio receivers.
3. Implement analog pulse modulation and demodulation circuits.
4. Demonstrate digital pulse modulation and demodulation techniques.
5. Verify the concepts of TDM and FDM.

Suggested list of Experiments:

Sr. No	Title
1	Generation of AM modulation and demodulation.
2	Analyze waveforms at various stages of SSB system.
3	Generation of FM modulation and demodulation.
4	Analyze the output waveforms of each block of AM transmitter /receiver
5	Analyze the output waveforms of each block of FM transmitter /receiver
6	Design and implement Pre-emphasis and De-emphasis circuit.
7	Verification of sampling theorem.
8	Generation of PAM modulation and demodulation.
9	Generation of PWM and PPM modulation and demodulation.
10	Demonstrate Digital pulse transmission technique (PCM)
11	Demonstrate Digital pulse transmission technique (DM,ADM)
12	Observation of TDM multiplexing and de-multiplexing signals.
13	Observation of FDM multiplexing and de-multiplexing signals.

Term Work (25-Marks):

At least **10** experiments (**07 hardware experiments and at least 03 software experiments**) 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 experiments more meaningful, interesting and application oriented. Signal should be analyzed in time and frequency domain.

Term work assessment must be based on the overall performance of the student with every Experiments are 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 the above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all 10 experiments for examination.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL404	Skill Lab: Python Programming	-	04	--	--	02	--	02

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. of Test 1 and Test 2				
ECL404	Skill Lab: Python Programming	-	-	-	-	25	25	50

NOTE: Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

Course pre-requisite:

1. ECL304 – 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.	Topics	Hrs.
1.0		**Introduction to Python**	6
	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	
2.0		**Functions and File I/O Handling**	8
	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.	
3.0		**Object Oriented Programming**	9
	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.	
4.0		**Graphical User Interface and Image processing**	9
	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.	
5.0		**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.	
6.0		**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	**52**

Text Books:

1. Yashavant Kanetkar, “Let us Python: Python is Future, Embrace it fast”, BPB Publications; 1 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.
7. Zed A. Shaw, “Learn Python the Hard Way: A Very Simple Introduction to the Terrifyingly Beautiful World of Computers and Code”, Addison Wesley; 3 edition (1 October 2013).

Reference Books:

1. Eric Matthes, “Python Crash Course A hands-on, Project Based Introduction to programming” No Starch Press; 1 edition (8 December 2015).
2. Paul Barry, “Head First Python” O′Reilly; 2 edition (16 December 2016)
3. Andreas C. Mueller, “Introduction to Machine Learning with Python”, O′Reilly; 1 edition (7 October 2016)
4. David Beazley, Brian K. Jones, “Python Cookbook: Recipes for Mastering Python 3”, O'Reilly Media; 3 edition (10 May 2013).
5. Bhaskar Chaudhary, “Tkinter GUI Application Development Blueprints: Master GUI programming in Tkinter as you design, implement, and deliver 10 real world application”, Packt Publishing (November 30, 2015)

Software Tools:

1. Python IDE: https://www.python.org/downloads/
2. 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/

The following list of experiments and course project is for illustration purpose. Faculty members are required to introduce their own innovative list of experiments based on above curriculum.

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.	Module 1

	4. Assume a suitable value for distance between two cities (in km). Write a program to convert and print this distance in meters, feet, inches and centimetre. 5. Write a program to carry out the following operations on the given set 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.	
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. Generate and print a list of tuples containing name, age and salary from the 3lists. 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. 5. Write a program to find the factorial value of any number entered through 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 a recursive function to calculate sum of digits of 5-digit number.	Module 3
4.	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 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	Module 4
5.	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	Module 5

	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. a. View: aircraft make name, state name, aircraft model name, text information, flight phase, event description type, b. fatal flag c. b. Clean the dataset and replace the fatal flag NaN with "No". d. c. Find the aircraft types and their occurrences in the dataset e. d. Remove all the observations where aircraft names are not available f. Display the observations where fatal flag is "Yes" 5. Analyze the "auto mpg data" and draw a pair plot using seaborn library 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 • horsepower: continuous • weight: continuous • acceleration: continuous • model year: multi-valued discrete • origin: multi-valued discrete • car name: string (unique for each instance) 5. Write python program to use SciPy to solve a linear algebra problem. 6. There is a test with 30 questions worth 150 marks. The test has two types 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. 7. Write Python Program to study image morphological operations.	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:

1. Use of free cloud service such as Google Colab to run python scripts is encouraged.

2. Necessary theory part should be taught by the teacher at the beginning of the laboratory session.

Term Work (25-Marks):

At least **12 experiments and 01 course project** should be performed. Term work assessment must be based on the overall performance of the student with every experiment and project 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.

The practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM401	Mini Project 1B	--	04[$]	--	--	2	--	2

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam			
		Test1	Test2	Avg. Of Test1 and Test2				
ECM401	Mini Project 1B	--	--	--	--	25	25	50

$ Indicates work load of a learner (Not Faculty) for Mini Project 1A. Faculty Load: 1 hour per week per four groups.

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.

Outcome: At the end of the course learners 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

NOTE: For Electronics & Telecommunication Engineering we recommend following syllabus for Mini-Project 1B, in case it is half-year project.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECM401	Mini-Project 1B: Arduino & Raspberry Pi based Projects	-	04[$]	--	--	02	--	02

Subject Code	Subject Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Avg. Of Test 1 and Test 2				
ECM401	Mini-Project 1B: Arduino & Raspberry Pi based Projects	-	-	-	-	25	25	50

$ indicates work load of Learner (Not Faculty), for Mini Project 1B. Faculty Load: 1 hour per week per four groups.

Course pre-requisite:

1. ECM301 – Mini-Project 1A
2. ECL304 – C++ and Java Programming
3. ECC302 – Electronic Devices and Circuit

Course Objectives:

1. To make students familiar with the basics of Electronics, Microcontroller, Arduino board, Raspberry Pi, Arduino IDE (Integrated Development Environment) and Python programming.
2. To familiarize the students with the programming and interfacing of different devices with Arduino and Raspberry Pi Board.
3. To increase students critical thinking ability and provide solutions to some real time problems.

Course Outcomes:

After successful completion of the course student will be able to

1. Write basic codes for the Arduino board using the IDE for utilizing the onboard resources.
2. Apply the knowledge of interfacing different devices to the Arduino board to accomplish a given task.
3. Design Arduino based projects for a given problem.
4. Write code using python language using IDE for utilizing the onboard resources.
5. Apply the knowledge of interfacing different devices to raspberry Pi board to accomplish a given task.
6. Design Raspberry Pi based projects for a given problem.

Experiment No.	Unit No.	Section A: Arduino Board	Hrs.
EX.1.0		**Introduction to Arduino Board**	**02**
	1.1	**Introduction to Arduino Uno board and integrated development environment (IDE**	
	1	**Write the code for blinking the on board led with a specified delay** Apparatus Requirement: Hardware: Arduino Board LED, Software: Arduino IDE Software.	
EX.2.0		**GPIO (along with Analog pin) Programming**	**04**
	2.1	**Introduction to programming GPIO, Analog and PWM PINS.**	
	1	**Interface any Digital Sensors to the Arduino board and display sensor values on serial Monitor.**	
	2	**Interface any Analog sensor to the Arduino board and display sensor values on serial Monitor.**	
	3.	**Generate varying duty cycle PWM using Arduino.**	
EX.3.0		**Controlling output devices/Displaying**	**04**
	3.1	**Introduction to different sensor (Analog and Digital), Relays, Motors and display.**	
	1	**Interface an Analog Sensors to the Arduino board and display sensor values on LCD/TFT/Seven segment Display.**	
	2	**Interface a temperature sensor to Arduino and switch on a relay to operate a fan if temperature exceeds given threshold. Also display the temperature on any of the display device**	
EX.4.0		**Interfacing Communication Devices and Cloud Networking**	**04**
	4.1	**Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.**	
	1	**Interface Wi-Fi /Bluetooth/GSM/Zigbee/RF module to Arduino and program it to transfer sensor data wirelessly between two devices. Any two techniques from the above-mentioned modules needs to be interfaced.**	
5.0		**Sample Projects**	**10**
	1.	**Waste Management System**	
	2.	**Smart City Solutions**	
	3.	**Energy Monitoring Systems**	
	4.	**Smart Classrooms and learning Solutions**	
	5.	**Home security systems**	
	6.	**Smart Agriculture solutions**	
	7.	**Healthcare solutions.**	
	8.	**Industrial Applications**	
	9.	**IoT Applications**	
	10.	**Robotics**	
		Section 'A' Total Hrs.	**24**

Experiment No.	Unit No.	Section B: Raspberry Pi	Hrs.
EX.1.0		**Introduction to Raspberry PI**	**02**
	1.1	**What is Raspberry PI? Downloading and Installation of NOOBS, First Power-Up & Having a Look around, Introduction to the Shell and Staying updated.**	
	1	**Familiarization with Raspberry PI and perform necessary software installation.** Apparatus Requirement: Hardware: Raspberry PI Board, Memory of 16GB, Power adapter, Memory Writer. Software: NOOBS, Raspbian OS, Win32 disk Imager, SD-Formatter software.	

EX.2.0		**Interfacing with Input / Output Devices using Python**	**04**
	2.1	**Introduction to Python, Connecting to the outside World with GPIO.**	
	1	**To Interface LED/Buzzer with Raspberry PI and write a program to turn ON LED for 1 sec after every 2 sec.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, LED, Buzzer.	
	2	**To interface Push Button / Digital Sensor (IR/LDR) with Raspberry PI and write a program to turn ON LED when Push button is pressed or at sensor detection.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Push Button Switch, Digital Sensor (IR/LDR).	
	3.	**To interface analog sensor using MCP 3008 analog to digital converter chip.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, analog sensor, MCP 3008 chip.	
EX.3.0		**Interfacing Temperature Sensor, Motors, Display Devices.**	**04**
	3.1	**Introduction to Temperature sensor (Analog and Digital), Relays, Motors (DC, Stepper) and Driver circuits.**	
	1	**To interface DHT11 sensor with Raspberry PI and write a program to print temperature and humidity readings.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, DTH11 Sensor.	
	2	**To interface motor using relay with Raspberry PI and write a program to turn ON motor when push button is pressed.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Relays, Motor Driver, Motors.	
	3	**To interface OLED with Raspberry PI and write a program to print temperature and humidity readings on it.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, OLED display device.	
EX.4.0		**Interfacing Communication Devices and Cloud Networking**	**04**
	4.1	**Introduction to Bluetooth, Zigbee, RFID and WIFI, specifications and interfacing methods.**	
	1	**To interface Bluetooth/Zigbee/RFID/WiFI with Raspberry PI and write a program to send sensor data to smartphone using Bluetooth/Zigbee/RFID/WIFI. (Any one can be used for performing)** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Bluetooth/Zigbee/RFID/WIFI.	
	2	**Introduction to Cloud computing, different types cloud networks and interconnection using Raspberry PI**	
	3	**Write a program on Raspberry PI to upload temperature and humidity data from thingspeak cloud.** Apparatus Requirement: Raspberry PI with inbuilt Python Package, Cloud networks such as thingspeak (open source), AWS, Azure, etc. anyone can be used for understanding purpose and building projects.	
EX.5.0		**Understanding of Communication Protocols**	**04**
	5.1	**Introduction to MQTT, IFTTT protocols and configuration steps.**	
	1	**Write a program on Raspberry PI to publish temperature data to MQTT broker**	
	2	**Write a program on Raspberry Pi to subscribe to MQTT broker for temperature data and print it.**	
	3	**Configuration of Webserver using Raspberry PI.**	
6.0		**Sample Projects**	**10**
	1.	**MQTT Based Raspberry Pi Home Automation: Controlling Raspberry Pi GPIO using MQTT Cloud**	
	2.	**License Plate Recognition using Raspberry Pi and OpenCV**	
	3.	**Real Time Face Recognition with Raspberry Pi and OpenCV**	
	4.	**Smart Garage Door Opener using Raspberry Pi**	

	5.	**Remote Controlled Car Using Raspberry Pi and Bluetooth**	
	6.	**Fingerprint Sensor based door locking system using Raspberry Pi**	
	7.	**Raspberry Pi Ball Tracking Robot using Processing**	
	8.	**Web Controlled Home Automation using Raspberry Pi**	
	9.	**Line Follower Robot using Raspberry Pi**	
	10.	**Raspberry Pi based Smart Phone Controlled Home Automation**	
	11.	**Web Controlled Raspberry Pi Surveillance Robotic Car**	
	12.	**Raspberry Pi Based Weight Sensing Automatic Gate**	
	13.	**Raspberry Pi Emergency Light with Darkness and AC Power Line Off Detector**	
	14.	**Detecting Colors using Raspberry Pi and Color Sensor TCS3200**	
	15.	**Measure Distance using Raspberry Pi and HCSR04 Ultrasonic Sensor**	
	16.	**Call and Text using Raspberry Pi and GSM Module**	
	17.	**Raspberry Pi Home Security System with Email Alert**	
	18.	**Raspberry Pi Based Obstacle Avoiding Robot using Ultrasonic Sensor**	
	19.	**Web Controlled Notice Board using Raspberry Pi**	
	20.	**RF Remote Controlled LEDs Using Raspberry Pi**	
	21.	**RFID and Raspberry Pi Based Attendance System**	
	22.	**Raspberry Pi Interactive Led-Mirror**	
	23.	**Garage Door monitor using Raspberry Pi**	
	24.	**Raspberry Pi Digital Code Lock on Breadboard**	
	25.	**Electronic Voting Machine using Raspberry Pi**	
		Section 'B' Total Hrs.	**28**
		Total A + B	**52**

Reference Books:

1. Simon Monk, "Hacking Electronic: Learning Arduino and Raspberry Pi", McGraw-Hill Education TAB; 2 edition (September 28, 2017)
2. Simon Monk, "Raspberry PI Cookbook Software and Hardware Problems and Solutions" O'Reilly 2nd Edition
3. Simon Monk, Programming the Raspberry Pi, 2nd Edition: Getting Started with Python" The McGraw Hill
4. "DK Workbooks: Raspberry Pi Project Workbook", DK Children; Workbook edition (March 7, 2017)
5. Donald Norris, "Raspberry Pi Electronic Projects for Evil Genius", McGraw-Hill Education TAB; 1 edition (May 20, 2016)

Software Tools:

1. Raspbian OS: https://www.raspberrypi.org/downloads/
2. Win32 Disk Imager: https://sourceforge.net/projects/win32diskimager/
3. SD Card Formatter: https://www.sdcard.org/downloads/formatter/
4. Arduino IDE: https://www.arduino.cc/en/main/software

Online Repository:

1. GitHub
2. NPTEL Videos on Raspberry Pi and Arduino Programming
3. https://www.electronicsforu.com/raspberry-pi-projects
4. https://circuitdigest.com/simple-raspberry-pi-projects-for-beginners
5. https://www.electronicshub.org/raspberry-pi-projects/

6. Spoken Tutorial Project-IIT Bombay: https://spoken-tutorial.org/tutorial-search/?search_foss=Arduino&search_language=English
7. Teachers are recommended to use a free online simulation platform “Tinkercad” for the simulation of Arduino based circuits before the students implement it in the hardware: https://www.tinkercad.com/

AC 7/6/2014

Item No. 4.21

UNIVERSITY OF MUMBAI

Bachelor of Engineering
Electronics and Telecommunication Engineering

Third Year Engineering

(Sem. V and Sem. VI), (Rev-2012)

effective from Academic Year 2014 -15

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

From Dean's Desk:

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 Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes 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. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.
Semester 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. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. 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 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.
Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean, Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble:
In the process of change in the curriculum there is a limited scope to have major changes in the fundamental subjects which are mainly part of second year of engineering. The exposure to the latest technology and tools used all over the world is given by properly selecting subjects and their hierarchy in pre-final and final year. Thus this syllabus is made to groom the undergraduate students best suited and competent in all respect with best possible efforts put in by the experts in framing detail contents of individual subjects.

The engineering education in India is expanding in manifolds and the main challenge is the quality education. All the stakeholders are very much concerned about it. To meet this challenge, the issue of quality needs to be addressed, debated and taken forward in a systematic manner.

An engineering program must ensure that its graduates understand the basic concepts of science and mathematics have gone through one engineering field and have acquired skills for life-long learning.

An engineering program must therefore have a mission statement which is in conformity with program objectives and program outcomes that are expected of the educational process. The outcomes of a program must be measureable and must be assessed regularly through proper feedback for improvement of the programme. There must be a quality assurance process in place within the institute to make use of the feedback for improvement of the programme. The curriculum must be constantly refined and updated to ensure that the defined objectives and outcomes are achieved. Students must be encouraged to comment on the objectives and outcomes and the role played by the individual courses in achieving them. In line with this Faculty of Technology, University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, the Chairman, Board of Studies in Electronics and Telecommunication Engineering University of Mumbai, am happy to state that, heads of the department and senior faculty from various Institutes took timely and valuable initiative to frame Program Educational Objectives as listed below.

- To provide students with a strong foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduate studies.
- To prepare students to demonstrate an ability to identify, formulate and solve electronics and telecommunication engineering problems.
- To prepare students to demonstrate ability to design electrical and electronics systems and conduct experiments, analyze and interpret data.
- To prepare students to demonstrate for successful career in industry to meet needs of Indian and multi-national companies.
- To develop the ability among students to synthesize data and technical concepts from applications to product design.
- To provide opportunity for students to work as part of teams on multidisciplinary projects.
- To promote awareness among students for the life-long learning and to introduce them to professional ethics and codes of professional practice.

These are the suggested and expected main objectives and individual affiliated institute may add further in the list. In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

At the end, I must extend my gratitude to all the experts who contributed to make curriculum competent at par with latest technological development in the field of Electronics and Telecommunication Engineering.

Dr. Udhav Bhosle
Chairman, Board of Studies in Electronics and Telecommunication Engineering

SEMESTER V

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC501	Microcontrollers and Applications	04	--	--	04	--	--	04
ETC502	Analog Communication	04	--	--	04	--	--	04
ETC503	Random Signal Analysis	04	--	01	04	--	01	05
ETC504	RF Modeling and Antennas	04	--	--	04	--	--	04
ETC505	Integrated Circuits	04	--	--	04	--	--	04
ETS506	Business Communication and Ethics	--	04 *	--	--	02	--	02
ETL501	Microcontrollers and Applications Laboratory	--	02	--	--	01	--	01
ETL502	Communication Engineering Laboratory I		02			01	--	01
ETL503	Communication Engineering Laboratory II	--	02	--	--	01	--	01
ETL504	Mini Project I	--	02	--	--	01	--	01
Total		**20**	**12**	**01**	**20**	**06**	**01**	**27**

*** Out of 4 hours, 2 hours class wise theory and 2 hours batch wise practical**

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. of Test 1 & Test 2					
ETC501	Microcontrollers and Applications	20	20	20	80	--	--	--	100
ETC502	Analog Communication	20	20	20	80	--	--	--	100
ETC503	Random Signal Analysis	20	20	20	80	25	--	--	125
ETC504	RF Modeling and Antennas	20	20	20	80	--	--	--	100
ETC505	Integrated Circuits	20	20	20	80	--	--	--	100
ETS506	Business Communication and Ethics	--	--	--	--	50	--	--	50
ETL501	Microcontrollers and Applications Laboratory	--	--	--	--	25	25	--	50
ETL502	Communication Engineering Laboratory I	--	--	--	--	25	25	--	50
ETL503	Communication Engineering Laboratory II	--	--	--	--	25	25	--	50
ETL504	Mini Project I	--	--	--	--	25	25	--	50
Total		**100**	**100**	**100**	**400**	**175**	**100**	**--**	**775**

SEMESTER VI

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ETC601	Digital Communication	04	--		04	--		04
ETC602	Discrete Time Signal Processing	04	--	--	04	--	--	04
ETC603	Computer Communication and Telecom Networks	04	--	--	04	--	--	04
ETC604	Television Engineering	04	--	--	04	--	--	04
ETC605	Operating Systems	04	--	--	04	--	--	04
ETC606	VLSI Design	04	--	--	04	--	--	04
ETL601	Discrete Time Signal Processing Laboratory	--	02	--	--	01	--	01
ETL602	Communication Engineering Laboratory III		02			01	--	01
ETL603	Communication Engineering Laboratory IV	--	02	--	--	01	--	01
ETL604	Mini Project II	--	02	--	--	01	--	01
Total		**24**	**08**	**--**	**24**	**04**	**--**	**28**

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical And Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. of Test 1 & Test 2					
ETC601	Digital Communication	20	20	20	80	--	--	--	100
ETC602	Discrete Time Signal Processing	20	20	20	80	--	--	--	100
ETC603	Computer Communication and Telecom Networks	20	20	20	80	--	--	--	100
ETC604	Television Engineering	20	20	20	80	--	--	--	100
ETC605	Operating Systems	20	20	20	80	--	--	--	100
ETC606	VLSI Design	20	20	20	80	--	--	--	100
ETL601	Discrete Time Signal Processing Laboratory	--	--	--	--	25	25	--	50
ETL602	Communication Engineering Laboratory III	--	--	--	--	25	25	--	50
ETL603	Communication Engineering Laboratory IV	--	--	--	--	25	25	--	50
ETL604	Mini Project II	--	--	--	--	25	25	--	50
Total		**120**	**120**	**120**	**480**	**100**	**100**	**--**	**800**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
ETC501	Microcontroller & Applications	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC501	Microcontroller & Applications	20	20	20	80	-	-	-	100

Course Pre –requisite:

- ETC303: Digital electronics
- ETC403: Microprocessor and Peripherals

Course Objectives:

- To develop background knowledge and core expertise of microcontroller.
- To know the importance of different peripheral devices and their interfacing to microcontrollers.
- To know the design aspects of microcontrollers.
- To write assembly language programs of microcontrollers for various applications.

Course Outcomes: At the end of course, a student will be able to

- Draw and describe architecture of 8051 and ARM7 microcontroller.
- Interface various peripheral devices to the microcontrollers.
- Write assembly language program for microcontrollers.
- Design microcontroller based system for various applications.

Module No.		Topics	Hrs.
1.	**8051 Microcontroller**		**12**
	1.1	Comparison between Microprocessor and Microcontroller	
	1.2	Features, architecture and pin configurations	
	1.3	CPU timing and machine cycle	
	1.4	Input / Output ports	
	1.5	Memory organization	
	1.6	Counters and timers	
	1.7	Interrupts	
	1.8	Serial data input and output	
2.	**8051 Assembly Language Programming.**		
	2.1	Instruction set	**08**
	2.2	Addressing mode	
	2.3	Assembler directives	
	2.4	**Programs related to:** arithmetic, logical, delay, input, output port, serial communication, and interrupts	
3	**8051 Interfacing and Applications**		**12**
	3.1	Interfacing of display: LED, LCD, and seven segment display	
	3.2	Keyboard Interfacing	
	3.3	Interfacing of ADC and DAC (0808/09)	
	3.4	Stepper motor and relay	
	3.5	Connection to RS 232 for serial communication	
	3.6	Manual and auto reset	
	3.7	IR based wireless communication system design	
4		**ARM7: A 32-bit Microcontroller**	**08**
	4.1	The RISC design philosophy	
	4.2	Concept of Cortex-A, the Cortex-R, and the Cortex-M	
	4.3	Features of ARM Microcontroller	
	4.4	Operating modes	
	4.5	Architecture (ARM core dataflow model)	
	4.6	Registers	
	4.7	Current program status register	
	4.8	Pipeline	
	4.9	Exceptions, interrupt and vector table	
	4.0	Memory management	
	4.11	ARM7 processor families	
5		**ARM7 Programming**	**08**
	5.1	Instruction set for data processing, branching, load-store, software interrupt, and program status register	
	5.2	Addressing modes	
	5.3	Programming for ARM7	
6		**Introduction to Embedded Systems**	**04**
	6.1	Concepts of embedded systems	
	6.2	Optimizing design matrices and common design matrices	
	6.3	Study of embedded systems 1) Digital camera 2) Stepper motor controller	
		Total	**52**

Recommended Books:

1. M. A. Mazidi, J. G. Mazidi and R. D. Mckinlay, "*The 8051 Microcontroller & Embedded systems*", Pearson Publications, Second Edition 2006.
2. C. Kenneth J. Ayala and D. V. Gadre, "*The 8051 Microcontroller & Embedded system using assembly & 'C*' ", Cengage Learning, Edition 2010.
3. Satish Shah, "*The 8051 Microcontrollers",* Oxford publication first edition 2010.
4. Andrew Sloss, Dominic Symes, and Chris Wright, "*ARM System Developer's Guide*" Morgan Kaufmann Publishers, First Edition 2004.
5. James A. Langbridge, "*Professional Embedded Arm Development*", Wrox, John Wiley Brand& Sons Inc., Edition 2014
6. Frank Vahid& tony Gavages "*Embedded system design – A unified hardware / software introduction*", Wiley publication, Third edition 2002.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should 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 for 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	TW/Practical	Tutorial	Total
ETC502	Analog Communication	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC502	Analog Communication	20	20	20	80	-	-	-	100

Course Pre–requisite:-

- ETC302: Analog Electronics-I
- ETC405: Signals and Systems

Course Objective: To teach students

- The fundamentals of basic communication system.
- Various modulation and demodulation techniques used in analog communication, noise handling and multiplexing.
- The working principles of transmitters and receivers used in analog communication systems.

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

- The different modulation and demodulation techniques used in analog communication.
- Identify and solve basic communication problems, analyze transmitter and receivers.
- Detect the errors that occur due to noise during transmission.
- Compare and contrast advantages and limitations of analog communication systems.

Module No.		Topics	Hrs.
1		**Basics of Communication System**	**04**
	1.1	Block diagram, electromagnetic spectrum, signal bandwidth and power, types of communication channels	
	1.2	Types of noise, signal to noise ratio, noise figure, and noise temperature	
2		**Amplitude Modulation and Demodulation**	**12**
	2.1	Basic concept, signal representation, need for modulation	
	2.2	**S**pectrum, waveforms, modulation index, bandwidth, voltage distribution, and power calculation	
	2.3	**DSBFC**: Principles, modulating circuits, low level and high level transmitters **DSB suppressed carrier**:- Multiplier modulator, nonlinear modulator, and switching modulator, **Single Side Band (SSB):-**Principle, Filter method, phase shift method and third method Quadrature amplitude modulation (QAM), Independent sideband (ISB) and Vestigial Side Band (VSB) principles and transmitters	
	2.4	**Amplitude demodulation:** Diode detector, practical diode detector, and square law detector.	
	2.5	Applications of AM and use of VSB in broadcast television	
3		**Angle Modulation and Demodulation**	**14**
	3.1	**Frequency modulation (FM):** Basic concept, mathematical analysis, frequency spectrum of FM wave, sensitivity, phase deviation and modulation index, frequency deviation and percent modulated waves, bandwidth requirement of angle modulated waves, deviation ratio, narrow Band FM, and Wide Band FM.	
	3.2	Varactor diode modulator, FET reactance modulator, stabilized reactance modulator-AFC, Direct FM transmitter, indirect FM Transmitter, noise triangle in FM, pre-emphasis and de-emphasis.	
	3.3	**Phase modulation (PM): P**rinciple and working of Transistor direct PM modulator and relationship and comparison between FM and PM	
	3.4	**FM demodulation:** Balance slope detector, Foster-Seely discriminator, ratio detector, Phase lock loop(PLL) FM demodulator, amplitude limiting and thresholding, comparison between FM demodulators, comparison between AM, FM and PM.	
	3.5	Applications of FM and PM	
4		**Radio Receivers**	**10**
	4.1	TRF, Super-heterodyne receiver, receiver parameters, and choice of IF.	
	4.2	AM receiver circuits and analysis, simple AGC, delayed AGC, forward AGC, and communication receiver	
	4.3	FM receiver circuits, comparison with AM receiver	
	4.4	Single and independent sideband (SSB and ISB) receivers	
5		**Sampling Techniques**	**04**
	5.1	Theorem for low pass and band pass signals, proof with spectrum, Nyquist criteria	
	5.2	Sampling techniques, aliasing error, and aperture effect	
6		**Pulse Modulation and Demodulation**	**08**
	6.1	PAM, PWM, PPM generation and detection	
	6.2	Delta modulation, adaptive delta modulation, principle, generation and detection	
	6.3	TDM and FDM basic concepts and block diagram	
	6.4	Applications of pulse communication	
Total			**52**

Recommended Books:

1. WayneTomasi, "*Electronics Communication Systems*", Pearson education, Fifth edition.
2. Kennedy and Davis, "*Electronics Communication System*", Tata McGraw Hill, Fourth edition.
3. B.P. Lathi, Zhi Ding,*"Modern Digital and Analog Communication system*", Oxford University Press, Fourth edition
4. Taub, Schilling and Saha, "*Taub's Principles of Communication systems*", Tata McGraw Hill,Third edition.
5. P. Sing and S.D. Sapre, "*Communication Systems: Analog and Digital*", Tata McGraw Hill,Third edition.
6. Simon Haykin, Michel Moher, "*Introduction to Analog and Digital Communication*", Wiley, Second edition.
7. Dennis Roddy and John Coolen, "*Electronic Communication*", Prentice Hall, Third Edition.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should 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 for 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	TW/Practical	Tutorial	Total
ETC503	**Random Signal Analysis**	04	--	01	04	--	01	05

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC503	**Random Signal Analysis**	20	20	20	80	25	-	-	125

Course Pre –requisite:

- ETC 405: Signals and Systems
- ETC 401: Applied Mathematics IV

Course Objective: To teach students

- Random Variables and Random Process
- The design of the systems which involves randomness using mathematical analysis and computer simulations.

Course Outcome : At the end of the course, students will able to

- Apply theory of probability in identifying and solving relevant problems.
- Define and differentiate random variables and vector through the use of cumulative distribution function (CDF), probability density function (PDF), probability mass function (PMF) as well as joint, marginal and conditional CDF, PDF and PMF.
- Show probability and expectation computations using important discrete and continuous random variable types.
- Define and specify random processes and determine whether a given process is stationary or wide sense stationary.
- Determine the response of a linear time invariant system to such a random process.
- Describe basic concepts related to Markov chains and queuing theory and relate it to seal world applications.

Module No.		Overview of Probability Theory and Basics of Random Variables	Hrs.
1	1.1	Sample space, events, set operations, the notion and axioms of probability.	10
	1.2	Conditional probability**,** Joint probability, Baye's rule, Independence of events, Sequential Experiments.	
	1.3	Notion of random variable.	
	1.4	Continuous random variables, probability density function, probability distribution function, Uniform, Exponential and Gaussian continuous random variables and distributions.	
	1.5	Discrete random variables, probability mass function, probability distribution function, binomial, Poisson and geometric discrete random variables and distributions	
2		**Operations on One Random Variable**	07
	2.1	Functions of a random variable and their distribution and density functions.	
	2.2	Expectation, Variance and Moments of random variable.	
	2.3	Transformation of a random variable, Markov, Chebyshev and Chernoff bounds, characteristic functions, moment theorem	
3		**Multiple of Random Variables And Convergence**	08
	3.1	Vector random variables, Pairs of random variables, Joint CDF, Joint PDF Independence , Conditional CDF and PDF, Conditional Expectation	
	3.2	One function of two random variable, two functions of two random variables; joint moments, joint characteristic function, covariance and correlation-independent, uncorrelated and orthogonal random variables.	
4		**Sequence Of Random Variables And Convergence:**	05
	4.1	Random sequences, Limit theorems; Strong and weak laws of large numbers,	
	4.2	Central limit theorem and its significance.	
5		**Random Process**	10
	5.1	Random process: Definition, realizations, sample paths, discrete and continuous time processes	
	5.2	Probabilistic structure of a Random process; mean, correlation and covariance functions, stationarity of random process.	
	5.3	Ergodicity, Transmission of WSS random process through LTI system	
	5.4	Spectral analysis of random processes, power density spectrum bandwidth, cross-power density spectrum.	
	5.5	Gaussian and Poisson random process	
6		**Markov Chains And Introduction To Queuing Theory**	12
	6.1	Markov processes	
	6.2	Discrete Markov chains, The n–step transition probabilities, steady state probabilities.	
	6.3	Introduction to Continuous time Markov chains.	
	6.4	Classifications of states.	
	6.5	Markovian models	
	6.6	Birth and death queuing models	
	6.7	Steady state results	
	6.8	Single and Multiple server Queuing models	
	6.9	Finite source models	
	6.10	Little's formula	
Total			**52**

1. Alberto Leon Garcia, "*Probability And Random Processes For Electrical Engineering*", second edition Low price edition Pearson education.
2. Miller, "Probability And Random Processes-With Applications to Signal Processing and Communication", first edition 2007, Elsevier.
3. Papoulis and S. Unnikrishnan Pillai, "*Probability, Random Variables and Stochastic Processes*," Fourth Edition, McGraw Hill.
4. H. Stark and J. Woods, ``*Probability and Random Processes with Applications to Signal Processing*,'' Third Edition, Pearson Education.
5. Hwei Hsu, "*Probability Random Variable,s Random Process, Schaulm's Outlines*, Tata McGraw Hill, 2004.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should 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 for 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	TW/ Practical	Tutorial	Total
ETC504	RF Modeling and Antennas	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC504	RF Modeling and Antennas	20	20	20	80	-	-	-	100

Course Pre –requisite: : ETC 404: Wave Theory and Propagation

Course Objective: To teach students

- Design of different types of passive filters used for radio frequency application.
- Radiation phenomena and pattern of various antennas.
- The various characteristics of different types of antennas.

Course Outcome: On Completion of this course Student will be able to

- Analyze and design RF Filters
- Analyze the radiation mechanisms of antennas
- Demonstrate knowledge of antennas in communication systems. Ability to discriminate between antennas on the basis of their electrical performance.
- Discriminate various antennas on the basis of their electrical performance.

Module No.		Topics	Hrs.
1.		**Behavior of Active and Passive Components in RF range**	**04**
	1.1	Frequency Spectrum, hazards of Electromagnetic Radiations, and fundamentals of radio frequency design	
	1.2	High Frequency behavior, equivalent circuit and frequency response of resistor, capacitor, inductor, diode, BJT, and FET	
	1.3	Characteristics, structure and applications of coaxial line, stripline, microstrip line, and coplanar lines	
2		**Filter Design**	**12**
	2.1	Analysis of infinite periodic structures terminated Periodic structures, k-β diagrams and wave velocities.	
	2.2	**Image Parameter Method:** Image impedances and transfer functions for two port networks, constant-k filter sections, m-derived filter sections, and composite filters	
	2.3	**Insertion Loss Method:** Characterization by power loss ratio, maximally flat, equal ripple, and linear phase low pass filter prototype.	
	2.4	**Filter transformations:** impedances, frequency scaling, and band pass and band stop	
	2.5	Richard's transformation, Kuroda's identity, impedance, and admittance inverters	
3		**Fundamentals of Antenna**	**14**
	3.1	Conceptual understanding and radiation mechanism	
	3.2	**Fundamental Parameters of Antennas:** Radiation pattern, radiation power density, radiation intensity , beam width, directivity, antenna efficiency, gain, beam efficiency, bandwidth, input impedance, antenna radiation efficiency, antenna vector effective length and equivalent areas, maximum directivity and maximum effective areas.	
	3.3	Friss transmission equation, antenna temperature	
	3.4	Vector potential *A* for an electric current source *J*, vector potential *F* for an magnetic current source *M*, electric and magnetic fields for electric *J* and Magnetic *M* current sources, and concept of near and far field radiation.	
4		**Wire Antennas**	**10**
	4.1	**Infinitesimal dipole and small dipole:** Radiation field, near field, far field directivity, region separation	
	4.2	**Finite Length dipole**: Basic parameters of half wavelength dipole, folded dipole	
	4.3	Monopole antenna	
	4.4	Ground Effects	
	4.5	Linear elements near or on infinite perfect conductors	
	4.6	**Loop antennas**: Basic parameters	
5		**Antenna Arrays:**	**04**
	5.1	Linear arrays, planner arrays, and circular arrays	
	5.2	Array of two isotropic point sources, non-isotropic sources	
	5.3	Principle of pattern multiplication,	
	5.4	Linear arrays of n elements, broadside, radiation pattern, directivity, beam width and null directions, array factor	
	5.5	Antenna analysis using Binomial, Dolph-Tschebyscheff, Yagi Uda antenna	
6		**Special types of antennas**	**08**
	6.1	**Frequency Independent Antennas:** Log periodic and helical antennas **Microstrip Antennas: C**haracteristics, applications and limitations	
	6.2	**Reflector Antennas and Horn Antennas:** Characteristics, applications and limitations	
Total			**52**

Recommended Books:

1. David M Pozar, "*Microwave Engineering*", John Wieley and Sons, Inc. Hobokenh, New Jersey, Fourth Edition, 2012
2. Costantine A. Balanis, "*Antenna Theory Analysis And Design*", John Wiley Publication
3. John D. Kraus, " *Antennas*", Tata McGraw Hill publication
4. Annapurna Das and Sisir K Das, "*Microwave Engineering*", Tata McGraw Hill,New Delhi, Second Edition, 2009
5. Reinhold Ludwig and Pavel Bretchko, "*RF Circuit Design*", Pearson Education Asia.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should 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 for 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	TW/Practical	Tutorial	Total
ETC505	Integrated Circuits	04	--	--	04	--	--	04

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					
ETC505	Integrated Circuits	20	20	20	80	--	--	--	100

Course Pre-requisite:

- FEC105: Basic Electrical & Electronics Engineering
- ETC302: Analog Electronics-I
- ETC303: Digital Electronics
- ETC402: Analog Electronics-II

Course Objectives: To teach students

- Fundamentals of analog and digital integrated circuits.
- Design methodologies using practical integrated circuits.
- The application areas of integrated circuits.

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

- Understand the fundamentals and areas of applications for the Integrated Circuits.
- Analyze important types of integrated circuits of day-to-day requirements.
- Demonstrate the ability to design practical circuits that perform the desired operations.
- Understand the differences among theoretical, practical & simulated results in integrated circuits.
- Choose the appropriate integrated circuit modules to build a given application.

Module No.		Topics	Hrs.
1.		**Review of Operational Amplifier**	04
	1.1	Operational amplifier overview: parameters, open loop and closed loop configurations	
2		**Applications of Operational Amplifier**	12
	2.1	**Amplifiers:** Current amplifier, difference amplifier, instrumentation amplifier, and programmable gain amplifier	
	2.2	**Converters:** Current to voltage converters, voltage to current converters, generalized impedance converter, voltage to frequency converter, frequency to voltage converter, logarithmic converters and antilog converters	
	2.3	**Active Filters:** Second order active finite and infinite gain low pass, high pass, band pass and band reject filters	
	2.4	**Sine Wave Oscillators:** RC phase shift oscillator, Wien bridge oscillator, Quadrature oscillator	
3		**Non-Linear Applications of Operational Amplifier**	10
	3.1	**Comparators:** Inverting comparator, non-inverting comparator, zero crossing detector, window detector and level detector	
	3.2	**Schmitt Triggers:** Inverting Schmitt trigger, non-inverting Schmitt trigger, and adjustable threshold levels	
	3.3	**Waveform Generators:** Square wave generator, triangular wave generator, and duty cycle modulation	
	3.4	**Precision Rectifiers:** Half wave, full wave, and applications	
	3.5	Peak detectors, sample and hold circuits	
4		**Special Purpose Integrated Circuits**	08
	4.1	**Functional block diagram, working, design and applications:** Timer 555	
	4.2	**Functional block diagram, working and applications:** VCO 566, PLL 565, multiplier 534, waveform generator XR 2206, power amplifier LM380	
5		**Voltage Regulators**	08
	5.1	Functional block diagram, working and design of three terminal fixed (78XX, 79XX series) and three terminal adjustable (LM 317, LM 337) voltage regulators.	
	5.2	Functional block diagram, working and design of general purpose 723 (LVLC, LVHC, HVLC and HVHC) with current limit and current fold-back protection, Switching regulator topologies, Functional block diagram and working of LT1070 monolithic switching regulator	
6		**Counters, Shift Registers and ALU (Logic Diagram and applications)**	10
	6.1	**MSI Counters:** Ripple counters (7490 decade, 7492 modulus-12, 7493 4-bitbinary), synchronous counters (74162 decade, 74163 4-bit binary, 74169 4-bit up/down binary)	
	6.2	**MSI Shift Registers:** 74164 serial input parallel output, 74166 parallel input serial output, 74191 serial input serial output, 74194 universal shift register	
	6.3	**Arithmetic Logic Unit:** 74181 ALU	
Total			52

Recommended Books:

1. Sergio Franco, "*Design with Operational Amplifiers and Analog Integrated Circuits*", Tata McGraw Hill, 3rd Edition
2. John F. Wakerly, "*Digital Design – Principles & Practices*", Pearson Education, 3rd Edition
3. J. Millman and A. Grabel, "*Microelectronics*", Tata McGraw Hill, 2nd Edition.
4. D. Roy Choudhury and S. B. Jain, "*Linear Integrated Circuits*", New Age International Publishers, 4th Edition
5. David A. Bell, "*Operation Amplifiers and Linear Integrated Circuits*", Oxford University Press, Indian Edition
6. Ramakant A. Gayakwad, "*Op-Amps and Linear Integrated Circuits*", Pearson Prentice Hall, 4th Edition
7. R. F. Coughlin and F. F. Driscoll, "*Operation Amplifiers and Linear Integrated Circuits*", Prentice Hall, 6th Edition
8. J. G. Graeme, G. E. Tobey and L. P. Huelsman, "*Operational Amplifiers- Design & Applications*", New York: McGraw-Hill, Burr-Brown Research Corporation

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should 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 for 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	TW/Practical	Tutorial	Total
ETS506	Business Communication and Ethics	--	2 + 2	--	--	02	--	02

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETS506	Business Communication and Ethics	--	--	--	--	50	--	--	50

Course Pre-requisite : FEC206 Communication Skills

Course Objective :

- To inculcate in students professional and ethical attitude, effective communication skills, teamwork, multidisciplinary approach and an ability to understand engineer's social responsibilities.
- To provide students with an academic environment where they will be aware of the excellence, leadership and lifelong learning needed for a successful professional career.
- To inculcate professional ethics and codes of professional practice and leadership.
- To prepare students for successful careers that meets the global Industrial and Corporate requirement' provide an environment for students to work on Multidisciplinary projects as part of different teams to enhance their team building capabilities like leadership, motivation, teamwork etc.

Expected Outcomes

After completion of this course students will be able to:

- Communicate effectively in both verbal and written form and demonstrate knowledge of professional and ethical responsibilities
- Participate and succeed in Campus placements and competitive examinations like GATE, CET.
- Possess entrepreneurial approach and ability for life-long learning.
- Have education necessary for understanding the impact of engineering solutions on Society and demonstrate awareness of contemporary issues.

Module No.	Unit No.	Topics	Hrs
1.0	**1.0**	**Report Writing**	**08**
	1.1	Objectives of report writing	
	1.2	Language and style in a report	
	1.3	Types of reports	
	1.4	Formats of reports: Memo, letter, project and survey based	
2.0	**2.0**	**Technical Proposals**	**02**
	2.1	Objective of technical proposals	
	2.2	Parts of proposal	
3.0	**3.0**	**Introduction to Interpersonal Skills**	**08**
	3.1	Emotional Intelligence	
	3.2	Leadership	
	3.3	Team building	
	3.4	Assertiveness	
	3.5	Conflict Resolution	
	3.6	Negotiation Skills	
	3.7	Motivation	
	3.8	Time Management	
4.0	**4.0**	**Meetings and Documentation**	**02**
	4.1	Strategies for conducting effective meetings	
	4.2	Notice	
	4.3	Agenda	
	4.4	Minutes of the meeting	
5.0	**5.0**	**Introduction to Corporate Ethics and etiquettes**	**02**
	5.1	Business meeting etiquettes, interview etiquettes, professional and work etiquettes, social skills	
	5.2	Greetings and art of conversation	
	5.3	Dressing and grooming	
	5.4	Dinning etiquette	
	5.5	Ethical codes of conduct in business and corporate activities (Personal ethics, conflicting values, choosing a moral response, the process of making ethical decisions)	
6.0	**6.0**	**Employment Skills**	**06**
	6.1	Cover letter	
	6.2	Resume	
	6.3	Group Discussion	
	6.4	Presentation Skills	
	6.5	Interview Skills	
Total			**28**

Reference Books:

1. Fred Luthans, "*Organisational Behavior"* , McGraw Hill, edition
2. Lesiker and Petit, "*Report Writing for Business"* , McGraw Hill, edition
3. Huckin and Olsen, "*Technical Writing and Professional Communication"*, McGraw Hill
4. Wallace and Masters, "*Personal Development for Life and Work"* , Thomson Learning, 12th edition
5. Heta Murphy, "*Effective Business Communication"*, McGraw Hill, edition
6. R.C Sharma and Krishna Mohan, "*Business Correspondence and Report Writing"*
7. B N Ghosh, "*Managing Soft Skills for Personality Development*", Tata McGraw Hill.Lehman, Dufrene, Sinha, "*BCOM*", Cengage Learning, 2nd edition
8. Bell . Smith,"Management Communication" Wiley India edition, 3rd edition.

Internal Assessment (IA):
There will be no IA written examination

End Semester Examination:
There will be no ESE written examination.

List of assignments:
Term work shall consist of assignments as listed below:

1. Report writing (Synopsis or the first draft of the Report)
2. Technical Proposal (Group activity, document of the proposal
3. Interpersonal Skills (Group activity and Role play)
4. Interpersonal Skills (Documentation in the form of soft copy or hard copy)
5. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
6. Corporate ethics and etiquettes (case study, Role play)
7. Cover Letter and Resume Printout of the Power Point presentation

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

1. Assignments - 20 marks
2. Project Report Presentation – 15 marks
3. Group Discussion – 10 marks
4. Attendance - 5 marks

At least total 08 assignments, project report presentation and group discussion covering entire syllabus must be given during the batch wise practical. The assignments and project work should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment / project / group discussion graded from time to time. The average of grades converted in to marks should be taken into account for term work assessment.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL501	Microcontrollers and Applications	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL501	Microcontrollers and Applications	--	--	--	--	25	25	-	50

Term Work:
At least ten experiments covering entire syllabus of ETC501 Microcontrollers and Applications should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must 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. Practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL502	Communication Engineering Laboratory I	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL502	Communication Engineering Laboratory I	--	--	--	--	25	25	-	50

Term Work:
At least ten experiments covering entire syllabus of ETC502: Analog Communication 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 and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and average. Based on above scheme grading and term work assessment should be done.
Practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL503	Communication Engineering Laboratory II	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL503	Communication Engineering Laboratory II	--	--	--	--	25	25	-	50

Term Work:
At least ten experiments covering entire syllabus for ETC 504: RF Modeling and antenna and ETC 505: Integrated circuits should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and average. Based on above scheme grading and term work assessment should be done.
Practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL504	Mini Project 1	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
ETL504	Mini Project 1	--	--	--	--	25	25	50

Term Work:

The main intention of Mini Project is to make student enable to apply the knowledge and skills learned out of courses studied to solve/implement predefined practical problem. The students undergo various laboratory/tutorial/simulation laboratory/work shop courses in which they do experimentation based on the curriculum requirement. The Mini Project may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be on

- Learning additional skills
- Development of ability to define and design the problem and lead to its accomplishment with proper planning
- Learn the behavioral science by working in a group

The group may be maximum **four** (04) students. Each group will be assigned one faculty as a supervisor. The college should keep proper assessment record of progress of the project and at the end of the semester it should be assessed for awarding TW marks. The TW may be examined by approved internal faculty appointed by the head of the institute. The final examination will be based on demonstration in front of internal and external examiner. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed.

The students may use this opportunity to learn different computational techniques as well as some model development. This they can achieve by making proper selection of Mini Projects.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETC601	Digital Communication	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC601	Digital Communication	20	20	20	80	-	-	-	100

Pre-requisite:

- ETC405 Signal and System,
- ETC502 Analog Communication,
- ETC503 Random Signal Analysis

Course Objective:

- Aim is to identify the functions of different components
- Learn about theoretical bounds on the rates of digital communication system and represent a digital signal using several modulation methods
- Draw signal space diagrams, compute spectra of modulated signals and apply redundancy for reliable communication.

Course Outcome: At the end of course, student will be able to :

- Understand the basics of information theory and coding techniques.
- Determine the minimum number of bits per symbol required to represent the source and the maximum rate at which a reliable communication can take place over the channel.
- Describe and determine the performance of different waveform techniques for the generation of digital representation of signals.
- Determine methods to mitigate inter symbol interference in baseband transmission system.
- Describe and determine the performance of different error control coding schemes for the reliable transmission of digital representation of signals and information over the channel.
- Understand various spreading techniques and determine bit error performance of various digital communication systems.

Module No.		Topics	Hrs.
1.		**Information theory and source coding**	6
	1.1	Block diagram and sub-system description of a digital communication system, measure of information and properties, entropy and it's properties	
	1.2	Source Coding, Shannon's Source Coding Theorem, Shannon-Fano Source Coding, Huffman Source Coding	
	1.3	Differential Entropy, joint and conditional entropy, mutual information and channel capacity, channel coding theorem, channel capacity theorem	
2		**Baseband Modulation and Transmission**	6
	2.1	Discrete PAM signals and it's power spectra	
	2.2	Inter-symbol interference, Nyquist criterion for zero ISI, sinusoidal roll-off filtering, correlative coding, equalizers, and eye pattern	
3		**Base band Detection**	5
	3.1	Orthogonality, representation of signals	
	3.2	Maximum likelihood decoding	
	3.3	Correlation receiver, equivalence with matched filter	
4		**Bandpass Modulation and Demodulation**	12
	4.1	Bandpass digital transmitter and receiver model, digital modulation schemes	
	4.2	**Generation, detection, signal space diagram, spectrum, bandwidth efficiency, and probability of error analysis of:** Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK)Modulations, Binary Phase Shift Keying (BPSK) Modulation, Quaternary Phase Shift Keying QPSK), M-ary PSK Modulations, Quadrature Amplitude Modulation (QAM), Minimum Shift Keying (MSK)	
	4.3	Comparison between bandwidth and bit rate, applications of digital modulation schemes	
5		**Error Control Systems**	10
	5.1	Types of error control, error control codes, linear block codes, vector spaces ,vector sub spaces, generator matrix, systematic linear block codes, parity check matrix, syndrome testing ,error correction, and decoder implementation	
	5.2	**Cyclic codes:** Algebraic structure of cyclic codes, binary cyclic code properties, encoding in systematic form, circuits for dividing polynomials, systematic encoding with shift register and error detection	
	5.3	**Convolution Codes:** Time domain and transform domain approach, graphical representation, code tree, trellis, state diagram, decoding methods, maximum likelihood decoding, and free distance	7
	5.4	Viterbi decoding, hard decision Viterbi decoding , decoding window, soft decision Viterbi decoding, code spectra, recursive systematic codes, code transfer function, and application areas	
6		**Spread Spectrum**	6
	6.1	Spread Spectrum (SS) concept, PN Sequences, Direct Sequence(DS), Frequency Hopping (FH), and Time Hopping	
	6.2	Comparison of Spread Spectrum Methods, SS Communication System, DSSS with Coherent BPSK, Processing Gain, Probability of Error of FHSS Transmitter and FHSS Receiver	
Total			**52**

Recommended Books:

1. Sklar B, and Ray P. K., *"Digital Communication: Fundamentals and applications,"* Pearson, Dorling Kindersley (India), Delhi, Second Edition, 2009.
2. Haykin Simon, *"Digital Communication Systems*," John Wiley and Sons, New Delhi, Forth Edition, 2014.
3. H. Taub, D. Schlling, and G. Saha, "*Principles of Communication Systems*," Tata Mc-Graw Hill, New Delhi, Third Edition, 2012.
4. Lathi B P, and Ding Z., "*Modern Digital and Analog Communication Systems*," Oxford University Press, Forth Edition, 2009.
5. T L Singal, "*Analog and Digital Communication*," Tata Mc-Graw Hill, New Delhi, First Edition, 2012.
6. P Ramakrishna Rao, *"Digital Communication*," Tata Mc-Graw Hill, New Delhi, First Edition, 2011.
7. M F Mesiya, *"Contempory Communication systems*", Mc-Graw Hill, Singapore, First Edition, 2013.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should 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 for 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	TW/Practical	Tutorial	Total
ETC602	**Discrete Time Signal Processing**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC602	**Discrete Time Signal Processing**	20	20	20	80	-	-	-	100

Course Prerequisite: ETC 405: Signals and System

Course Objectives:

- To develop a thorough understanding of the central elements of discrete time signal processing theory and the ability to apply this theory to real-world signal processing applications.
- Use z-transforms and discrete time Fourier transforms to analyze a digital system.
- Understand the discrete Fourier transform (DFT), its applications and its implementation by FFT techniques.
- Design and understand finite & infinite impulse response filters for various applications.
- The course is a prerequisite course for further studying of other multimedia related courses, such as speech processing, image processing, audio and video data compression, pattern recognition, communication systems and so forth.

Course Outcomes: Student will able to

- Formulate engineering problems in terms of DSP tasks
- Apply engineering problem solving strategies to DSP problems
- Design and test signal processing algorithms for various applications
- Recover information from signals
- Design and simulate digital filters

Module No.		Topics	Hrs.
1		**Transform Analysis of Linear Time Invariant System**	04
	1.1	Review of *Z* transform and its properties, response to sinusoidal and complex exponential signals, steady-state response to periodic input signals, response to aperiodic input signals, relationships between the system function and the frequency response function, computation of the frequency response function	
	1.2	LTI systems as frequency-selective filters like; low pass, high pass, band pass, notch, comb, all-Pass filters, and digital resonators.	
	1.3	Invertibility of LTI systems, minimum-phase, maximum-phase, mixed-phase systems	
2		**The Discrete Fourier Transform and Efficient Computation.**	12
	2.1	Frequency domain sampling and reconstruction of discrete time signals, discrete Fourier transform (DFT), DFT as a linear transformation, properties of the DFT, relationship of the DFT to other transforms	
	2.2	Fast Fourier Transform: Radix-2 and split-radix fast Fourier transform (FFT) algorithms and their applications	
	2.3	Quantization effects in the computation of the DFT	
3		**Design of Digital filters and Implementation**	12
	3.1	Design of Infinite Impulse Response (IIR) filters using impulse invariant method and bilinear transformation method, Butterworth and Chebyshev filter approximation.	
	3.2	Concepts of Finite Impulse Response (FIR) filter, symmetric and anti symmetric FIR filter, FIR filter design using window method and frequency sampling method.	
	3.3	Realization structures for IIR and FIR filters using direct form structures, cascade, parallel structures, and lattice, ladder structure (only conceptual understanding)	
4		**Multi rate Signal Processing**	08
	4.1	Decimation by a factor *D*, interpolation by I, sampling rate conversion by a rational factor I/D	
	4.2	Polyphase filter structures, interchange of filers and down samplers/up samplers, sampling rate conversion with cascade integrator comb filters, polyphase structures for decimation and interpolation filters, structures for rational sampling rate conversion	
	4.3	Multistage implementation of sampling rate conversion.	
	4.4	Sampling rate conversion of band pass signals	
	4.5	Sampling rate conversion by an arbitrary factor – arbitrary re-sampling with polyphase interpolators, narrow band filter structures.	
	4.6	Application of Multirate Signal Processing for design of phase shifters, interfacing of digital systems with different sampling rates, implementation of narrowband low pass filters, sub band coding of speech signals	
5		**Analysis of Finite Word length effects**	08
	5.1	Quantization process and errors, quantization of fixed-point numbers, quantization of floating-point numbers, analysis of coefficient quantization effects	
	5.2	A/D Conversion Noise Analysis, Analysis of Arithmetic Round-Off Errors and dynamic range scaling	
6		**Applications of Digital Signal processing:**	08
	6.1	Dual –Tone multi frequency signal detection, spectral analysis of sinusoidal signals, spectral analysis of non stationary signals, and spectral analysis of random signals	
	6.2	Musical sound processing, digital music synthesis, discrete time analytic signal generation.	
	6.3	Trans-multiplexers, oversampling ADC and DAC and sparse antenna array design	

Total	52

Recommended Books:

1. Alan V. Oppenheim and Ronald Schafer, "*Discrete Time Signal Processing*", Pearson Education
2. J. Proakis, D. G. Manolakis, and D. Sharma, "*Digital Signal Processing: Principles, Algorithms and Applications*", Pearson Education.
3. P.P. Vaidyanathan, "*Multirate Systems and Filter Banks*", Pearson.
4. Robert Schilling and Sandra Harris, "*Fundamentals of Digital Signal Processing using MATLAB",* Cengage Learning.
5. Sanjit K.Mitra, "*Digital Signal Processing*", McGrawHill education

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should 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 for 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	TW/ Practical	Tutorial	Total
ETC603	**Computer Communication Networks**	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC603	**Computer Communication Networks**	20	20	20	80	-	-	-	100

Course pre requisite: ETC 502 Analog Communication

Course Objective:

- To introduce analysis and design of computer and communication networks.
- To understand the network layered architecture and the protocol stack.

Course Outcomes:

Upon completion of the subject, students will be able to:

- Assemble the components of a PC and install one or more network operating systems resulting in a functioning
- Design a small or medium sized computer network including media types, end devices, and interconnecting devices that meets a customer's specific needs.
- Perform basic configurations on routers and Ethernet switches.
- Demonstrate knowledge of programming for network communications
- Learn to simulate computer networks and analyze the simulation results
- Troubleshoot connectivity problems in a host occurring at multiple layers of the OSI model
- Develop knowledge and skills necessary to gain employment as computer network engineer and network administrator.

Module No.		Topics	Hrs.
1.		**Network Architectures, Protocol layers, and their Service Models:**	04
	1.1	OSI-RM model and TCP/IP protocol	
2		**Principles of Network Applications:**	10
	2.1	Application layer protocols such as HTTP, FTP, and SMTP.	
	2.2	Peer-to-Peer File Sharing Protocols and Architectures	
	2.3	ISPs and Domain name systems, Socket API and network socket programming	
3	3.1	**Reliable and Unreliable Transport-layer protocols:**	10
	3.2	TCP and UDP, Port numbers, Multiplexing and de-multiplexing	
	3.3	Flow control and congestion control. fairness delay, jitter, and loss in packet-switched networks	
	3.4	Bandwidth, throughput, and quality-of-service	
4	4.1	**Network layer Services and Protocols**	10
	4.2	Switching fabric, routing and forwarding, queues and buffering	
	4.3	Virtual-circuit and datagram networks, internet protocol. IPv4 and IPv6 tunneling	
	4.4	Link State and Distance Vector algorithms, Routing in the Internet RIP, OSPF, and BGP	
	4.5	Broadcast and multicast, handling mobility	
5		**Data link layer Services and Protocols:**	10
	5.1	Link-layer and its services, Ethernet, hubs, bridges, and switches	
	5.2	Link-layer addressing, ATM and MPLS	
	5.3	Local area networks and IEEE 802.11 wireless LANs, multiple-access protocols. Random access, efficiency of pure and slotted ALOHA, CSMA, CSMA/CD, and CSMA/CA	
6		**Introduction to Physical-layer Services and Systems**	08
	6.1	Introduction to physical media, Coax, fiber, twisted pair, DSL, HFC, WiMax, cellular, satellite, and telephone networks, bit transmission, frequency division multiplexing. time division multiplexing	
Total			52

Recommended Books:

1. Andrew Tanenbaum, *"Computer Networks",* PHI New Dehli,
2. Natalia Olifer and Victor Olifer, " Computer Networks", Wiley India,New Delhi
3. J. F. Kurose and K. W. Ross, "*Computer Networking: A Top-Down Approach*", Pearson Publication , 5th Edition, March 2009
4. L.Garcia et al, "*Communication Networks*", McGraw Hill Publication, 2nd Edition
5. B. Forouzan, "*Data Communication and Networking*", McGraw Hill Publication, 5th edition.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should 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 for 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	TW/Practical	Tutorial	Total
ETC 604	Television Engineering	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC 604	Television Engineering	20	20	20	80	-	-	-	100

Pre requisite : ETC 502 Analog Communication

Course Objective:

- To introduce the basics of picture transmission and reception.
- To become well conversant with new development in video engineering.
- To introduce most latest and revolutionary ideas in the field of digital TV, HDTV, WDTV.

Course outcome: The students will be able to

- Describe and differentiate working principles of latest digital TV, HDTV, WDTV.
- Understand, use and working principles of latest display like LCD, LED, Plasma and large plat panel monitors

Module No.		Topics	Hrs.
1		**Fundamentals of Analog T V system**	10
	1.1	Transmitter and receiver- block diagram approach, interlaced scanning, composite video signal, VSB transmission and reception (CCIR-B standards)	
	1.2	Camera tubes: basic principle ,Vidicon and Image orthicon	
2		**Color T V**	
	2.1	Compatibility considerations, Color theory, chromaticity diagram, generation of color TV signals, luminance signal, chrominance signal, frequency interleaving process, color subcarrier frequency.	10
	2.2	NTSC system- transmitter and receiver, PAL system- transmitter and receiver	
3		**Fundamental Concept of Digital Video**	
	3.1	Digitization, pixel array, scanning notation, viewing distance and angle, aspect ratio, frame rate and refresh rate.	12
	3.2	Raster scanning, scan line waveform, interlace, scanning standards.	
	3.3	Sync structure, data rate, linearity, bandwidth and data rate, resolution, luma, color difference coding, chroma sub sampling	
	3.4	Component digital video, composite video	
4		**Advanced TV systems**	6
	4.1	Digital video and audio signals	
	4.2	MAC signal, D2-MAC/packet signal, MAC decoding and interfacing, advantages of MAC signal	
	4.3	Direct-to-home TV(DTH)	
5		**High definition televisions**	8
	5.1	High definition TV systems, HDTV standards and compatibility, resolution and working.	
	5.2	Wide dimensions high definition TV	
	5.3	Standards of wide dimensions HDTV	
	5.4	MUSE system	
6		**Displays**	6
	6.1	Principle, working, advantages and disadvantages of Plasma, LED,LCD	
Total			52

Recommended Books:

1. Gulati R.R, " *Monochrome and Color Television*," Wiley Eastern Limited publication.
2. R.G.Gupta , "*Television and Video Engineering*", Tata Mc Graw Hill publication.
3. Dhake A.M, "*Television and Video Engineering*", Tata McGraw Hill publication.
4. Keith Jack, "*Video Demystified*", 4e, , Elsevier
5. Charles Poynton, "*San Francisco, Digital video and HDTV, Algorithms And Interfaces*," Morgan Kaufmann publishers, 2003.
6. Stan Prentiss, *"High Definition TV*", second edition, , Tata McGraw Hill publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should 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 for 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	TW/Practical	Tutorial	Total
ETC 605	Operating System	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETC 605	Operating System	20	20	20	80	-	-	-	100

Course Pre-requisite: Basic concepts of computer systems

Course Objectives:

- To introduce operating system as a resource manager, its evolutions and fundamentals.
- To help student understand concept of process and different process (linear and concurrent) Scheduling policies.
- To help student familiar with memory, file and I/O management policies.

Course Outcomes: On completing this course Student will able to:

- Understand the role of an operating system, its function and issues.
- Compare between different algorithms used for management and scheduling of processes, Memory and input-output operation.
- Appreciate the role of various productivity enhancing tools.

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Module No.		Topics	Hrs.
1		**Fundamental of Operating System(OS)**	06
	1.1	Definition, objectives, functions, evolution, services, types, and different views of OS	
	1.2	Operating System as a resource manager, system calls, and shell	
	1.3	Monolithic systems, layered systems, client server model, monolithic kernel and microkernel	
2		**Process Management and Memory Management**	10
	2.1	Process, process creation, process control block, process states, process state transition diagram	
	2.2	Scheduling queues and schedulers, preemptive and non- preemptive scheduling algorithms, types of threads, multithreading models	
	2.3	Race condition, critical section, mutual exclusion, semaphores, monitors	
	2.4	Multiprogramming with fixed and variable partitions, memory allocation strategies	
	2.5	Logical and physical address space, paging and segmentation	
	2.6	Concept, performance of demand paging, page replacement algorithms.	
	2.7	Deadlock Problem, deadlock characterization, deadlock prevention and deadlock avoidance deadlock detection and recovery	
3		**File Management and Input Output Management**	10
	3.1	File Naming, File Structure, File Types, File Access, File Attributes, File Operations, Memory Mapped Files, Implementing Files, contiguous allocation, linked list allocation, indexed allocations, Inode	
	3.2	Single level directory system, Two level directory system, Hierarchical Directory System	
	3.3	Principles of Input/output H/W: I/O Devices, Device Controllers, Direct Memory Access.	
	3.4	Principles of Input/output S/W: Goals Of I/O S/W, Interrupt Handler, Device Driver, Device Independent I/O Software	
	3.5	Disks : RAID levels, Disks Arm Scheduling Algorithms	
	3.6	Management of free blocks.	
4		**Unix Operating System**	06
	4.1	History of UNIX, UNIX Goals, Unix Shell, interfaces to Unix, UNIX utility programs	
	4.2	Traditional UNIX Kernel, Modern UNIX Systems	
	4.3	Unix process management: Concept, Scheduling in Unix	
	4.4	Unix Memory management: Paging, Page replacement strategies	
	4.5	Unix file management: I-node, File allocation, I/O management	
	4.6	Unix Security measures	
5		**Linux Operating System**	10
	5.1	History, Linux Processes and Thread management	
	5.2	Scheduling in Linux, Linux System calls	
	5.3	Memory management: Virtual memory, Buddy Algorithm, Page replacement policy	
	5.4	Linux File System	
	5.5	I/O management: Disk Scheduling	
	5.6	Advantages of Linux and Unix over Windows	

6		**Real Time Operating System(RTOS)**	**10**
	6.1	Introduction, Characteristics of real-time operating systems	
	6.2	Real Time task Scheduling, Modeling Timing constraints, Table-driven scheduling	
	6.3	Cyclic schedulers	
	6.4	Earliest Deadline First (EDF) scheduling	
	6.5	Rate Monotonic Algorithm(RMA)	
Total			**52**

Recommended Books:

1. Tanenbaum, "*Modern Operating Systems*", III[rd] Edition, PHI
2. Silberschatz A., Galvin P., and Gagne G, "*Operating Systems Concepts*", VIII[th] Edition Wiley.
3. William Stallings, "*Operating System-Internal & Design Principles*", VI[th] Edition, , Pearson
4. Rajib Mall, "*Real-Time Systems: Theory and Practice*," Pearson, 2008.
5. Maurice J. Bach, "*The Design of Unix Operating System*", Prentine Hall
6. Achyut S. Godbole, "*Operating Systems*", 2nd edition, Tata McGraw Hill
7. Richard Blum and Christine Bresnahan, "*Linux Command Line & Shell Scripting*", 2nd edition, Wiley

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should 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 for 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	TW/Practical	Tutorial	Total
ETC606	VLSI Design	04	--	--	04	--	--	04

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					
ETC606	VLSI Design	20	20	20	80	--	--	--	100

Course Pre-requisite:

- ETC303: Digital Electronics
- ETC302: Analog Electronics-I
- ETC402: Analog Electronics-II
- ETC505: Integrated Circuits

Course Objectives:

- To teach fundamentals of VLSI circuit design and implementation using circuit simulators and layout editors.
- To highlight the circuit design issues in the context of VLSI technology.

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

- Demonstrate a clear understanding of CMOS fabrication flow and technology scaling.
- Design MOSFET based logic circuit
- Draw layout of a given logic circuit
- Realize logic circuits with different design styles
- Demonstrate an understanding of working principle of operation of different types of memories
- Demonstrate an understanding of working principles of clocking, power reduction and distribution

Module No.		Topics	Hrs.
1		**MOSFET Fabrication and Scaling**	08
	1.1	**Fabrication:** Fabrication process flow for NMOS and CMOS, CMOS Latch-up	
	1.2	**MOSFET Scaling:** Types of scaling, short channel effects, Level 1 and Level 2 MOSFET Models	
	1.3	**Layout:** Lambda based design rules, MOSFET capacitances	
2		**MOSFET Inverters**	10
	2.1	**Circuit Analysis:** Static and dynamic analysis (Noise, propagation delay and power dissipation) of resistive load and CMOS inverter. Comparison of all types of MOS inverters. Design of CMOS inverters and its layout.	
	2.2	**Logic Circuit Design:** Analysis and design of 2-I/P NAND and NOR using equivalent CMOS inverter.	
3		**MOS Circuit Design Styles**	10
	3.1	**Design Styles:** Static CMOS, Pass Transistor Logic, Transmission Gate, Pseudo NMOS, Domino, NORA, Zipper, C^2MOS	
	3.2	**Circuit Realization:** SR Latch, JK FF, D FF, 1 Bit Shift Register, MUX, Decoder using above design styles and their layouts	
4		**Semiconductor Memories**	08
	4.1	**SRAM:** ROM Array, SRAM (operation, design strategy, leakage currents, read/write circuits), DRAM (Operation 3T, 1T, operation modes, leakage currents, refresh operation, Input-Output circuits), Flash (mechanism, NOR flash, NAND flash), layout of SRAM and DRAM	
	4.2	**Peripheral Circuits:** Sense Amplifier, Decoder	
5		**Data Path Design**	08
	5.1	**Adder:** Bit adder circuits, Ripple carry adder, CLA adder	
	5.2	**Multipliers and shifter:** Partial-product generation, partial-product accumulation, final addition, Barrel Shifter	
6		**VLSI Clocking and System design**	08
	6.1	**Clocking:** CMOS clocking styles, Clock generation, stabilization and distribution	
	6.2	**Low Power CMOS Circuits:** Various components of power dissipation in CMOS, Limits on low power design, low power design through voltage scaling.	
	6.3	**IO pads and Power Distribution:** ESD protection, Input circuits, Output circuits, Simultaneous switching noise, power distribution scheme	
	6.4	**Interconnect:** Interconnect delay model, interconnect scaling and crosstalk	
Total			52

Recommended Books:

1. Sung-Mo Kang and Yusuf Leblebici, "*CMOS Digital Integrated Circuits Analysis and Design*", Tata McGraw Hill, 3rd Edition, 2012.
2. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "*Digital Integrated Circuits: A Design Perspective*", Pearson Education, 2nd Edition.
3. John P. Uyemura, "*Introduction to VLSI Circuits and Systems*", Wiley, Student Edition, 2013.
4. Neil H. E. Weste, David Harris and Ayan Banerjee, "*CMOS VLSI Design: A Circuits and Systems Perspective*", Pearson Education, 3rd Edition.
5. R. Jacob Baker, "*CMOS Circuit Design, Layout and Simulation*", Wiley, 2nd Edition, 2013

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of two tests should 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 for 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	TW/Practical	Tutorial	Total
ETL601	Discrete Time Signal Processing	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL601	Discrete Time Signal Processing	--	--	--	--	25	25	-	50

Term Work:
At least ten experiments covering entire syllabus of ETC 602:Discrete Time Signal Processing on should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and average. Base on above scheme grading and term work assessment should be done.
Practical and oral examination will be based on entire syllabus.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL602	Communication Engineering Laboratory III	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL602	Communication Engineering Laboratory III	--	--	--	--	25	25	-	50

Term Work:
At least ten experiments covering entire syllabus for ETC 601: Digital Communication and ETC 603 Computer Communication and Networks should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and average. Base on above scheme grading and term work assessment should be done.
Practical and oral examination will be based on entire syllabus of ETC 601 and ETC 603

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL604	Communication Engineering Laboratory IV	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
ETL604	Communication Engineering Laboratory -IV	--	--	--	--	25	25	-	50

Term Work:
At least six experiments covering entire syllabus for ETC 606:VLSI Design and minimum four experiments for ETC 604: Television Engineering. should be set to have well predefined inference and conclusion. The experiments should be student's centric and attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on overall performance of the student with every experiment graded. The grade must be converted to marks as per credit and grading system manual, and should be added and average. Base on above scheme grading and term work assessment should be done.
Practical and oral examination will be based on entire syllabus for ETC 606 and ETC 604.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
ETL605	Mini Project II	--	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	Ave. Of Test 1 and Test 2				
ETL605	Mini Project II	--	--	--	--	25	25	50

Term Work:

The main intention of Mini Project is to make student enable to apply the knowledge and skills learned out of courses studied to solve/implement predefined practical problem. The students undergo various laboratory/tutorial/simulation laboratory/work shop courses in which they do experimentation based on the curriculum requirement. The mini Project may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be on

- Learning additional skills
- Development of ability to define and design the problem and lead to its accomplishment with proper planning.
- Learn the behavioral science by working in a group

The group may be maximum **four** (04) students. Each group will be assigned one faculty as a supervisor. The college should keep proper assessment record of progress of the project and at the end of the semester it should be assessed for awarding TW marks. The TW may be examined by approved internal faculty appointed by the head of the institute. The final examination will be based on demonstration in front of internal and external examiner. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained about the task completed.

The topic of Mini Project I and II may be different and / or may be advancement in the same topic. The students may use this opportunity to learn different computational techniques as well as some model development. This they can achieve by making proper selection of Mini Projects.

University of Mumbai

No. AAMS_UGS/ICC/2022-23/ \18

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/42 of 2018-19 dated 25th June, 2018 relating to the revised syllabus for the T.E. & B.E. in Electronics & Telecommunication Engineering (Sem.– V to VIII) (CBCS).

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Electronics and Telecommunication Engineering at its meeting held on 11th May, 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. 6.30 (R) have been accepted by the Academic Council at its meeting held on 11th July, 2022 **vide** item No. 6.30 (R) and that in accordance therewith, the revised syllabus of B.E.(Electronics and Telecommunication Engineering) (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).

(Dr. Shailendra Deolankar)
I/c Registrar

MUMBAI – 400 032
20th October, 2022

To,

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

A.C/6.30(R)/11/07/2022

****

No. AAMS_UGS/ICC/ 2022-23/ \19 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 and Telecommunication 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. – 6.30 (R)

University of Mumbai

Revised Syllabus for

B.E. (Electronics & Telecommunication Engineering)

(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 and Telecommunication Engineering)
O: _____ **Eligibility**	After Passing Third Year Engineering as per the Ordinance 0.6243
R: _____ **Passing Marks**	40%
No. of years/Semesters:	8 semesters
Level:	~~P.G.~~ / U.G./ ~~Diploma / Certificate~~
Pattern:	~~Yearly~~ / Semester
Status:	~~New~~ / Revised
To be implemented from Academic Year :	With effect from Academic Year : 2022-23

Dr Faruk Kazi
Chairman
of Ad-hoc Board of Studies in Electronics and Telecommunication 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 13 weeks and remaining 2 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 171, 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 By BoS

Technological developments in the field of electronics and telecommunication engineering have revolutionized the way people see the world today. Hence, there is a need for continuously enriching the quality of education by a regular revision in the curriculum, which will help our students achieve better employability, start-ups, and other avenues of higher studies. The current revision in the Bachelor of Engineering program (REV- 2019 'C' Scheme) aims at providing a strong foundation with required analytical concepts in the field of electronics and telecommunication engineering.

Some of the salient features of this revised curriculum are as below and they fall in line with the features in AICTE Model Curriculum.

1. The curriculum is designed in such a way that it encourages innovation and research as the total number of credits has been reduced from around 200 credits in an earlier curriculum to 171 credits in the current revision.
2. In the second and third-year curriculum, skill-based laboratories and mini-projects are introduced.
3. It will result in the students developing a problem-solving approach and will be able to meet the challenges of the future.
4. The University of Mumbai and BoS – Electronics and Telecommunication Engineering will ensure the revision of the curriculum on regular basis in the future as well and this update will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

The BoS would like to thank all the subject experts, industry representatives, alumni, and various other stakeholders for their sincere efforts and valuable time in the preparation of course contents, reviewing the contents, giving valuable suggestions, and critically analyzing the contents.

Board of Studies in Electronics and Telecommunication Engineering

Dr. Faruk Kazi: Chairman

Dr. V. N. Pawar: Member

Dr. Ravindra Duche: Member

Dr. Milind Shah: Member

Dr. R. K. Kulkarni: Member

Dr. Baban U. Rindhe: Member

Dr. Mrs. Nair: Member

Dr. Nalbarwar: Member

Dr. Sudhakar Mande: Member

Dr. S. D. Deshmukh: Member

Program Structure for Final Year
Electronics & Telecommunication Engineering

Semester VII & VIII
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)
Semester VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC701	Microwave Engineering	3	--	--	3	--	--	3
ECC702	Mobile Communication System	3	--	--	3	--	--	3
ECCDLO701X	Department Optional Course-3	3	--	--	3	--	--	3
ECCDLO702X	Department Optional Course-4	3	--	--	3	--	--	3
ILO701X	Institute Level Optional Course-1	3	--	--	3	--	--	3
ECL701	Microwave Engineering Laboratory	--	2	--	--	1	--	1
ECL702	Mobile Communication System Laboratory	--	2	--	--	1	--	1
ECP701	Major Project-I	--	6#	--	--	3	--	3
Total		15	10	--	15	5	--	20

 # indicates work load of Learner (Not Faculty), for Major Project

Project Guide Load = ½ hour per week per project group

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Test 1	Test 2	Avg.					
ECC701	Microwave Engineering	20	20	20	80	3	--	--	100
ECC702	Mobile Communication System	20	20	20	80	3	--	--	100
ECCDLO 701X	Department Level Optional Course-3	20	20	20	80	3	--	--	100
ECCDLO 702X	Department Level Optional Course-4	20	20	20	80	3	--	--	100
ILO701X	Institute Level Optional Course-1	20	20	20	80	3	--	--	100
ECL701	Microwave Engineering Laboratory	--	--	--	--	--	25	25	50
ECL702	Mobile Communication System Laboratory	--	--	--	--	--	25	25	50
ECP701	Major Project-I	--	--	--	--	--	25	25	50
Total		--	--	100	400	--	75	75	650

Department Level Optional Course-3

Course Code	Course Name
ECCDLO 7011	Efficient Architectures for DSP Algorithms
ECCDLO 7012	Deep Learning
ECCDLO 7013	Cloud Computing and Security
ECCDLO 7014	Big Data Analytics
ECCDLO 7015	Software Defined Radio

Department Level Optional Course-4

Course Code	Course Name
ECCDLO 7021	Robotics
ECCDLO 7022	5G Technology
ECCDLO 7023	Internet Communication Engineering
ECCDLO 7024	Advanced Digital Signal Processing
ECCDLO 7025	Quantum Computing

Institute Level Optional Course-1

Course Code	Course Name
ILO 7011	Product Lifecycle Management
ILO 7012	Reliability Engineering
ILO 7013	Management Information System
ILO 7014	Design of Experiments
ILO 7015	Operation Research
ILO 7016	Cyber Security and Laws
ILO 7017	Disaster Management and Mitigation Measures
ILO 7018	Energy Audit and Management
ILO 7019	Development Engineering

Program Structure for Final Year
Electronics & Telecommunication Engineering

Semester VII & VIII
UNIVERSITY OF MUMBAI
(With Effect from 2022-2023)
Semester VIII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECC801	Optical Communication and Networks	3	--	--	3	--	--	3
ECCDLO801X	Department Level Optional Course-5	3	--	--	3	--	--	3
ECCDLO802X	Department Level Optional Course-6	3	--	--	3	--	--	3
ILO801X	Institute Level Optional Course-2	3	--	--	3	--	--	3
ECL801	Optical Communication and Networks Laboratory	--	2	--	--	1	--	1
ECP801	Major Project-II	--	12#	--	--	6	--	6
Total		12	14	--	12	7	--	19

 # indicates work load of Learner (Not Faculty), for Major Project

Project Guide Load = 01 hour per week per project group

Course Code	Course Name	Examination Scheme							
		Theory							
		Internal Assessment			End Sem. Exam	Exam Duration (in Hrs)	Term Work	Practical & Oral	Total
		Test 1	Test 2	Avg.					
ECC801	Optical Communication and Networks	20	20	20	80	3	--	--	100
ECCDLO801X	Department Level Optional Course-5	20	20	20	80	3	--	--	100
ECCDLO802X	Department Level Optional Course-6	20	20	20	80	3	--	--	100
ILO801X	Institute Level Optional Course-2	20	20	20	80	3	--	--	100
ECL801	Optical Communication and Networks Laboratory	--	--	--	--	--	25	25	50
ECP801	Major Project-II	--	--	--	--	--	50	100	150
Total		--	--	80	320	--	75	125	600

Department Level Optional Course-5

Course Code	Course Name
ECCDLO 8011	System On Chip Design
ECCDLO 8012	Natural Language Processing
ECCDLO 8013	Wireless Networks
ECCDLO 8014	Web Design
ECCDLO 8015	RF Design

Department Level Optional Course-6

Course Code	Course Name
ECCDLO 8021	Autonomous Vehicle
ECCDLO 8022	Satellite and Nano Satellite Communication
ECCDLO 8023	Network Management in Telecommunication
ECCDLO 8024	Microstrip Antenna
ECCDLO 8025	Augmented Reality and Virtual Reality

Institute Level Optional Course-1

Course Code	Course Name
ILO 8011	Project Management
ILO 8012	Finance Management
ILO 8013	Entrepreneurship Development and Management
ILO 8014	Human Resource Management
ILO 8015	Professional Ethics and CSR
ILO 8016	Research Methodology
ILO 8017	IPR and Patenting
ILO 8018	Digital Business Management
ILO 8019	Environmental Management

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC701	Microwave Engineering	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.					
ECC701	Microwave Engineering	20	20	20	80	03	--	--	100

Course Pre-requisite: Knowledge of Electromagnetic Engineering

-

Course Objectives:

The course should enable the students to:

1. Perceive the concepts of waveguides and analyze the field components in different types of Waveguides.
2. Categorize different types of microwave components based on their applications.
3. Imbibe knowledge to use microwave oscillators & amplifiers in microwave communication and Compare their characteristics. IV.
4. Demonstrate the ability to measure different microwave parameters using microwave bench setup.

Course Outcomes:

1. Describe the types of waveguides, rectangular waveguides and field equations
2. Understand the coupling mechanisms in waveguides and analyze the waveguide multiport junctions
3. .Explore the microwave linear tubes and analyze with microwave cross field tubes
4. Understand the microwave solid state devices and avalanche transit time devices
5. Demonstrate the microwave bench set up and conducting measurements of different parameters

Module No.	Unit No.	Topics	Hrs.
1.0		**TRANSMISSION LINES**	**06**
	1.1	Transmission line equations, open and short circuit transmission lines, variation of impedance over length of line, Smith chart, use of Smith chart in impedance matching	
	1.2	Planar transmission lines: microstrip line, strip line and coplanar lines	
2.0		**WAVEGUIDES**	**07**
	2.1	Introduction, microwave spectrum and bands, applications of microwaves, Types of waveguides, rectangular waveguides, field equations in rectangular waveguide, field components of TM and TE waves for rectangular waveguide, modes of TM and TE waves in rectangular waveguide, impossibility of TEM waves, cut off frequency of rectangular waveguide; Wave impedance in rectangular waveguide: Wave impedance for a TM and TE wave in rectangular waveguide, Dominant mode and degenerate modes, mode characteristics of phase velocity, group velocity, wavelength and impedance relations; Illustrative problems;	
	2.2	Cavity resonators: Types of cavity resonators; Rectangular cavity resonator: Dominant modes and resonant frequencies, illustrative problems.	
3.0		**WAVEGUIDE COMPONENTS**	**06**
	3.1	Coupling mechanisms: Probe, loop, coupling to a cavity resonator, waveguide discontinuities, waveguide irises, tuning screws and posts, matched loads; Waveguide attenuators; Waveguide phase shifters; waveguide	
	3.2	multiport junctions: E plane Tee, H plane Tee, Magic Tee, applications of Magic Tee, hybrid ring; Ferrites: Faraday rotation principle, gyrator, isolator, circulator	
4.0		**MICROWAVE TUBES**	**10**
	4.1	Microwave linear beam tubes (O type): Limitations of conventional tubes at microwave frequencies; Klystron: Velocity modulation process, bunching process, output power and beam loading; Multicavity Klystron amplifiers: Beam current density, output current and output power of two cavity Klystron; Reflex Klystron: Velocity modulation, power output and efficiency.	
	4.2	Helix Traveling Wave tube: Slow wave structures, amplification process, conventional current; Microwave cross field tubes (M type): Introduction, cross-field effects; Magnetrons: Different types, 8-cavity cylindrical travelling wave Magnetron, Hull cut-off and Hartree conditions, modes of resonance and PI-mode operation.	
5.0		**MICROWAVE SEMICONDUCTOR DEVICES**	**06**
	4.1	Microwave solid-state devices: Microwave tunnel diode; Pin diodes, varactor diodes, crystal detectors. Transferred electron devices: Gunn-effect diodes, RWH theory, modes of operations; Avalanche transit time devices: IMPATT diode, TRAPATT diode, BARITT diode,	
6.0		**MICROWAVE MEASUREMNETS**	**04**

	6.1	Description of microwave bench: Different blocks and their features, precautions; Microwave power measurement: Bolometers; Measurement of attenuation; Frequency standing wave measurements: measurement of low and high VSWR; Cavity Q; Impedance measurements.	
		Total	**39**

Text Books:

1. Samuel Y. Liao, ―Microwave Devices and Circuits‖, Pearson, 3rd Edition, 2003.
2. Peter A. Rizzi, ―Microwave Engineering Passive Circuits‖ PHI, 3rd Edition, 1999
3. M.L. Sisodia, G.S.Raghuvanshi, ―Microwave Circuits and Passive Devices‖ Wiley Eastern Ltd., New Age International Publishers Ltd, 1stEdition, 1995.

Reference books

1. R.E. Collin ―Foundations for Microwave Engineering‖ IEEE Press, John Wiley

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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC702	Mobile Communication System	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.					
ECC702	Mobile Communication System	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC405 - Principles of Communication Engineering
ECC501 - Digital Communication
ECC602 - Computer Communication and Networks

Course Objectives:

1. To understand the cellular fundamentals and different types of radio propagation models.
2. To study evolution of 2G and 3G mobile technologies.
3. To illustrate the working principle of LTE.
4. To learn the concepts of emerging technologies for 4 G standards and beyond.

Course Outcomes:

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

1. Explain the cellular fundamentals and estimate the coverage and capacity of cellular systems.
2. Classify different types of propagation models and analyse the link budget.
3. Compare and contrast GSM, GPRS, HSCSD, EDGE and IS-95 Technologies.
4. Apply the concepts of 3G technologies for UMTS and CDMA 2000.
5. Describe the features and working principle of 3GPP LTE.
6. Discuss the emerging technologies for upcoming mobile communication systems.

Module No.	Unit No.	Topics	Hrs.
1.0		**Fundamentals of Mobile Communication**	**07**
	1.1	Introduction to Wireless Communication: Mobile Radio Telephony, Examples of Wireless Communication Systems	01
	1.2	The Cellular Concept System Design Fundamentals: Frequency reuse, Channel assignment strategies, Interference and system capacity, Trunking and Grade of service, Improving Coverage and Capacity in Cellular System and related problems.	06
2.0		**Mobile Radio Propagation**	**08**
	2.1	Large scale fading: Free space propagation model, ground reflection (two-ray) model, practical Link budget design using path loss models. Self-learning: Basic propagation mechanisms, reflection, diffraction and scattering.	03
	2.2	Small scale fading: Small-scale multipath propagation, parameters of mobile multipath channels, types of small-scale fading, Rayleigh and Ricean distributions.	02
	2.3	Features of all conventional multiple access techniques: Frequency Division Multiple Access (FDMA), Time Division Multiple Access (TDMA), Space Spectrum Multiple Access (SSMA), Space Division Multiple Access (SDMA), Orthogonal Frequency Division Multiple Access (OFDMA), OFDM-PAPR	03
3.0		**2G Technologies**	**08**
	3.1	GSM: GSM Network Architecture, air interface specifications, GSM signaling protocol architecture, GSM channels, GSM services and features, GSM multifare structure, GSM speech coding, GSM Call procedures, Authentication and security in GSM, and handoff procedures in GSM.	04
	3.2	GSM evolution: GPRS, HSCSD and EDGE architecture, radio specifications	02
	3.3	IS-95: CDMA air interface, CDMA channels, power control in CDMA system, handoff, and RAKE receiver.	02
4.0		**3G Technologies**	**05**
	4.1	UMTS: Objectives, standardization and releases, network architecture, air interface specifications, channels, security procedure, W-CDMA air interface, attributes of W-CDMA system, W-CDMA channels.	03
	4.2	Cdma2000 cellular technologies: Forward and Reverse Channels, Handoff and Power Control.	02
5.0		**3GPP LTE**	**06**
	5.1	Introduction, system overview: Frequency bands and spectrum flexibility, network structure, protocol structure.	02
	5.2	Physical layer: Frames, slots, and symbols, modulation, coding, multiple-antenna techniques	02
	5.3	Logical and Physical Channels: Mapping of data onto (logical) sub-channels, Establishing a connection, Physical layer retransmissions and reliability, Power control, and handover.	02
6.0		**Advanced techniques for 4G deployment and beyond**	**05**
	6.1	Multi-antenna Techniques: Smart antennas, Multiple input Multiple output systems.	02
	6.2	Cognitive radio: Architecture, spectrum sensing. Software Defined Radio (SDR): Components and Applications.	02

	6.4	Introduction to 5G network and technologies used in 5G such as small cell concept, Massive MIMO, Beamforming, NOMA, and mm wave).	01
		Total	**39**

Textbooks:

1. T. L. Singal “wireless communications”, Mc Graw Hill Education.
2. Theodore S. Rappaport “wireless communications - principles and practice”, PEARSON, Second edition.
3. Andreas F. Molisch “wireless communications” WILEY INDIA PVT LTD, Second edition.

Reference Books:

1. Upena Dalal “Wireless and Mobile Communications‖”, Oxford university Press
2. Vijay K.Garg “Wireless Communications and Networking” ,Morgan–Kaufmann series in Networking-Elsevier.
3. J. H. Reed, Software-Defined Radio, Prentice-Hall, 2002
4. W. C. Y. Lee, Mobile Communication, Wiley
5. David Tse, Pramod Viswanath “Fundamentals of Wireless Communication” published by Cambridge University Press

E - Resources:

NPTEL courses:

1. http://nptel.ac.in/courses/117104099/ - (Advanced 3G and 4G Wireless Mobile communications)
2. https://nptel.ac.in/courses/117/102/117102062/ - (Wireless Communications)
3. Virtual lab: http://vlab.co.in

Internal Assessment (20-Marks):

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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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7011	Efficient Architectures for DSP Algorithms	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ECCDLO 7011	Efficient Architectures for DSP Algorithms	20	20	20	80	03	--	--	100

Course Prerequisite:

ECC303 Digital System Design
ECC404 Signals & Systems
ECC502 Discrete Time Signal Processing
ECC503 Digital VLSI Design
ECM601 Mini Project 2B- FPGA based Project

Course Objectives:

1. To describe the characteristics of computationally intensive algorithms
2. To identify the bottlenecks of intensive computations.
3. To learn various techniques to map DSP algorithms on hardware to improve performance.

Course Outcome:

After successful completion of the course students will be able to

CO1: Explain various typical DSP algorithms and their applications
CO2: Describe various methodologies/techniques to map DSP algorithms on Hardware
CO3: Analyze various hardware architectures available to implementation DSP algorithms
CO4: Evaluate and select efficient hardware architecture for implementation of given DSP algorithm.
CO5: Design/propose hardware architecture for effective implementation of given DSP algorithm.

Module No.	Unit No.	Topics	Hrs
1		**Introduction to DSP Systems**	**06**
	1.1	Typical DSP Algorithms, Graphical representation of DSP Algorithms	
	1.2	Signal flow graph (SFG), data flow graph (DFG) and dependence graph (DG), high level transformation, critical path	
2		**Efficient Algorithm to Architecture Mapping**	**07**
	2.1	Design of N-bit incrementer, decrementer, complimenter ,	
	2.2	Techniques to enhance circuit performance, pipelining and parallel processing, circuit design for N bit natural numbers, optimized circuit design for different functions	
3		**Efficient Adder Architecture**	**07**
	3.1	Introduction to Adder design, Variable Block Adder circuit design, Delay optimized Carry Look Ahead Adder	
	3.2	Carry Select Sum Adder, Conditional Sum Adder, Ling's Adder	
	3.3	Prefix and Parallel prefix adders, Running Average Circuit	
4		**Efficient Multiplier Design**	**07**
	4.1	Array Multiplier ,Signed and Unsigned Multiplier ,Booths Multiplier , Bough-Wooley Multiplier	
	4.2	Architecture of Squaring Circuit, Reconfigurable Constant Multiplier Design	
5		**DSP Architecture Design**	**06**
	5.1	Floating point representation IEE754, floating point operations-2's compliment representation, adder, subtractor, multiplier	
	5.2	CORDIC Architecture, FFT Architecture, FIR filter	
6		**Efficient Design of Machine Learning Hardware**	**06**
	6.1	Artificial Intelligence and Machine Learning, Software and Co-design Optimizations, Pruning, Systolic array convolution	
	6.2	Hardware-Level Techniques, RTL design of sum of differences, Energy efficient hardware accelerator design methodology for Neural Networks	
	Total		**39**

Textbooks:

1. VLSI Digital Signal Processing Systems Design and Implementation – Khesab Parhi
2. COMPUTER ARITHMETIC Algorithms and Hardware Designs-Behrooz Parhami
3. **Machine Learning in VLSI-Ibrahim (Abe) M. Elfadel, Duane S. Boning, Xin Li Computer-Aided Design**

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://nptel.ac.in/courses/108105118
2. https://nptel.ac.in/courses/108106149
3. https://nptel.ac.in/courses/108105157

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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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7012	Deep Learning	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 7012	Deep Learning	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. ECC 604-Artificial Neural Networks and Fuzzy logic

Course Objectives:

At the end of the course, the students will be expected to:

1. Learn how to use TensorFlow for building and testing Deep Learning models
2. Compare various CNN architectures
3. Know the importance of Regularisation and Optimization techniques in Deep Learning networks
4. Learn Deep Learning models for working with sequential data
5. Understand motivation and functioning of the most common types of Autoencoders and apply such mechanisms to various learning problems.

Course Outcomes:

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

1. Understand the fundamentals of Deep Learning
2. Understand the concepts of TensorFlow, its main functions, operations and the execution pipeline
3. Improve deep learning models using Regularization and Optimization techniques
4. Compare the Convolution Neural Network architectures and use them as per the application
5. Design and implement Sequence Neural Network systems and solve real-world problems
6. Illustrate the working of Autoencoders and use them for real-life applications

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Deep learning**	**03**
	1.1	History of Deep Learning- A Probabilistic Theory of Deep Learning	
	1.2	Introduction to Deep Feedforward Networks, Gradient Based Learning, Hidden Units	
	1.3	Architecture Design, Backpropagation Algorithm	
2.0		**TensorFlow for Deep learning**	**06**
	2.1	Introduction to TensorFlow using Python: Computational Graph, Key Highlights, Creating a Graph	
	2.2	Regression example, Gradient Descent, TensorBoard, Modularity, Sharing Variables, Keras	
	2.3	Preprocessing and Data Augmentation of Images and Datasets using TensorFlow	
3.0		**Regularization and Optimization Techniques**	**06**
	3.1	**Regularization:** Need of Regularization, L2 Regularization, L1 Regularization, Early Stopping and Dropout	
	3.2	**Optimization:** Challenges in NN Optimization, Gradient Descent Approaches, Parameter Initialization Approach, Adaptive Approaches - AdaGrad, RMSProp and Adam	
	3.2	Introduction to Batch Normalization	
4.0		**Evolution of CNN in Deep Learning**	**08**
	4.1	Review of CNN Architecture, Introduction of various CNN Architectures: LeNet, AlexNet, VGG, GoogleNet, ResNet and UNet	
	4.2	Comparison of CNN Architectures, Evaluation Parameters	
	4.3	Applications of CNN in Image Classification and Object Detection	
5.0		**Sequence Modeling**	**08**
	5.1	Recurrent and Recursive Nets: Recurrent Neural Networks, Bidirectional RNN, Encoder Decoder Architectures	
	5.2	Introduction to Long Short-Term Memory (LSTM) and Temporal Dependencies	
	5.3	Gated Recurrent Units (GRUs)	
	5.4	Applications of RNN in Real World- Image Captioning and Time Series Forecasting and Prediction	
6.0		**Encoder Decoder Models**	**08**
	6.1	Autoencoder: Encoder-Decoder Model, Training & Learning Manifold Space	
	6.2	Regularized Autoencoders: Sparse, De-noising and Contractive	
	6.3	Deep Autoencoder: Architecture and Working	
	6.4	Variational Autoencoders: Limitations of Autoencoders, Loss Function, Re-parameterization Trick, Latent Space Visualization	

	6.5	Applications of Autoencoders and Variational Autoencoders-Dimensionality Reduction , Image De-noising and Compression	
		Total	**39**
Self-learning Topics*:** Deep learning applications in Object Localization, Video Classification, Content based Image Retrieval, Recommender System, End-to-End Speech Recognition and Machine Translation *** No questions to be asked in exams.			

Text Books:

1. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer International Publishing, 2018.
2. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.

Reference books

1. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer-Verlag, 2006.
2. Duda, Richard, Peter Hart, and David Stork, Pattern Classification, 2nd edition, Wiley-Interscience, 2000.
3. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.
4. Reza Zadeh, Bharath Ramsundar, TensorFlow for Deep Learning, 1st edition, O'Reilly Media Inc, 2018.
5. Zaccone, Giancarlo, Deep Learning with TensorFlow, 2nd edition, Packt Publishing, 2018.

NPTEL / Swayam Courses:

1. NPTEL course on Deep learning by Prof. Sudarshan Iyengar, IIT Ropar. https://nptel.ac.in/courses/106/106/106106184/
2. NPTEL course on Deep learning by Prof. Prabir Kumar Biswas, IIT Kharagpur. https://nptel.ac.in/courses/106/105/106105215/
3. NPTEL Course on Practical Machine Learning with TensorFlow by Prof. Balaraman Ravindran, IIT Chennai. https://nptel.ac.in/courses/106/106/106106213/

Online Resources:

1. https://www.tensorflow.org/tutorials/images/data_augmentation
2. https://towardsai.net/p/machine-learning/improving-artificial-neural-network-with-regularization-and-optimization
3. https://towardsdatascience.com/regularization-techniques-for-neural-networks-e55f295f2866
4. https://www.kaggle.com/sid321axn/regularization-techniques-in-deep-learning
5. https://medium.com/@minions.k/optimization-techniques-popularly-used-in-deep-learning-3c219ec8e0cc
6. https://www.jeremyjordan.me/variational-autoencoders/

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End Semester Examination (80-Marks):

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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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLOC 7013	Cloud Computing and Security	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.					
ECCDLOC 7013	Cloud Computing and Security	20	20	20	80	03	--	--	100

Course Pre-requisite:

Computer Communication Network
Digital Encryption System

Course Objectives:

1. Understand the fundamentals of cloud computing .
2. Appreciate the importance of virtualization in cloud computing
3. Understand various cloud computing services and platforms
4. Understand application design concepts in cloud
5. Understand the security aspects of cloud computing
6. Understand the advances in cloud computing

Course Outcome:

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

1. Explain the fundamentals of cloud computing.
2. Interpret the significance of virtualization in the context of cloud computing
3. Describe cloud computing services working on AWS, Azure and Google cloud platforms
4. Explain application design aspects of cloud computing
5. Interpret security aspects to cloud computing.
6. Explain advances in cloud computing in terms of multimedia cloud, fog, edge computing and real applications of cloud.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Cloud**	**04**
	1.1	Introduction to Cloud Computing, Cloud Characteristics, Cloud Computing Components, Comparing of Cloud Computing with Peer to Peer architecture, Client Server , Distributed, Grid, Cloud Deployment model (Cloud types- Public, Private, Community, Hybrid), Service Models-(IaaS,PaaS,SaaS,)	
2.0		**Virtualization**	**07**
	2.1	Introduction & benefit of Virtualization – Implementation Levels of Virtualization- VMM Design Requirements and Providers – Virtualization at OS level – Middleware support for Virtualization– Virtualization structure/tools and mechanisms: Hypervisor and Xen Architecture, Binary Translation with full Virtualization, Para Virtualization with Compiler Support - Virtualization of CPU, Memory and I/O Devices, Hardware support for Virtualization in intel x86 processor – CPU Virtualization – MemoryVirtualization and I/O Virtualization – Virtualization in Multicore processors	
3.0		**Cloud Computing Services**	**10**
	3.1	Compute Services - Amazon Elastic Compute Cloud, Google Compute Engine, Windows Azure Virtual Machines Storage Services - Amazon Simple Storage Service, Google Cloud Storage, Windows Azure Storage Database Services - Amazon Relational Data Store, Amazon DynamoDB, Google Cloud SQL, Google Cloud Datastore, Windows Azure SQL Database, Windows Azure Table Service Application Services - Application Runtimes & Frameworks, Queuing Services, Email Services, Notification Services, Media Services	
	3.2	Content Delivery Services - Amazon CloudFront, Windows Azure Content Delivery Network Analytics Services - Amazon Elastic MapReduce, Google MapReduce Service, Google BigQuery, Windows Azure HDInsight Deployment & Management Services - Amazon Elastic Beanstalk, Amazon CloudFormation Identity & Access Management Services - Amazon Identity & Access Management, Windows Azure Active Directory Open Source Private Cloud Software - CloudStack, Eucalyptus, OpenStack	
4.0		**Cloud Application Design**	**06**
	4.1	Design Considerations for Cloud Applications - Scalability, Reliability & Availability, Security, Maintenance & Upgradation, Performance	
	4.2	Cloud Application Design Methodologies - Service Oriented Architecture, Cloud Component Model, IaaS, PaaS and SaaS services for cloud applications, Model View Controller, RESTful Web Services, Data Storage Approaches - Relational (SQL) Approach, Non-Relational (No-SQL) Approach	
5.0		**Cloud Security**	**06**
	5.1	Security for Virtualization Platform – Host security for SaaS, PaaS and IaaS – Data Security – Data Security Concerns – Data Confidentiality and Encryption – Data Availability –Data Integrity – Cloud Storage Gateways – Cloud Firewall	
	5.2	AAA Administration for Clouds -AAA model – SSO for Clouds – Authentication management and Authorization management in clouds – Accounting for Clouds Resource utilization.	

6.0		**Cloud Computing Applications**	**06**
	6.1	Cloud Computing for Health care, Education, Transportation, Manufacturing Industry, Energy System, Mobile Computing	
	6.2	Multimedia Cloud - Introduction, Streaming Protocols - RTMP Streaming, HTTP Live Streaming, HTTP Dynamic Streaming	
	6.3	Case Studies - Live Video Streaming App , Video Transcoding App, Edge Computing, FOG Computing	
		Total	**39**

Text books :

1. Cloud Computing - A Hands-on Approach - Arshdeep Bahga and Vijay K. Madisetti
2. Mastering Cloud Computing: Foundations and Applications Programming Paperback – by Rajkumar Buyya , Christian Vecchiola , S.Thamarai Selvi , Publisher: Morgan Kaufmann
3. Amazon Web Services For Dummies (For Dummies Series) Paperback by Bernard Golden, Publisher: John Wiley & Sons
4. "The Cloud Computing Book: The Future of Computing Explained" , Douglas E. Comer
5. Cloud Computing for Dummies, Judith Hurwitz Daniel Kirsch

Reference books

1. Cloud Computing Black Book : Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah by Kogent Learning Solutions , Publisher : Dreamtech Press
2. Cloud Computing Concepts Technology and Architecture - Erl second hand book online from UsedBooksFactory
3. Practical Cloud Security by Chris Dotson, Publisher(s): O'Reilly Media, Inc. ISBN: 9781492037514
4. AWS Whitepapers & Guides https://aws.amazon.com/whitepapers/
5. Azure whitepapers https://azure.microsoft.com/en-in/resources/whitepapers/
6. Google Cloud whitepapers https://cloud.google.com/whitepapers

MOOC

1. NPTEL Swayam Course on Cloud computing By Prof. Soumya Kanti Ghosh https://nptel.ac.in/courses/106/105/106105167/
2. Cloud Computing and Distributed Systems By Prof. Rajiv Misra https://onlinecourses.nptel.ac.in/noc22_cs18/preview
3. Google Cloud Computing Foundation Course https://nptel.ac.in/courses/106/105/106105223

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End Semester Examination (80-Marks):

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1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
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3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

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 Outcome:

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 and scientific computing.
2. Acquire fundamental enabling techniques and scalable algorithms like Hadoop, MapReduce and 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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLOC 7015	Software Defined Radio	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.					
ECCDLOC 7015	Software Defined Radio	20	20	20	80	03	--	--	100

Prerequisites:

- Computer Communication and Networks
- Mobile Communication Systems

Course Objectives: The objective of this course is

1. To introduce fundamental knowledge of Software Defined Radio (SDR) and Cognitive Radio (CR) technology in next generation networks.
2. To introduce the hardware and software requirements and design aspects of CR
3. To introduce the architecture, spectrum sensing, spectrum awareness and allocation in CR networks.
4. To introduce the various standards available in CR technology and GNU platform for experimentation.

Course Outcomes: After learning the course the students will be able to demonstrate the ability

1. To Learn the hardware and software architecture and various design principles of SDR
2. To understand challenges of receiver design and select suitable hardware and software for SDR.
3. To understand the functions, components and challenges of CR technology for better spectrum exploitation.
4. To analyze various spectrum sensing techniques in CR environment.
5. To understand and apply the techniques of dynamic spectrum allocation and scheduling in CR based networks.
6. To understand various standards of CR Technology and its role in next generation networks and GNU platform.

Module No	Unit No.	Topic	No. of Hrs
1		**Software Defined Radio**	**5**
	1.1	Basic components of Software Defined Radios, Software defined radio hardware architectures	
	1.2	Distortion parameters - Sources and metrics of distortion in a transceiver, Nonlinear distortion and nonlinearity specifications, Power amplifiers: Nonlinear Distortion in Transmitted Signals	
2		**SDR Architecture and Components**	**8**
	2.1	Power amplifier Line-up for linearity & power requirement calculations, Linearization Techniques for nonlinear distortion in SDR, Pre distortion Techniques for nonlinear distortion in SDR	
	2.2	Digital Pre distortion Techniques for Linear/Nonlinear Distortion	
	2.3	SDR Software architecture, Software Tunable Analog Radio Components	
	2.4	Antenna Systems, Reconfigurable Digital Radio Technologies, Basic Digital Radio Components	
3		**Cognitive Radio**	**6**
	3.1	**Cognitive radio features and capabilities**: Cognitive radio architecture Functions of cognitive radio Dynamic spectrum access, Components of cognitive radio Interference temperature ,Spectrum sensing Spectrum analysis and spectrum decision	
	3.2	**Research challenges in Cognitive Radio:** Issues in spectrum sensing, Spectrum management issues Spectrum mobility issues , Network layer and transport layer issues, Cross-layer design for cognitive radio networks, Artificial intelligence approach for designing cognitive radio, Location-aware cognitive radio	
4		**Spectrum Sensing for Cognitive Radio**	**6**
	4.1	Challenges, Matched Filtering, Waveform-Based Sensing, Cyclostationarity - Based Sensing, Energy Detector-Based Sensing, Radio Identification, Cooperative Sensing, External Sensing, Statistical Approaches and Prediction.	
	4.2	Sensing Frequency, Hardware Requirements and Approaches, Multi-dimensional Spectrum Awareness	
5		**Dynamic spectrum access and management in Cognitive Radio**	**8**
	5.1	Spectrum access models : Exclusive-use model , Shared-use model Spectrum commons model	
	5.2	Dynamic spectrum access architecture: Infrastructure-based versus infra structure less cognitive radio network Centralized versus distributed dynamic spectrum access Inter- and intra-RAN dynamic spectrum allocation	
	5.3	Medium access control for dynamic spectrum access :	

		Optimal decision on spectrum sensing and spectrum access Multichannel and multiuser MAC Spectrum allocation and scheduling, Spectrum trading Performance analysis of cognitive MAC protocols	
6		**Advanced topics in Cognitive Radio**	**6**
	6.1	Cognitive radio architectures for NeXt Generation (XG) networks	
	6.2	Cognitive radio standardization : IEEE SCC 41, IEEE 802.22 for wireless regional area networks (WRANs)	
	6.3	GNU Radio for cognitive radio experimentation	
		Total	**39**

Recommended Books:

1. Huseyin Arslan, “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems”, Springer, 2007

2. Ekram Hossain, Dusit Niyato, Zhu Han, “Dynamic Spectrum Access and Management in Cognitive Radio Networks”, Cambridge University Press, 2009

3. Bruce Fette, “Cognitive radio technology”, Elsevier, 2nd edition, 2009.

4 Alexandar M Wylingskey, Maziar Nikovee, Y Thomas Hou, “Cognitive Radio Communications and Networks Principles and Practice”, Elsevier, 2010

REFERENCES:

1. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive radio networks”, John Wiley & Sons Ltd., 2009.

2. Francisco Rodrigo Porto Cavalcanti, Soren Andersson, “Optimizing Wireless Communication Systems” Springer, 2009.

3. Linda Doyle, “Essentials of Cognitive Radio”, Cambridge University Press, 2009.

E-Resources:

1. NPTEL: https://nptel.ac.in/courses/108/107/108107107/
2. GNU Radio: https://www.gnuradio.org/
   https://wiki.gnuradio.org/index.php/Tutorials
   http://www.gcndevelopment.com/gnuradio/downloads.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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7021	Robotics	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 7021	Robotics	20	20	20	80	03	--	--	100

Course Prerequisite: - Engineering Mathematics III and IV

Course Objectives:

1. To introduce the functional elements of Robotics
2. To impart knowledge on the direct and inverse kinematics
3. To introduce the manipulator differential motion and control
4. To educate on various path planning techniques
5. To introduce the dynamics and control of manipulators
6. To study about the localization, planning and navigation

Course Outcomes:

After successful completion of the course students will be able to

- Explain basic concept of robotics.
- Describe the differential motion, add statics in robotics
- Describe the various path planning techniques.
- Describe the dynamics and control in robotics industries.
- Write program to use a robot for a typical application
- Use Robots in different applications

Module No.	Unit No.	Topics	Hrs.
1.	**BASIC CONCEPTS**		3
	1.1	Brief History	
	1.2	Types of Robot–Technology-Robot classifications and specifications	
	1.3	Design and Control issues	
	1.4	Various manipulators	
	1.5	Sensors , work cell	
	1.6	Programming languages	
2.	**DIRECT AND INVERSE KINEMATICS**		8
	2.1	Mathematical representation of Robots - Position and orientation	
	2.2	Homogeneous transformation Various joints, Degrees of freedom	
	2.3	Representation using the Denavit Hattenberg parameters	
	2.4	Direct kinematics-Inverse kinematics	
	2.5	Solvability – Solution methods-Closed form solution	
	2.6	SCARA robots-	
3.	**PATH PLANNING**		8
	3.1	Joint space technique	
	3.2	Use of p-degree polynomial, Cubic polynomial, Cartesian space technique	
	3.3	Parametric descriptions	
	3.4	Straight line and circular paths	
	3.5	Position and orientation planning	
4.	**DYNAMICS AND CONTROL**		7
	4.1	Lagrangian mechanics	
	4.2	2DOF Manipulator	
	4.3	Lagrange Euler formulation	
	4.4	Dynamic model	
	4.5	Manipulator control problem-Linear control schemes-PID control scheme-Force control of robotic manipulator	
5.	**SERVICE ROBOTICS**		7
	5.1	Need for service robots	
	5.2	**LOCALIZATION:** Challenges of Localization- Map Representation- Probabilistic Map based Localization Monte carlo localization- Landmark based navigation-Globally unique localization- Positioning beacon systems- Route based localization	
	5.3	**PLANNING AND NAVIGATION:** Path planning overview, Cell decomposition path planning Potential field path planning-Obstacle avoidance	
6.	**APPLICATIONS**		6
	6.1	Ariel robots	
	6.2	Collision avoidance	
	6.3	Robots for agriculture, mining, exploration, underwater, civilian and military applications, nuclear applications, Space applications	
	6.4	Humanoids	
Total			39

Text Books:

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009.

3. M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 1996.
4. Roland Siegwart, Illah Reza Nourbakhsh, Davide Scaramuzza, „Introduction to Autonomous Mobile Robots", Bradford Company Scituate, USA, 2004

Reference Books:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. K. K.Appu Kuttan, Robotics, I K International, 2007.
3. Edwin Wise, Applied Robotics, Cengage Learning, 2003.
4. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers,Chennai, 1998
5. Riadh Siaer, „The future of Humanoid Robots- Research and applications, Intech Publications, 2012.

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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7022	5G Technology	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 7022	5G Technology	20	20	20	80	03	--	--	100

Course pre-requisite:

Digital Communication
Mobile Communication Systems

Course Objectives:

1. Learn the basics of 5G and beyond wireless communication
2. Study 5G network architecture and Heterogeneous Network and Small cells
3. Provide understanding of the key technologies and enablers of 5G and beyond communication systems.
4. Learn 5G technology like massive MIMO, mmWave etc.

Course Outcome:

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

1. Distinguish between the major cellular communication standards (1G/2G/3G/4G/5G systems) and architecture of wireless communications networks.
2. Apply the 5G techniques e.g., massive MIMO, mmWave etc. for the design of communication systems.
3. Analyse various modulation and multiplexing techniques e.g., OFDM, NOMA etc.
4. Describe applications of cognitive radio in 5G Wireless Communications.

Module No.	Unit No.	Topics	Hrs.
1		**Introduction**	**04**
	1.1	Introduction to 5G Technology, Features, Requirements, Applications, 5G Services, Introduction to 5Gi	
	1.2	Digital modulations (OFDM, 5G Technology Modulation Techniques) and performance metrics, 5G Internet, Internet of Things and Context-Awareness, Software Defined Networking, Network Function Virtualisation (NFV)	
2		**5G Architecture**	**08**
	2.1	5G Network Architecture, Cloud RAN(C-RAN), Definitions of Heterogeneous Networks, Radio Resource and Interference Management for Heterogeneous Networks, Traffic offloading scenarios for heterogeneous networks, mobility management and handover	
	2.2	Small cell deployments: different types, Deployment scenarios, performance and analysis, Energy efficient mechanism with BS sleep mode in green small cell networks, Game theory and learning techniques for self-organization in small cell networks, 3GPP RAN standards for small cell	
3		**Mm Wave**	**08**
	3.1	mmWave: Millimeter bands, radio-wave propagation Physical layer design and algorithms, mmWave MIMO challenges, channel modelling, channel estimation and Beam-forming. Types of transceivers, Merits and Demerits, Applications	
	3.2	Physical or Radio layer Technologies - Massive MIMO (Sub 6Ghz) -mm wave MIMO (above 6 GHz)	
4		**NOMA**	**05**
		Non orthogonal Multiple Access (NOMA), Different Types: power domain NOMA and code domain NOMA, Difference between Orthogonal multiple access and NOMA, Filter Bank multi carrier -Full duplex Radio Techniques, Precoding	
5		**Cognitive Radio for 5G Wireless Networks**	**08**
	5.1	Introduction, Overview of Cognitive Radio Technology in 5G Wireless, Spectrum Optimisation using Cognitive Radio, Cognitive Radio and Carrier Aggregation, Energy-Efficient Cognitive Radio Technology	
	5.2	Cognitive Radios to Mitigate Interference in Macro/femto Heterogeneous Networks, Cognitive Radio enabled Operations, Interference Coordination: Orthogonality in the Time/Frequency domain, Intra-tier Interference mitigation, Compressive sensing	
6		**Trends in 5G**	**06**
		5G NR, Carrier Aggregation in 5G, Open RAN, Use cases of 5G:eMBB, URLLC and mMTC, Advance applications: Robotic surgery, driverless car and Industrial IoT (IIoT), Tactile Internet, 5G-IoT applications, AR/VR in 5G	
		Total	**39**

Text books:

1. Principles of Modern Wireless communication systems by Aditya k Jagannathan
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

Reference books

1. R. Vannithamby and S. Talwar, Towards 5G: Applications, Requirements and Candidate Technologies., John Willey & Sons, West Sussex, 2017.
2. Manish, M., Devendra, G., Pattanayak, P., Ha, N., 5G and Beyond Wireless Systems PHY Layer Perspective, Series in Wireless Technology Springer, 2021
3. Alagan Anpalagan, Mehdi Bennis, Rath Vannithamby, Design and deployment of small cell networks, Cambridge university press, 2015
4. Rose Qingyang Hu, Yi Qian**,** Heterogeneous Cellular Networks, John Wiley & Sons, Ltd., Publication, 2013
5. T. S. Rappaport, R. W. Heath Jr., R. C. Daniels, and J. M. Murdock, Millimeter Wave Wireless Communication., Pearson Education, 2015.
6. M. Vaezi, Z. Ding, and H. V. Poor, Multiple Access techniques for 5G Wireless Networks and Beyond., Springer Nature, Switzerland, 2019

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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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7023	Internet Communication Engineering	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.				
		Test 1	Test 2	Avg.					
ECCDLO 7023	Internet Communication Engineering	20	20	20	80	03	--	--	100

Course Pre-requisite:

- Analog communication
- Digital Communication
- Computer Communication and Networks

Course Objectives:

1. To focus on Internet protocol, standards, services and administration.
2. To discuss the Internet security protocol and security services
3. To discuss multimedia communication standards and compression techniques
4. To add insights on software defined network & network automation
5. To introduce Internet of Things

Course Outcomes:

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

1. Compare the protocols at each layer of TCP/IP protocol suite.
2. Explain the internet security aspects of protocols at various layers of TCP/IP protocol suite.
3. Apply the various compression algorithms for audio, image & video coding.
4. Categorize and design simple networked multimedia systems.
5. Compare integrated & differentiated services for quality of service.
6. Explain a software defined Network.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Internet**	**03**
	1.1	What is the Internet, Evolution of the Internet, service description, Network protocol?	
	1.2	Overview of TCP/IP, layer functions	
2.0		**Application Layer in the Internet**	**06**
	2.1	Application Layer- Host configuration, DHCP, Domain Name System (DNS), Multicast DNS	
	2.2	Remote Login, TELNET and SSH, HTTPS, electronic mail	
3.0		**Internet Security**	**05**
	3.1	Network layer security (AH, ESP, IPsec)	
	3.2	Transport layer security (SSL), Application layer security (secure E mail- PGP, S/MIME)	
	3.3	VPN Firewall, Intrusion Detection System.	
4.0		**Multimedia Communications**	**10**
	4.1	Information Representation- text, images, audio and video, Text and image compression, Audio and video compression, video	
	4.2	compression standards: H.261, H.263, P1.323, MPEG 1, MPEG 2, Other coding formats for text, speech, image and video	
	4.3	multimedia transport across IP networks and relevant protocols such as RSVP, RTP, RTCP, DVMRP, Signalling Protocols: Real-Time Streaming Protocol (RTSP).	
	4.4	VoIP, IPTV	
5.0		**Quality of Services (QoS)**	**07**
	5.1	Integrated services (intserv): Architecture and Service Model, Resource Reservation Protocol (RSVP), Packet Scheduling Disciplines in the Internet	
	5.2	Differentiated Services (diffserv): Framework and Concept, Assured and Expedited Services, Packet Classification, Routers Internals and Packet Dropping Techniques	
6.0		**Network Industry Trends & Automation**	**08**
	6.1	Introduction to software defined networking, OPENFLOW	
	6.2	Why network automation? Simplified Architectures, Deterministic outcomes, Business Agility, Types of network automation, Device Provisioning, Data collection, Migrations, Configuration Management, Compliance, Reporting, Troubleshooting, Evolving from the management plane from SNMP to device APIs--- Impact of open networking, Network Automation in the SDN era.	
	6.3	Introduction to Internet of Things (IoT): Definition and characteristics of IoT, Physical design of IoT: Things in IoT, IoT Protocols.	
		Total	**39**

Text Books:

1. B. Forouzan, ―*TCP/IP Protocol Suite*‖, 4th Edition, McGraw-Hill Publication
2. K. R. Rao, Zaron S. Bojkovic, Dragorad A. Milocanovic, Multimedia Communication Systems, Prentice Hall India, 2002. ISBN: 81-203-2145-6.
3. Network Programmability & Automation---Jason Edelman, Scott S. Lowe & Matt Oswalt, OREILLY.

References:

1. Steve Heath, Multimedia and Communication Technology, Second Edition, Focal Press, 2003.
2. ISBN: 81-8147-145-8. Ted Wallingford, ―*Switching to VoIP*‖, Oreilly Publication
3. Fred Halsall, ―Multimedia Communications‖, Pearson education, 2001
4. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, ―Multimedia Communication Systems‖, Pearson education, 2004
5. Raif steinmetz, Klara Nahrstedt, ―Multimedia: Computing, Communications and Applications‖, Pearson education, 2002
6. Tay Vaughan, ―Multimedia: Making it Work‖, 6th edition, Tata McGraw Hill, 2004
7. Pallapa Venkataram, ―Multimedia information systems‖, Pearson education (InPress),2005.
8. Multimedia Communication Techniques and Standards
9. Arshdeep Bagha, Vijay Madisetti "Internet of Things", universities Press.

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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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7024	Advanced Digital Signal 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 7024	Advanced Digital Signal Processing	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC502 Discrete-Time Signal Processing

Course Objectives:

1. To develop a thorough understanding of power spectrum estimation and different models for the same.
2. To apply optimum linear filters, linear prediction, and adaptive filtering techniques for signal processing applications.
3. To process multi-rate data.
4. To develop multi-resolution analysis using wavelets.

Course Outcomes:

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

1. Illustrate parametric and non-parametric techniques of power spectrum estimation.
2. Explain optimum linear filters and their different forms.
3. Perform linear estimation and prediction of discrete time signals.
4. Implement various types of adaptive filters for the given applications.
5. Design interpolator, decimator and sampling rate convertors for multi-rate signal processing.
6. Apply concepts of wavelets and filter banks for signal processing applications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Power Spectrum Estimation**	**09**
	1.1	Principle of Power Spectrum Estimation	
	1.2	Non Parametric Method of Power Spectrum Estimation: Modified Periodogram, Bartlett's Method, Welch's Method, Blackman-Tukey Method	
	1.3	Parametric Methods for Power Spectrum Estimation: Relationships between the Autocorrelation and the Model Parameters, AR, MA & ARMA Models	
	1.4	Introduction to Least-Squares Method for the AR Model Parameters and Yule-Walker Method for the AR Model Parameters	
2.0		**Optimum Linear Filters**	**03**
	2.1	Wiener Filters	
	2.2	FIR Wiener Filter (Wiener-Hopf filter)	
	2.3	IIR Wiener filter (Non-Causal and Causal IIR Wiener Filter)	
	2.4	Orthogonality Principle in Linear Mean-Square Estimation	
3.0		**Linear Prediction**	**05**
	3.1	Forward and Backward Linear Prediction	
	3.2	Solution of Normal Equation (Levinson-Durbin and Schur Algorithm)	
	3.3	AR Lattice and ARMA Lattice Ladder Filters	
	3.4	MMSE Estimation	
	3.5	Introduction to Kalman Filter, Matched Filter	
4.0		**Adaptive Filters**	**07**
	4.1	Adaptive Algorithms: LMS Algorithm, NLMS Algorithm, RLS Algorithm, Lattice Ladder Algorithm	
	4.2	Applications of Adaptive Filters: System Identification, Adaptive Channel Equalization, Echo Cancellation, Adaptive Noise Cancellation	
		Self-Study: Suppression of Narrowband Interference in Wideband Signals, Adaptive Array	
5.0		**Multi-rate Signal Processing**	**08**
	5.1	Introduction to Multi-rate Signal Processing	
	5.2	Interpolation and Decimation, Sampling Rate Conversion by Non-integer Factor	
	5.3	Multistage Interpolation and Decimation	
	5.4	Polyphase Decomposition	
	5.5	Filter Banks: Quadrature Mirror Filter Banks	
		Self-Study: Subband Coding	
6.0		**Introduction to Wavelets**	**07**
	6.1	Limitations of Fourier Transform and Short Time Fourier Transform, Introduction to Time-Frequency Tiling	
	6.2	Multi-resolution analysis using Discrete Time Wavelet Transform: Haar MRA, Analysis of two band dyadic filter banks, Frequency response of the Haar Filter Bank	
	6.3	Introduction to Daubechies Wavelets	
	6.4	Application of Wavelet theory to Signal Denoising (Soft and Hard Thresholding)	
		Self-Study: Signal Compression, Image Compression	
		Total	**39**

Note: No questions will be asked in the end semester exam from self-study topics. However, students are encouraged to explore these topics for better understanding of the subject.

Textbooks:

1. John G. Proakis, Dimitris K. Manolakis, “Digital Signal Processing Principles, Algorithms, and Applications”, Prentice-Hall, 4th Edition, 2012.
2. Simon Haykin, “Adaptive Filter Theory”, Pearson Education, Fourth Edition, 2002
3. Martin Vetterli, Jelena Kovacevic, “Wavelets and Subband Coding”, Prentice-Hall, 1995.
4. Burrus, C. Sidney, Ramesh A. Gopinath, and Haitao Guo, "Introduction to wavelets and wavelet transforms", Prentice Hall Inc. 1997"

Reference Books:

1. Emmanuel C. Ifeachor, Barrie W. Jervis, “Digital Signal Processing: A Practical Approach”, Pearson Education, 2008.
2. E. Chandrasekhar, V. P. Dimri, V. M. Gadre (Eds.), “Wavelets and Fractals in Earth System Sciences”, CRC Press, 2013.
3. Tarun Kumar Rawat, “Digital Signal Processing”, Oxford University Press, 2014.
4. K. Deergha Rao, M.N.S. Swamy, “Digital Signal Processing: Theory and Practice”, Springer, 2018.
5. K. P. Soman, K.I. Ramchandran and N. G. Reshmi, “Insight into Wavelets: From Theory to Practice", Third Edition PHI, 2010.
6. P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice-Hall, 1993.
7. Sanjit K. Mitra, “Digital Signal Processing: A Computer-Based Approach”, McGraw Hill, 2011.

NPTEL / Swayam Course:

1. “Estimation of Signals and Systems” by Prof. S. Mukhopadhyay, IIT Kharagpur. https://nptel.ac.in/courses/108/105/108105059/
2. “Adv. Digital Signal Processing - Multirate and wavelets” by Prof. V. M. Gadre, IIT Bombay. https://nptel.ac.in/courses/117/101/117101001/

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-1). 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.

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-qubits States Quantum superposition of qubits (valid and invalid 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 Other Super-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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7011	Product Life Cycle Management	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.					
ILO 7011	Product Life Cycle Management	20	20	20	80	03	--	--	100

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	**Product Design:** 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	09

	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	
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
Total		39

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, ImmonenAnselmie, “Product Life Cycle Management”, Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, “Product Lifecycle Management: Driving the next generation of lean thinking”, Tata McGraw Hill, 2006, ISBN: 0070636265

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7012	Reliability Engineering	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.					
ILO 7012	Reliability Engineering	20	20	20	80	03	--	--	100

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. System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	08
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts	05

	standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	
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
Total		39

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	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7013	Management Information System	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.					
ILO 7013	Management Information System	20	20	20	80	03	--	--	100

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 computing model.	6

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
Total		39

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. 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	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7014	Design of Experiments	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.					
ILO 7014	Design of Experiments	20	20	20	80	03	--	--	100

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** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design,	07

	3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	
04	**Two-Level Fractional Factorial Designs** 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	**Response Surface Methods and Designs** 5.1 Introduction to Response Surface Methodology 5.2 The Method of Steepest Ascent 5.3 Analysis of a Second-Order Response Surface 5.4 Experimental Designs for Fitting Response Surfaces	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04
Total		39

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. 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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7015	Operations Research	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.					
ILO 7015	Operations Research	20	20	20	80	03	--	--	100

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	14

	Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem, 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
Total		39

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	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7016	Cyber Security and Laws	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.					
ILO 7016	Cyber Security and Laws	20	20	20	80	03	--	--	100

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 and information 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 of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security 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 ,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	8
05	**Indian IT Act.**	6

	Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6
Total		39

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. 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	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7017	Disaster Management and Mitigation Measures	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.					
ILO 7017	Disaster Management and Mitigation Measures	20	20	20	80	03	--	--	100

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**	06

	3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management. 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
Total		39

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. '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	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7018	Energy Audit and Management	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.					
ILO 7018	Energy Audit and Management	20	20	20	80	03	--	--	100

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; 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.	10
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
Total		39

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 (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 7019	Development Engineering	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ILO 7019	Development Engineering	20	20	20	80	--	--	--	100

Course objectives:

- To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development.
- To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas
- An exploration of human values, which go into making a _good‘ human being, a _good‘ professional, a _good‘ society and a _good life‘ in the context of work life and the personal life of modern Indian professionals
- To understand the Nature and Type of Human Values relevant to Planning Institutions

Course outcomes:

After successful completion of the course student will be able to

- Apply knowledge for Rural Development.
- Apply knowledge for Management Issues.
- Apply knowledge for Initiatives and Strategies
- Develop acumen for higher education and research.
- Master the art of working in group of different nature.
- Develop confidence to take up rural project activities independently

Module No.	Unit No.	Topics	Hrs.
1.0			**08**
	1.1	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services.	
2.0			**04**
	2.1	Post-Independence rural Development Balwant Rai Mehta Committee - three tier system of rural local Government; Need and scope for people‘s participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	
3.0			**06**
	3.1	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Data base for local planning; Need for decentralized planning; Sustainable rural development.	
4.0			**04**
	4.1	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments.	
5.0			**10**

	5.1	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	
6.0			**04**
	6.1	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	
		Total	**36**

References :

1. ITPI, Village Planning and Rural Development, ITPI, New Delhi
2. Thooyavan, K.R. Human Settlements: A 2005 MA Publication, Chennai
3. GoI, Constitution (73rd GoI, New Delhi Amendment) Act, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi
6. Planning Guide to Beginners
7. Weaver, R.C., The Urban Complex, Doubleday.
8. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
9. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
10. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory andPractice, Vol. 4, No.4, pp.395 – 407

Internal Assessment:
Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approximately 40% syllabus is completed and second class test when additional 40% syllabus is completed. The average marks of both the test will be considered for final Internal Assessment. Duration of each test shall be of one hour.

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL701	Microwave Engineering Laboratory	--	02	--	--	01	--	01

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.					
ECL701	Microwave Engineering Laboratory	--	--	--	--	--	25	25	50

Course Objectives:

1. To become familiar working with rectangular waveguides and doing microwave bench set up
2. To determine the characteristics of various microwave components
3. To be able to measure wave parameters like impedance, frequency, wavelength using microwave bench and VSWR/power meter
4. To study characteristics and behavior of various microwave semiconductor devices.

Course outcomes: On completion of this lab course the students will be able to:

1. Able to handle microwave equipments
2. Able to understand microwave measurements and test the characteristics of microwave components
3. Able to understand Wave guide and transmission line measurements
4. Demonstrate working of microwave semiconductor devices
5. Demonstrate the microwave bench set up and conducting measurements of different parameters

	Suggested List of Experiments
1	Measurement of microwave frequency using direct and indirect method
2	Measurement of guide wavelength
3	Measurement of VSWR of unknown load
4	Measurement of impedance of unknown load.
5	Study of field patterns of various modes inside a rectangular waveguide cavity using Virtual lab
6	Study of field patterns of various modes inside a rectangular waveguide using Virtual lab
7	Find the change in characteristics impedance and reflection coefficients of the transmission line by changing the dielectric properties of materials Embedded between two conductors. using Virtual lab
8	Determination of VI characteristics of Gunn diode using microwave test bench.
9	Measurement of attenuation
10	Measurement of microwave power
11	Characterization of E plane TEE, H plane TEE and Magic TEE
12	Measurement of reflection coefficient using transmission line bench

Term Work:

At least 8 experiments covering the entire syllabus must be given "**Batch Wise"**. The experiments can be conducted with the help of appropriate hardware setup/simulation tool (preferably open source)/breadboard and components. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments 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 the above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all the 8 experiments for examination.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL702	Mobile Communication System Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL702	Mobile Communication System Laboratory	--	--	--	--	25	25	50

Course objectives:

1. To understand the inter-dependencies of design parameters of cellular system.
2. To examine orthogonality condition for CDMA systems.
3. To Classify different types of propagation models and analyze the link budget
4. To understand the working principles of OFDM, MIMO, and Cognitive radio.

Course outcomes:

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

1. Demonstrate the effect of cellular system design parameters on system capacity and quality of service.
2. Compare and contrast trunking radio systems.
3. Examine the effect of small-scale fading parameters on the performance of radio channel characteristics.
4. Analyze link budget for various propagation path-loss models.
5. Summarize the attributes of OFDM, MIMO, and Cognitive radio.
6. Evaluate the performance of different MIMO systems.

Suggested list of experiments: (Course teacher can design their own experiments based on the prescribed syllabus)

Suggested Experiment List

- To observe the effect of velocity and direction of arrival of a vehicle on Doppler frequency.
- To observe the effect of Cluster size (N) on C/I ratio and comment on the voice quality.
- To observe the effect of incidence angle on reflection coefficient.
- To observe the effect of different propagation models on coverage distance.
- To analyze the effect of delay on blocking probability of a call for Erlang B and Erlang C systems.

- To observe the effect of C/I ratio in a sectorised cell site and perform worst case analysis for different values of N and degree of sectorisation
    - A) Worst case C/I in a 3-sector cellular system for N = 7
    - B) Worst case C/I in a 3-sector cellular system for N = 4
    - C) Worst case C/I in a 6-sector cellular system for N = 7
    - D) Worst case C/I in a 6-sector cellular system for N = 4
- To generate Pseudo noise code used in a CDMA system.
- To generate Walsh Codes using Hadamard Matrix.
- To plot Knife edge diffraction gain as a function of Fresnel diffraction parameter.
- To analyze the effect of multipath diversity (RAKE receiver) on Bit Error Rate in CDMA system.
- To plot channel capacity versus SNR for different MIMO systems.
- Simulation of OFDMA system.
- GSM Network simulation.
- CDMA Network simulation.
- Simulation of spectrum sensing using energy detection method in cognitive radio.
- Demonstration of OFDM / MIMO /Cognitive radio.

Term Work, Practical and Oral:

At least 8 experiments covering the entire syllabus must be given "**Batch Wise"**. The experiments can be conducted with the help of simulation tool (preferably open source) and breadboard and components. Teacher should refer the suggested list of experiments and can design additional experiments to acquire practical design skills. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every experiment and assignments 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 the above scheme grading and term work assessment should be done.

The practical and oral examination will be based on entire syllabus. Students are encouraged to share their experiments codes on online repository. Practical exam slip should cover all the 8 experiments for examination.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECP701	Major Project-1	--	06	--	--	3	--	3

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECP701	Major Project-1	--	--	--	--	25	25	--	50

Objective: The Project work enables the students to develop the required skills and knowledge gained during the programme by applying them for the analysis of a specific problem or issue, via a substantial piece of work which is carried out over an extended period. It also enables the students to demonstrate the proficiency in the design of a research project, application of appropriate research methods, collection and analysis of data and presentation of results.

Guidelines:

1. **Project Topic:**
   - To proceed with the project work it is very important to select a right topic. Project can be undertaken on any domain of electronics and telecommunication programme. Research and development projects on problems of practical and theoretical interest should be encouraged.
   - Project work must be carried out by the group of at least two students and maximum four and must be original.
   - Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements.
   - The project work can be undertaken in a research institute or organization/company/any business establishment.
   - Student must consult internal guide along with external guide (if any) in selection of topic.
   - Head of department and senior staff in the department will take decision regarding selection of projects.
   - Student has to submit weekly progress report to the internal guide and whereas internal guide has to keep track on the progress of the project and also has to maintain attendance report. This progress report can be used for awarding the term work marks.

- In case of industry projects, visit by internal guide will be preferred.

2. **Project Report Format:**

At the end of semester a project report should preferably contain at least following details:-

- Abstract
- Introduction
- Literature Survey
  a) Survey Existing system
  b) Limitation of the Existing system or research gap
  c) Problem Statement and Objective
  d) Scope
- Proposed System
  a) Analysis/Framework/ Algorithm
  b) Details of Hardware & Software
  c) Design details
  d) Methodology (your approach to solve the problem)
- Implementation Plan for next semester
- Conclusion
- References

3. **Term Work:**

Distribution of marks for term work shall be as follows:

a) Weekly Attendance on Project Day
b) Contribution in the Project work
c) Project Report (Spiral Bound)
d) Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

4. **Oral & Practical :**

Oral &Practical examination of Project-I should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project- I.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECC801	Optical Communication and Networks	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.					
ECC801	Optical Communication and Networks	20	20	20	80	03	--	--	100

Course pre-requisite:

FEC102 - Engineering Physics-I
FEC202 - Engineering Physics-II
ECC302 - Electronic Devices & Circuits
ECC405 - Principles of Communication Engineering
ECC501 - Digital Communication
ECC601 - Electromagnetics and Antenna

Course Objectives:

- Introduction to optical fiber network it's need, elements and fundamentals.
- To learn Parameters that limits the repeaterless transmission , its mitigation and Managing techniques.
- To learn high speed optical sources, detectors and Amplifiers.
- Study the multiplexing schemes SDH ,PDH and WDM and its applications for current and NGNs
- To have an insight into optical packet switched, bust switched and advanced networks
- Learn high speed network management techniques and challenges in its counterpart Free Space Optics

Course Outcome:

- Understand optical networks at large by identifying the types of fibers, cables and deployment.
- Design point to point optical fiber communication links using appropriate optical fibers, light sources, couplers, detectors, and multiplexers.
- Design a short haul or long-haul optical network with repeater by incorporating suitable amplifiers.
- Compare SDH, PDH and WDM techniques and implement.
- Explore concepts of designing and operating principles of modern optical communication systems and networks.
- Apply the knowledge acquired to design the next generation fiber and FSO networks for indoor and outdoor applications

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction and Basics of Optical fiber communication**	**07**
	1.1	Historical Development, Electromagnetic Spectrum, Optical Bands and Windows, Need for optical fiber communication, Fiber optic cable types and color codes, Block diagram**,** advantages and disadvantages of optical fiber cables, loss and bandwidth, applications and deployment.	
	1.2	Basics of Optical Fiber: Review of Ray theory, Wave theory, Light propagation in optical fiber Classification of optical fibers, Propagation modes, MFD in SMF	
	1.3	Fiber material, Fabrication techniques for high quality fiber: MCVD, fiber joints, fiber connectors, splices. Brief introduction to Photonic Crystal Fiber and its types.	
2.0		**Transmission Characteristic of Optical Fiber**	**07**
	2.1	Dispersion in Optical fiber, types of dispersion, Dispersion compensation techniques and dispersion measurements, Time domain and Frequency Domain measurements. Dispersion management, Need for dispersion management and Post compensation techniques.	
	2.2	Transmission losses in the optical fiber, Attenuation, Absorption losses, radiation losses and linear scattering losses, Comparison of optical fibers, Measurement of attenuation: Insertion loss, Return loss, OTDR.	
3.0		**Optical Communication Systems**	**07**
	3.1	Working principle and **c**haracteristics of sources Edge emitting LED,, Edge emitting LASER, VCEL, Spectrum, Noise, and Optical amplifiers .	
	3.2	Working principle and characteristics of detectors (PIN, APD),coherent and non-coherent detection, Intensity modulated direct detection, optical receivers, receiver performance: Bit error rate, Q function and Eye diagram	
	3.3	Point to point links system considerations, link power budget, and rise time budget	
4.0		**Optical Network System Components and Optical Networks**	**08**
	4.1	Couplers, isolators , circulators, multiplexers, Optical routers and filters - **f**iber gratings, Fabry ,switches and wavelength converters ,Add drop multiplexers	
	4.2	SONET and SDH standards, architecture of optical transport networks (OTNs), protection schemes in SONET/SDH, PDH	
	4.3	Operational principle of WDM, WDM network elements and Architectures. Types of WDM Networks, WDM Access Network, WDM Metro Networks, WDM Long Haul Networks Data center networks and Elastic Networks	
5.0		**Packet Switching and Access Networks**	**04**
	5.1	OTDM, multiplexing and de-multiplexing, synchronization and broadcast OTDM networks.	
	5.2	Network architecture overview, optical access networks. FTTH Network	
	5.3	Optical Burst switching Networks	
6.0		**Network Design and Management**	**06**
	6.1	Transmission system model, power penalty, transmitter, receiver, optical amplifiers, crosstalk.	
	6.2	Network management functions, configuration management, performance management, fault management, optical safety, and service interface	
	6.3	Introduction to free space optics and its challenges	
		Total	**39**

Text books:

1. John M. Senior, ―*Optical Fiber Communication*‖, Prentice Hall of India Publication, Chicago, 3rd Edition, 2013
2. Gerd Keiser, ―*Optical Fiber Communication*‖, Mc-Graw Hill Publication , Singapore, 4th Edition, 2012
3. T.L.Singhal –*Optical Fiber Communication Principles and Applications,* Cambridge Press, Edition 2016
4. Kumar Sivarajan and Rajiv Ramaswamy, Morgan Kauffman, *Optical Networks: A Practical Perspective,* Elsevier Publication Elsevier India Pvt. Ltd, 3rd Edition, 2010.
5. Ivan B. Djordjevin,__*Advanced Optical and Wireless Communication Systems,*Springer,Edition 2018.
6. Debasish Datta,*Optical Networks,*Oxword Cambridge University Press,2021
7. Kaushal, H.Jain, V.K. Kar,S, *Free Space Optical Communication* ,Springer,2017

Reference books

1. G Agarwal, ―*Fiber optic communication Systems*‖, John Wiley and Sons, 3rd Edition, New York 2014
2. Rajiv Ramaswami and Kumar N. Sivarajan, ―*Optical Networks: A Practical Perespective*‖, Elsevier Publication Elsevier India Pvt.ltd, 3rd Edition, 2010
3. P.E.Green, ―*Optical Networks*‖, Prentice Hall,1994
4. Biswanath Mukherjee, ―*Optical Communication Networks*‖, McGraw-Hill, 1997.
5. Le Nguyen Binh, ―*Optical Fiber Communication System: Theory and Practice with MATLAB and Simulink*‖, CRC Press, 2010
6. 2. Harry G. Parros, Communication Oriented Networks, Wiley
7. G. Agrwal, *Fiber Optic Communication Systems,* John Wiley and Sons, 3rd Edition, New York, 2014.

Further reading:

https://www.iitg.ac.in/psm/qip2015/material/Subir_Bandyopadhyay_Lecture1.pdf
https://www.rp-photonics.com/fiber_fabrication.html
www.osa.org

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.

Course Code	Course Name	Teaching Scheme (Contact Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8011	System on Chip Design	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. Of Test 1 and Test 2					
ECCDLO 8011	System on Chip Design	20	20	20	80	03	--	--	100

Course Prerequisite:

ECC303 Digital System Design
ECC503 Digital VLSI Design
ECM601 Mini Project 2B- FPGA based Project

Course Objectives:

1. To introduce modern system design using SoC
2. To understand the concept of hardware software co-design
3. To learn software and hardware design integration

Course Outcome:

After successful completion of the course student will be able to
CO1: Explain basics of SoC design
CO2: Design and verify SoC system
CO3: Explain physical design flow
CO4: Analyze routing issues in SoC Design
CO5: Interpret complex SoC design issues
CO6: Explain non-technical issues related to SoC

Module No.	Unit No.	Topics	Hrs.
1		**Introduction to SoC Design**	**08**
	1.1	The fundamental trends of SoC design, SoC design flow, The Semiconductor Economics, Challenges in SoC design	03
	1.2	Hardware system structure, Software structure, Accelerating Processors for traditional software task, System Design with multiple processor design	05
2		**System Level Design**	**05**
	2.1	Complex SoC system architecture, Processor centric SoC organization, Communication Design – Hardware and Software interconnects	03
	2.2	Balancing computation and Communication, SoC Design flow, Non-processor building block in SoC design	02
3		**RTL Synthesis**	**08**
	3.1	Review of Verilog - RTL Coding and RTL Synthesis RTL coding guidelines, Synthesizable coding style, FSM Coding style, Memory Modelling.	08
4		**SoC Verification**	**08**
	4.1	Verification technology options, Verification methodology. System level verification, block-level verification. Timing verification.	08
5		**Physical Design**	**06**
	5.1	Partitioning, Floor Planning, Placement, Routing, Goals of routing, Global routing, Physical verification and design sign-off.	06
6		**Reconfigurable SoC Arithmetic: Case Study**	**04**
	6.1	16 bit Carry Skip Adder on FPGA using LUT, 16 bit Carry Select Adder on FPGA using LUT, Divide-and-conquer 4 × 4 multiplier design using LUT	04
Total			**39**

Textbooks:

1. Engineering the Complex SOC: Fast, Flexible Design with Configurable Processors-Chris Rowen, Pesrson, 2004.
2. System on a chip verification: Methodology and Verification-Second edition, Prakash Rashinkar, Peter Paterson, Leena Singh, Kluwer Academic Publishers
3. Digital Design with RTL Design, VHDL and VERILOG- Frank Vahid, John Wiley and Sons Publisher, 2010

Reference Books:

1. System-on-a-Chip: Design and Test- Rochit Rajsuman-Artech house-2002
2. VLSI Physical design Automation: Theory and Practice, Sadiq Sait, Habib Youssef, World Scientific Publishing, 1999
3. Surviving the SoC revolution- Henry Chang, Larry Cooke, Grant Martin, Kluwer Academic Publishers-2002

E-Resources:

1. https://nptel.ac.in/content/storage2/courses/117101058/downloads/Lec-2.pdf

2. https://www.btechguru.com/engineering-videos--electrical-engineering--circuit-theory--system-on-chip-(soc)-video-lecture--1790--4--21.html

3. http://www.asic.co.in/DesignGuidlinesRTLcoding.htm#:~:text=1.1%20STYLE%20AND%20NAMING%20GUIDELINES&text=WHY%3A%20Readability%20is%20required%20to,well%20as%20transferability%20between%20designers.&text=WHY%3A%20To%20avoid%20conflict%2C%20module,%E2%80%9Ccontrol%E2%80%9D%20are%20too%20generic

Internal Assessment (20-Marks):

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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.

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:

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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 and 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 Linguistics and 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):

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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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDL OC8013	Wireless Networks	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.					
ECCDL OC8013	Wireless Networks	20	20	20	80	03	--	--	100

Course Pre-requisite:

ECC602 - Computer Communication and Networks
ECC702 - Mobile Communication System

Course Objectives:

1. To analyze the fundamental architecture, design issues and standards of wireless networks.
2. To compare Personal Area Network (PAN) technologies such as ZigBee, Bluetooth, UWB, NFC and 6LoWPAN.
3. To classify different LAN topologies and technologies and ad hoc networks.
4. To classify network protocols, ad hoc vehicle networks and Wireless MANs.
5. To understand planning and design of GSM and CDMA system in Wireless WANs.
6. To apply Wireless sensor networks concepts to develop an IoT applications.

Course Outcomes:

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

1. Explain fundamental architecture, design issues and standards of wireless networks.
2. Compare different types of Personal Area Network (PAN) technologies such as ZigBee, Bluetooth, UWB, NFC and 6LoWPAN.
3. Analyze different LAN topologies and technologies and ad hoc networks.
4. Compare various types of network protocols, ad hoc vehicle networks and Wireless MANs.
5. Evaluate the planning and design of performance of GSM and CDMA system in Wireless WANs.
6. Understand the basic network architecture of Wireless sensor networks concepts to develop an IoT applications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Overview of wireless networks**	**04**
	1.1	**Wireless Networks**: Architecture, Classifications, Switching technology, Communication Problems, Reference Models. Networking issues and Networking Standard.	02
	1.2	**Wireless Body Area Networks:** Properties, Network Architecture, Network components and Applications	02
2.0		**Wireless Personal Area Networks**	**10**
	2.1	**WPAN:** Bluetooth (802.15.1): Radio Specifications, Protocol Stack, Link Types, Security, Topologies, Applications.	02
	2.2	**ZigBee (802.15.4):** Radio Specifications, Components, Topologies, Protocol Stack, Applications.	02
	2.3	**RFID:** Radio Specifications, Architecture, Types and applications.	02
	2.4	**Near Field Communication & UWB (802.15.3 a):** Introduction and working.	02
	2.5	**6LoWPAN:** Features, Architecture, protocol stack and applications	02
3.0		**Wireless Local Area Network & Wireless Adhoc Networks**	**06**
	3.1	**Wireless Local Area Network:** Equipment, Topologies, Technologies, Applications, Main features of IEEE802.11a,b, i and n, Protocol Architecture of WLAN	03
	3.2	**Wireless Adhoc Networks**: Features, advantages & Applications **Mobile Adhoc Networks:** Network Architecture, MAC Protocol.	03
4.0		**Wireless Metropolitan & Vehicular Adhoc Networks**	**05**
	4.1	**WMAN(IEEE802.16):**Introduction, WMAN Network Architecture, Network Protocols, Broadband Wireless Networks, Applications	03
	4.2	**Vehicular Adhoc Networks (VANETs):** Characteristics, Protocols & Applications	02
5.0		**Wireless Wide Area Networks**	**06**
	5.1	Planning and design of Wireless Networks, Radio design for a cellular Network	04
	5.2	Receiver sensitivity, Link budget for GSM and CDMA Systems, HSDPA	02
6.0		**Advanced Technologies of Wireless Networks**	**08**
	6.1	**Wireless Sensor Networks:** Network Architecture, Design Considerations, Network Protocol Stack, and Applications	04

	6.2	**Wireless Mesh Network:** Network architecture, Protocols, technologies & Applications	02
	6.3	**Internet of Things:** IoT Conceptual Frame work, Architecture, Technology & Examples. M2M Communication	02
		Total	**39**

Text Books & References:

1. Vijay K. Garg, "Wireless Communication and Networking", Morgan -Kaufmann Series in Networking—Elsevier
2. Kazem Sohraby, Daniel Minoli, and Taieb Znati, "Wireless Sensor Networks: Technology, Protocols, and Applications", Wiley Student Edition
3. Dr SunilkumarS. Manvi, Mahabaleshwar S. Kakkasageri, "Wireless and Mobile Networks Concepts and Protocol"Wiley India Pvt Ltd
4. Raj Kamal, "Internet of Things Architecture & Design Principles" Mcgraw Hill

Internal Assessment (20-Marks):

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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. Weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
5. **Total 04 questions** need to be solved.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8014	Web Design	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 8014	Web Design	20	20	20	80	03	--	--	100

Course pre-requisite:

ETS: 305 – Skill development lab Java
ETC: 405 - Skill development lab Python

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.
5. To use web services in web application development

Course Outcome:
After successful completion of the course students will be able to:
1. Design web pages using HTML5 and CSS3.
2. Apply the concepts of client-side validation and scripts to static web pages using JavaScript and its framework.
3. Build responsive web pages using front-end framework Bootstrap.
4. Develop a web application using appropriate web development framework.
5. Understand working of web services

Module No.	Unit No.	Topics	Hrs.
1.0		**INTRODUCTION TO WWW**	**03**
	1.1	Understanding web system architecture, understanding 3 - tier web architecture. Clients, Servers and Communication, The Internet, Basic Internet protocols, World wide web, HTTP Request Message, HTTP Response Message, Web Clients, Web Servers	
2.0		**CLIENTSIDE PROGRAMMING PART I**	**05**
	2.1	**HTML:** Basic structure of an HTML5 document, Creating an HTML5 document, Markup 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	
	2.2	**CSS:** Concept of CSS, Creating Style Sheet, CSS Properties, CSS Styling 4 (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)	
3.0		**CLIENTSIDE PROGRAMMING PART II**	**03**
	3.1	**Bootstrap** 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.	
4.0		**WEB DEVELOPMENT WITH JAVA**	**12**
	4.1	**Server-side programming Java Servlets**: Java Servlet Architecture, Servlet Life Cycle, Form GET and POST actions, Session Handling, Understanding Cookies,	
	4.2	**Client-side programming: 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, Handling Events.	
	4.3	**Client-side programming: JavaScript framework jQuery** jQuery: jQuery Basics, jQuery Getters and Setters, Altering Document Structure, Handling events with jQuery, Animated Effects, Utility functions, jQuery Selectors and Selection Methods,	
5.0		**SERVERSIDE PROGRAMMING**	**12**
	5.1	MVC architecture - Introduction and applications, Server side-scripting – Laravel Framework Managing Your Project Controllers, Layout, Views, and Other Assets.	
	5.2	Introduction to PHP, PHP Tags, Adding Dynamic content, accessing form variables, identifiers, user-declared variables, Data types, Constants, Operators, Control structures, Conditionals, Iteration constructs, using arrays, string manipulation and regular expressions, reusing code and writing functions.	
	5.3	Designing and creating your web database, Accessing MySQL database from the Web with PHP, Session Control in PHP	
	5.4	Introduction to AJAX: AJAX design basics, AJAX vs Traditional Approach, Rich User Interface using Ajax	

6.0		WEBSERVICES	03
	6.1	Introduction to Web Services: The definition of web services, basic operational model of web services (SOAP and REST), tools and technologies enabling web services, benefits and challenges of using web services.	
	6.2	Web Services Architecture: Web services Architecture and its characteristics, core building blocks of web services, standards and technologies available for implementing web services, web services communication, basic steps of implementing web services	
		Total	**39**

Text Books :

1. "Web Technology Black Book", Dreamtech Press, First Edition, 978-7722- 97
2. WEB TECHNOLOGIES A Computer Science Perspective Jeffrey C. Jackson Duquesne University
3 Developing Java Web Services, R. Nagappan, R. Skoczylas, R.P. Sriganesh, Wiley India, rp 2008
4. Learning Bootstrap Aravind Shenoy Ulrich Sossou PACKT PUBLISHING

Reference Books

1. Ralph Moseley, M.T. Savliya , "Developing Web Applications", Willy India, Second Edition,
2. 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)
3. Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward Benson, Wiley publications. https://ebooks-it.org/0470082801-ebook.htm
4. Jennifer Kyrnin, "SAMS Teach Yourself Bootstrap in 24 hours", 1st edition, Pearson Education.
5. Martin Bean, "Laravel 5 Essentials", PACKT Publishing Ltd
6. Harvey & Paul Deitel & Associates, Harvey Deitel and Abbey Deitel, "Internet and World Wide Web - How To Program", Fifth Edition, Pearson Education, 2011.
7. Achyut S Godbole and Atul Kahate, "Web Technologies", Second Edition, Tata McGraw Hill, 2012.
8. Thomas A Powell, Fritz Schneider, "JavaScript: The Complete Reference", Third Edition, Tata McGraw Hill, 2013.
9. David Flanagan, "JavaScript: The Definitive Guide, Sixth Edition", O'Reilly Media, 2011
10. Steven Holzner, "The Complete Reference – PHP", Tata McGraw Hill, 2008
11. Mike Mcgrath, "PHP & MySQL in easy Steps", Tata McGraw Hill, 2012.
12. J. Millman and A. Grabel, "Head First HTML and CSS", 2nd edition, O" Reilly..
13. Ben Frain, "Responsive Web design with HTML5 and CSS3", PACKT Publishing Ltd.
14. L. Welling and L. Thomson, "PHP and MySQL Web Development", 4th edition, Adison Wesley Professional.

Digital Material:

1. www.w3schools.com

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4. **Total 04 questions** need to be attempted.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8015	RF Design	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 8015	RF Design	20	20	20	80	03	--	--	100

Course Pre-requisite:

1. Electromagnetic and Antenna
2. Principles of Communication Engineering
3. Microwave Engineering

Course Objectives: The course should enable the students to:

1. To learn RF circuit fundamentals for designing various circuit building blocks in a typical RF transceiver
2. To learn importance of EMI/EMC

Course Outcomes:

1. Design impedance matching networks and passive RF filters
2. Design and appraise the RF amplifiers
3. Design and appraise the RF oscillators
4. Differentiate the RF mixers
5. Analyze EMI and EMC in RF circuits
6. Analyze stability of RF trans-receiver

Module No.	Unit No.	Topics	Hrs.
1.0		**RF Filter Design**	**08**
	1.1	Introduction to Periodic Structure	
	1.2	Filter design using Image parameter method (Theory and Numerical)	
	1.3	**Filter design using Insertion loss method-** Maximally flat low pass prototype, Equal ripple low pass prototype, Filter transformation and filter implementation. (Theory and Numerical)	
2.0		**Microwave Amplifier Design**	**10**
	2.1	Two-port power gain derivation, signal flow graph(SFG) and stability criterion (Theory and Numerical)	
	2.2	**Single stage amplifier design**: Design for maximum gain, design for specified gain, low noise amplifier design (Theory and Numerical)	
	2.3	**Power amplifier design**: Characteristics of power amplifier and classes of amplifiers, design of class A power amplifier. (Theory and Numerical)	
3.0		**Microwave Oscillator**	**06**
	3.1	One-port microwave oscillator design. (Theory and Numerical)	
	3.2	One-port microwave oscillator design. (Theory and Numerical)	
	3.3	Analysis of phase noise in oscillators	
4.0		**Microwave Mixer**	**05**
	4.1	**Mixers:** Characteristics, Various types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, Image reject mixers and other types of mixers	
5.0		**Electromagnetic Interference in RF circuits**	**04**
	5.1	**Introduction**: Natural and Nuclear Sources of EMI, EMI From Apparatus and Circuits. Quantification of Communication System EMI	
	5.2	**Elements of Interference** Including Antennas, Transmitters, Receivers and Propagation. Electronic Equipment And System EMI Concepts. Examples Of EMI Coupling Modes	
	5.3	**Mode of coupling**: Common-Mode coupling , Differential mode coupling, and other coupling mechanisms (Power supply and victim amplifiers)	
6.0		**Electromagnetic Compatibility**	**06**
	6.1	**For Achieving EMC**: Grounding, Bonding, Shielding Effectiveness, EMI Diagnostics And Fixes: Techniques Used In EMI Diagnostics Fixes, troubleshooting.	
	6.2	**Instruments, Tools, used to measure Electromagnetic Field (Radiated and Conducted Emission)**: voltage and current probe, LISN, CDN, Clamp, Field probes, Spectrum analyzer, Oscilloscope, EMI Receiver	
	6.3	**Electromagnetic Noise specification**: Surge, EFT (Electrical Fast transients), PFMF, Radiated and conducted susceptibility, Voltage and dips interruption, Ring wave, Damped oscillatory wave	
	6.4	**EMC Specifications, Standards And Measurements**: A Discussion of the Genesis of EMC documentation including a historical Summary, The Rationale, and A Review of MIL-Std., FCC And CISPR Requirements	
		Total	**39**

Text Books:

1. David Pozar, “Microwave Engineering”, Wiley Publication (Fourth Edition)
2. Ludwig R. and Bogdanov G., “RF Circuit Design”, Prentice Hall

3. Jack Smith, "Modern Communication circuits", Tata McGraw Hill
4. W. Prasad Kodali, "Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models", Wiley-IEEE Press (Second Edition)
5. David. A. Weston, "Electromagnetic Compatibility principles and applications", Marcel Dekker (Second Edition)
6. MARK I. MONTROSE EDWARD M. NAKAUCHI, "Testing for EMC compliance: Approaches and Techniques"

Reference books

1. Guillermo Gonzalez, "Microwave Transistor Amplifiers Analysis and Design "Prentice Hall. (Second Edition)
2. M. L. Sisodia, G. S. Raghuvanshi, " Microwave Circuits and Passive Devices", New Edge International Publisher(First Edition)
3. Clayton R. Paul, "Electromagnetic Compatibility", John Wiley & Sons. (Second Edition)

Useful Links:

1. www.nptelvideos.in
2. https://nptel.ac.in/courses/108/106/108106138/
3. https://freevideolectures.com/course/4367/nptel-microwave-theory-techniques

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-1). 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. 4.**Total 04 questions** need to be attempted.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8021	Autonomous Vehicles	03	--	--	03	--	--	03

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Exam Duration (in Hrs.)	Term Work	Practical And Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
ECCDLO 8021	Autonomous Vehicles	20	20	20	80	03	--	--	100

Course Pre-requisite:
ECCDLO5015 : Sensor Technology
ECC603 : IPMV
ECC604 : ANNFL
ECCDLO7012 : Deep Learning

Course Objectives:
1. Introduction to Autonomous vehicles/SDC (Self Driving Cars), advantages and challenges in SDC's.
2. Gain Knowledge about the Sensors in SDC's.
3. Understand the in- vehicle communication aspects in SDC's
4. Understand perception and localization in SDC.
5. Get to grips with planning and control in SDC.
6. To know the various applications of SDC's.

Course Outcome:
After successful completion of the course student will be able to
1. Understand fundamentals of SDC (Self Driving Cars).
2. Compare different types of Sensors in SDC's.
3. Illustrate different protocols of In - vehicle communication for SDC's.
4. Identify perception and localization in SDC's.
5. Analyze planning and control in SDC.
6. Evaluate different applications and algorithms in SDC's.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction**	**04**
	1.1	Introduction to Autonomous Vehicles /Self Driving cars (SDC), Benefits of SDCs, Challenges in Current Deployment.	
	1.2	Levels of Autonomy	
2.0		**Sensors in Autonomous Vehicles**	**06**
	2.1	Camera (3D and stereo), LiDAR, Sensor Fusion	
	2.2	Passive Perception with Sonar and Millimeter Wave Radar	
	2.3	Vehicle-to-Everything Infrastructure	
3.0		**In-Vehicle Communication Systems**	**08**
	3.1	CAN: Introduction and architecture	
	3.2	CANopen: Introduction and architecture	
	3.3	FlexRay protocol: Introduction and architecture	
	3.4	Introduction to Operating System for SDC's.	
4.0		**Perception and Localization in SDC**	**09**
	4.1	Introduction to Computer vision in SDC. Artificial eyes VS human eyes. Four pillars of autonomous driving: Perception, Localization, Planning and Control.	
	4.2	Perception: Object Detection and Line Lane detection Object/ obstacle Detection: Comparison of 2D and 3D object detection. Overview of ML algorithms for obstacle detection-Histogram of Oriented Gradients (HOG), Support Vector Machine (SVM). Object detection using deep learning algorithm: Architecture of YOLO	
	4.3	Line Lane Detection: Introduction to Semantic Segmentation, architecture, overview of different semantic segmentation architecture.	
	4.4	Localization: Introduction to GNSS, GNSS error analysis, Visual Odometry, SLAM Self-Learning: Implementation of YOLO for object Detection, Implementation of semantic segmentation for images.	
5.0		**Planning and Control in SDC**	**06**
	5.1	Planning and Control: Architecture of planning and control, Traffic Prediction and routing.	
	5.2	Behavioral decision, Motion Planning and feedback control.	
6.0		**Applications of SDC**	**06**
	6.1	DragonFly Model: Sensor Configuration and Software Architecture	
	6.2	Enabling Commercial Autonomous Space Robotic Explorers: Sensor configuration and its working.	
	6.3	Algorithm for YOLO object detection: Detecting objects in images and Detecting objects in videos	
		Total	**39**

Textbooks:

1. Sumit Ranjan, Dr. S. Senthamilarasu - Applied Deep Learning and Computer Vision for Self-Driving Cars , Packt Publishing Ltd. 2020.
2. Shaoshan Liu, Liyun Li , Jie Tang, Shuang Wu, Jean-Luc Gaudiot - Creating Autonomous Vehicle System , Second Edition , Morgan & Claypool Publishers , 2018.
3. William Ribbens - Understanding- Automotive-Electronics , Butterworth-Heinemann Publisher , Fifth Edition, 1998.

Reference Books:

1. Markus Maurer ,J. Christian Gerdes, Barbara Lenz , Hermann Winner - Autonomous Driving Technical, Legal, Social Aspects , Springer Open, 2015.
2. Shaoshan Liu - Engineering Autonomous Vehicles and Robots, Wiley, 2020.

E-Resources:

1. Open Innovation in EVs: A case study of Tesla Motors
   https://www.diva-portal.org/smash/get/diva2:635929/FULLTEXT01.pdf

2. Autonomous vehicles Research report by MRCagney
   https://drive.google.com/drive/folders/1nxROagqwDKUpVMDLFPPgG7_DKakuyItf

3. Reinventing Safety: A Joint Approach to Automated Driving Systems Mercedes-Benz and Bosch
   https://www.daimler.com/documents/innovation/other/vssa-mercedes-benz-and-bosch.pdf

Online Courses

1. https://digitaldefynd.com/best-self-driving-cars-courses/
2. https://www.classcentral.com/course/intro-self-driving-cars-13140

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.

Course Code	Course Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8022	Satellite and Nano Satellite Communication	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test1 and Test 2					
ECCDLO 8022	Satellite and Nano Satellite Communication	20	20	20	80	--	--	--	100

Prerequisites:

- Analog Communication
- Digital Communication

Course objectives:

- To understand the basics of satellite communications and different satellite orbits
- Provide an in-depth understanding of satellite communication system operation, launching techniques, and earth station technology
- To Analyze and evaluate satellite link design
- To review structure design, payload and space segment related to Nano satellite.

Course outcomes:

After successful completion of the course student will be able to

- Understand the basic concepts of satellite communication system and orbital parameters.
- Explain various satellite sub-systems, earth station technologies and launching mechanisms.
- Analyze and evaluate link budget and various performance parameters of satellite signal for proper communication.
- Understand Nano satellite's structure design, payloads, Thermal control system and space segment

Module No.	Unit No.	Topics	Hrs.
1.0		**Overview of Satellite Systems, Orbits and Launching**	**08**
	1.1	An overview of space and classification of satellite, orbital elements: apogee and perigee heights, semi-major axis, eccentricity, and mean anomaly, argument of perigee, inclination and right ascension of the ascending node, polar orbiting satellites, Kepler's first, second and third law, Orbital perturbations, effects of a non-spherical earth, atmospheric drag.	
	1.2	Sub-satellite point, predicting satellite position, antenna look angels, polar mount antenna, limits of visibility, near geostationary orbits, earth eclipse of satellite, sun transit outage.	
	1.3	Selection of launching site, launch window, zero and non-zero degree latitude launching, sea launch, Launchers: Polar Satellite Launch Vehicle (PSLV), Geostationary Satellite Launch Vehicle (GSLV), Reusable launch vehicles (RLV),Sounding rockets, Fuels used for launch Vehicles.	
2.0		**Space Segment**	**04**
	2.1	Satellite configuration, transponder sub-system, antenna sub- system, AOC sub-system, TT&C sub-system, power sub-system,thermal sub-system.	
	2.2	Reliability and quality assurance.	
3.0		**Earth Station**	**03**
	3.1	Design consideration.	
	3.2	General configuration: block diagram, receive only type earth, transmit-receive type earth station, antenna system, feed system, tracking system, LNA and HPA.	
4.0		**Satellite Losses and Links**	**10**
	4.1	Atmospheric losses, ionospheric losses, transmission losses, feeder losses, antenna misalignment losses, rain attenuation, other impairments, antenna polarization, polarization of satellite signals, cross polarization discrimination, ionospheric depolarization, rain depolarization and ice depolarization, Isotropic radiated power and link budget.	
	4.2	System noise, antenna noise, amplifier noise temperature, amplifiers in cascade, noise factor, noise temperature of absorptive networks, overall system noise temperature and carrier to noise ratio.	
	4.3	Saturation flux density, input back off, earth station HPA, output back off and satellite TWTA output.	
	4.4	Effects of rain, uplink rain-fade margin, downlink rain-fade margin, combined uplink and downlink C/N ratio and intermodulation noise.	
5.		**Overview of nano satellite**	**06**
	5.1	Introduction: Important transformation, Review of nano satellite, Global economics related to it, Evolution of nano satellite, ISRO's small satellite program and future scenario.	
	5.2	Payloads for nano satellite: Types of payloads: Earth observation payload, communication payload and scientific payload. Design considerations for payloads.	
	5.3	Nanosatellite structures: Function of satellite structure, Types of structure designs: Skin frame structure, Truss structure, Monocoque cylinders and Skin stringer structure, Overview for building of structure and materials for structures.	

6.		Space segment for nano satellite	08
	6.1	Thermal control system (TCS) implementation in nano satellite and it's testing for verification of TCS. Power system design for nano satellite.	
	6.2	Function and design consideration of Deployment mechanisms, Critical elements in deployment mechanisms, Overview of types of deployment mechanisms.	
	6.3	On board Computer and digital electronics (OBC): Block diagram of typical OBC, Overview of OBC Software and hardware, Telemetry and telecommand, Attitude control electronics	
	6.4	Quality, Quality assurance, product assurance and reliability analysis for Nano satellite	
		Total	**39**

Text Books & References:

1. Dennis Roddy, ‒Satellite Communications‖, 4th Ed., Mc. Graw-Hill International Ed. 2009.
2. M. Richharia, ‒Satellite Communication Systems Design Principles‖, Macmillan Press Ltd. Second Edition 2003.
3. R. N. Mutangi, ― Satellite Communication‖, Oxford university press, 2016.
4. Gerard Maral and Michel Bousquet, ‒Satellite Communication Systems‖, 4th Edition Wiley Publication
5. Gerard Maral, ―VSAT Networks‖, John Willy & Sons
6. Space technology Veterans, Quintessence of Nano satellite technology (small is big), Planet aerospace India,2020.
7. Timothy Pratt, Charles Bostian, and Jeremy Allmuti, ‒Satellite Communications‖, John Willy & Sons (Asia) Pvt. Ltd. 2004
8. Wilbur L. Pritchard, Henri G. Suyderehoud, and Robert A. Nelson, ‒Satellite Communication systems Engineering‖, Pearson Publication

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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8023	Network Management in Telecommunication	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 8023	Network Management in Telecommunication	20	20	20	80	03	--	--	100

Course pre-requisite:

ECC602- Computer Communication Networks

Course Objectives:

1. To understand the concepts of network management in Telecommunication (NMT), architectures and protocols.
2. To familiarize the student with the design, analysis, operation and management of modern data communications networks.
3. To provide the student with a working knowledge of the types of communication network management systems and their strengths and limitations in solving various information network management problems.

Course Outcome:

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

1. Explain the need for interoperable network management and analyze the trends and development of the Telecommunications Network Management.
2. Demonstrate broad knowledge of fundamental principles and technical standards underlying NMT.
3. Describe the concepts and architecture behind standards-based network management associated with SNMP and CMIP.
4. Apply basics of telecommunication, networking and information technologies and architect and implement networked informative systems.
5. Continuously improve their knowledge of technology and communication skills.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction of Network Management**	**6**
	1.1	Introducing Network Design Concepts: Case histories on network, system and service management, Network design based on economy and SLA-based services. Challenges of IT managers	
	1.2	Network Management: Goals, organization and functions	
	1.3	Network management architecture, organization network and management perspectives	
2.0		**OSI Network Management**	**6**
	2.1	Network Management standards	
	2.2	OSI Network Management model	
	2.3	Network Management layers	
	2.4	ISO Network Management functions	
	2.5	Communication model and functional model	
	2.6	Abstract Syntax Notation One (ASN.1): Terminology, symbols, and conventions. TLV encoding structure	
3.0		**Internet Management**	**10**
	3.1	**SNMP model**: SNMP Organizational model, System overview, Information model, Management of Information Base	
	3.2	**SNMP v1**: SNMP Communication model- SNMP architecture, Administrative model, SNMP Protocol specifications, SNMP operations, SNMP Functional model	
	3.3	**SNMPv2**: Major changes in SNMPv2, SNMPv2 architecture, SNMPv2 Management Information Base, SNMPv2 protocol, Compatibility with SNMPv1	
	3.4	**SNMPv3**:Key features, SNMPv3 architecture, SNMPv3 applications, Security, security model, message format, SNMPv3 User- based Security Model, Access control (VACM)	
	3.5	**RMON:** What is RMON? RMON 1, RMON 2	
4.0		**Telecommunication Management Networks(TMN)**	**4**
	4.1	Definition of TMN , TMN framework, TMN functional model	
	4.2	TMN Conceptual model, OSI functionality in TMN	
	4.3	TMN management services architecture and TMN implementation	
5.0		**Network Management Tools and Applications**	**9**
	5.1	System Utilities for Network Management: Basic tools, SNMP tools and Protocol analyzer	
	5.2	Network Statistics and Measurements: Traffic load, Protocol statistics, Data and Error statistics	
	5.3	NMS Design: Functional requirements, NMS Client design and NMS Server architecture, Distributed Management approaches	
	5.4	Network Management Systems: Commercial and Open-source NMSs	
	5.5	Network Management Applications: Fault, Configuration, Accounting, Performance and Security (FCAPS)	
	5.6	Event Correlation Techniques: Rule-based reasoning, Model-based reasoning, Case-based reasoning, Codebook, State Transition Graph model and Finite State Machine model	

	5.7	Report Management, Policy-based Management and Service Level Management	
6.0		**Broadband Network Management**	**4**
	6.1	Broadband networks and services, ATM Technology – VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN	
	6.2	ATM Network Management – ATM network reference model, Integrated Local Management Interface, role of SNMP and ILMI in ATM	
	6.3	ATM Management Information Base, M1, M2, M3, M4 interfaces	
		Total	**39**

Text books

1. Mani Subramaniam, *Network Management Principles and Practice*, New Delhi: Pearson, 2010.
2. Alexander Clemm, *Network Management Fundamentals*, Cisco Press, December 2006, ISBN-13: 978-158720137.
3. Benoit Claise and Ralf Wolter, *Network Management: Accounting and Performance Strategies*, CISCO Press, 2007.
4. J. Richard Burke, *Network Management: Concepts and Practice, A Hands-On Approach*,Pearson Education India, 2008, ISBN-13: 978-8131718490.
5. Salh Aiidarons, Thomas Plevoyak, *Telecommunications Network Technologies and Implementations*, Eastern Economy Edition, New Delhi:IEEE Press, 1998.
6. Henry Haojin Wang, *Telecommunication Network Management*, McGraw Hill, 1999.

Online Learning Resources:-

1. https://www.youtube.com/watch?v=liBB_Q7Go5k
2. https://www.youtube.com/watch?v=xdUjwlyyi9U
3. https://www.youtube.com/watch?v=aQGeSDauRso
4. https://nptel.ac.in/courses/117/101/117101050/
5. https://nptel.ac.in/courses/106/105/106105183/

Internal Assessment (20-Marks):

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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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8024	Microstrip Antenna	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 8024	Microstrip Antenna	20	20	20	80	03	--	--	100

Course Prerequisite:

1. **Electromagnetics and Antenna**
2. **Microwave Engineering**

Course Objectives:

In the course, Students will be introduced to :

1. Fundamental parameters and characteristics of Microstrip Antennas(MSA)
2. Design and analysis of Rectangular and Circular MSA.
3. Different compact and broadband techniques of MSA.
4. Circularly Polarized MSA's and various applications in wireless communication systems.

Course Outcomes:

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

1. Apply the fundamental parameters of MSA.
2. Analyze Rectangular and Circular MSA.
3. Identify various compact and broadband methods of MSA.
4. Examine the methods of circular polarization.
5. Compare various applications of MSA.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Microstrip Antennas**	**05**
	1.1	Types of MSA's, Characteristics of MSA's, Advantages and Disadvantages, Applications of MSA's.	01
	1.2	Reflection coefficient, VSWR, Return loss, Impedance mismatch, VSWR Bandwidth, Gain, Directivity, Antenna efficiency, E-Plane and H-Plane radiation pattern, Co and Cross polarization, Specific absorption rate (SAR), Axial ratio.	02
	1.3	Feeding Techniques, brief introduction to Methods of Analysis, Surface waves, Various substrates with dielectric constant for MSA.	02
2.0		**Design of Rectangular Microstrip Antenna (RMSA)**	**08**
	2.1	Design considerations of RMSA: Resonant frequency, Voltage and Current variation, Radiation Pattern, Calculation of effective dielectric constant, actual and effective length, width, feed point location.	04
	2.2	Parametric Study of RMSAs : Effect of - feed point location, width of RMSA(W), height of substrate(h), dielectric constant(Ɛr), probe diameter, finite ground plane, loss tangent.	03
	2.3	Analysis of Higher order modes of RMSA	01
3.0		**Design of Circular Microstrip Antenna (CMSA)**	**08**
	3.1	Design considerations of CMSA: Resonant frequency, Input Impedance and Voltage Distribution, Radiation Pattern, Calculation of effective dielectric constant, actual and effective radius, feed point location.	06
	3.2	Parametric Study of CMSAs : Effect of loss tangent	01
	3.3	Analysis of Higher order modes of CMSA	01
4.0		**Compact and Broadband Techniques**	**08**
	4.1	Compact Techniques for RMSA and CMSA:Introduction, Compact Shorted RMSA, Partially Shorted RMSA, Effect of Dimensions of RMSA with a Single Shorting Post, Effect of the Position of the Single Shorting Post.	04
	4.2	Broadband Techniques for RMSA and CMSA: Planar Multiresonator configurations (Radiating and Non-radiating Gap coupled concept), Electromagnetically coupled MSA's, Stacked Multiresonator Rectangular Patches on Thick Substrates, U slot technique.	04
5.0		**Circularly Polarized MSAs**	**05**
	5.1	Methods to achieve Circular Polarization in MSA : single feed and dual feed.	03
	5.2	Design procedure for single feed circularly polarized MSA (RMSA & CMSA).	02
6.0		**Applications of MSA**	**05**
	6.1	Introduction: Wearable and Fractal Antennas for wireless communication systems, MIMO Patch Antenna, Reconfigurable Antenna, Implanted Antennas in the medical field.	05
		Total	**39**

Text Books:

1. Girish Kumar, K. P. Ray, Broadband Microstrip Antennas, Artech House, 2003.
2. Constantine A. Balanis, Antenna Theory: Analysis and Design, John Wiley Publication 4th Edition.
3. Sabban, Albert. Wearable Communication Systems and Antennas for Commercial, Sport and Medical Applications. IOP Publishing 2018. https://dx.doi.org/10.1088/2053-2563/aade55
4. Abed, M. J. Abu-AlShaer, and A. M. Jawad, "Fractal Antennas for Wireless Communications", in Modern Printed-Circuit Antennas. London, United Kingdom: IntechOpen, 2020 [Online]. Available: https://www.intechopen.com/chapters/71491 doi: 10.5772/intechopen.90332
5. Sharawi Mohammad S., Printed MIMO antenna engineering, Artech House Publishers, 2014.
6. J. T. Bernhard, Reconfigurable Antennas. San Rafael, CA, USA: Morgan and Claypool Publishers, 2007.

7. Rahmat-Samii, Yahya, Kim, Jaehoon, Implanted Antennas in Medical Wireless Communications. United States: Morgan & Claypool Publishers, 2006. https://doi.org/10.2200/S00024ED1V01Y200605ANT001

Reference books

1. Ramesh Garg, Prakash Bhartia, Inder J. Bahl, A. Ittipiboon, Microstrip Antenna Design Handbook, Artech House, 2001.
2. Kin-Lu Wong, Compact and Broadband Microstrip Antennas, John Wiley & Sons Inc, United States, 2002.
3. Kai Fong Lee, Kwai Man Luk, Hau Wah Lai, Microstrip Patch Antennas, World Scientific; 2nd edition.

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 the number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of a total **of 06 questions**, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on the 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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 8025	Augmented and Virtual Reality	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 8025	Augmented and Virtual Reality	20	20	20	80	03	--	--	100

Prerequisite: Programming Language, Computer Graphics

Course Objectives: The course aims:

1. To learn the underlying concepts of Augmented and Virtual Reality and primitives of computer graphics.
2. To understand the use of hardware devices in AR-VR system.
3. To understand the tracking system in AR.
4. To apply concept of calibration and registration of different components in AR system
5. To design AR-VR applications.
6. To understand the use of AR-VR in interdisciplinary immersive applications

Course Outcomes: On successful completion of this course, learner /student will be able to:

1. Identify and compare different Virtual and Augmented Reality Technologies and apply modelling techniques.
2. Identify and use AR-VR hardware components.
3. Apply concepts of Computer Vision for tracking in AR Systems.
4. Apply calibration techniques and registration for components in AR.
5. Design AR-VR application
6. Apply insights of AR-VR in different applications.

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Augmented and Virtual Reality**	**05**
		Definition and Scope, A Brief History of Augmented and Virtual Reality, AR-VR Architecture, Challenges with AR-VR, AR-VR systems and functionality, Types of Augmented Reality Application (Location Based AR Apps Marker-Based AR Applications). Understanding Virtual Space and Geometry: coordinate systems, Geometric Modelling, 2D transformations, 3D rotation and 6 degree of freedom, View Transformation, projective transformation, Related fields: MR, XR and ubiquitous computing and their comparison.	
2.0		**Visual Physiology, perception and Interaction**	**05**
		Mechanics of Sight: the visual pathway, spatial vision and depth cues. Display fundamentals, optical architecture. Augmenting displays. Multimodal Displays; Visual Perception; Spatial Display Model; Visual Displays. Mechanics of hearing, audio displays. Augmented and Virtual reality Hardware	
3.0		**Tracking and Computer Vision for AR**	**10**
		Characteristics of Tracking Technology; Stationary Tracking Systems; Mobile Sensors; Optical Tracking; Sensor Fusion; Marker Tracking, infrared tracking, Natural feature tracking by detection.	
4.0		**Calibrations and Registration**	**06**
		Camera projection and setup for AR. Camera calibration techniques. Registration	
5.0		**AR-VR Application Development**	**07**
		AR-VR Application Requirements, Software engineering requirements, AR-VR Design Principles, Data Flow, Scene Graphs; Developer Support: Parameter Configuration, Tools used in AR-VR development.	
6.0		**Applications of AR-VR and Human Factors, Legal and Social Considerations**	**06**
		Applications of AR-VR in: Edutainment, Medical, Military, Production and Manufacturing, Navigation, Astronomical Observation, E-commerce; What are Human Factors, Physical Side Effects, Visual Side Effects, Legal Considerations, Moral and Ethical Considerations.	
		Total	**39**

Textbooks:

1. John Vince, “Virtual Reality Systems”, Pearson publication
2. Tony Parisi, “Learning Virtual Reality”, O’REILLY’
3. Dieter Schmalsteig and Tobias Hollerer, “Augmented Reality- Principles and Practice”, Pearson Education, Inc. 2016 Edition.
4. Chetankumar G Shetty, “Augmented Reality- Theory, Design and Development”, Mc Graw Hill, 2020 Edition.
5. Alan B. Craig, “Understanding Augmented Reality – Concepts and Applications”, Morgan Kaufmann, Elsevier, 2013 Edition.

References:

1. Borko Furht, “Handbook of Augmented Reality”, Springer.
2. Erin Pangilinan, Steve Lukas, and Vasanth Mohan, “Creating Augmented and Virtual Realities-Theory and Practice for Next-Generation Spatial Computing”, O’Reilly Media, Inc., 2019 Edition.
3. Jens Grubert, Dr. Raphael Grasset, “Augmented Reality for Android Application Development”, PACKT Publishing.

Online References:

1. www.nptel.ac.in
2. www.coursera.org

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.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 8011	Project Management	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.					
ILO 8011	Project Management	20	20	20	80	03	--	--	100

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, GANTT chart. Introduction to Project Management Information System (PMIS).	8
04	**Planning Projects:**	6

	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	
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
Total		39

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, 7th Ed.
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
1. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 8012	Finance Management	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.					
ILO 8012	Finance Management	20	20	20	80	03	--	--	100

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; Liquidity	09

	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
Total		39

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	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 8013	Entrepreneurship Development and Management	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.					
ILO 8013	Entrepreneurship Development and Management	20	20	20	80	03	--	--	100

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., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc	08

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
Total		39

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. 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	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 8014	Human Resource Management	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.					
ILO 8014	Human Resource Management	20	20	20	80	03	--	--	100

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	7

	• Perception: Attitude and Value, Effect of perception on Individual Decision-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 **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	10
Total		39

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	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 8015	Professional Ethics and CSR	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.					
ILO 8015	Professional Ethics and CSR	20	20	20	80	03	--	--	100

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 Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	08

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
Total		39

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 Bidyut Chakrabarty, Routledge, New Delhi.

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 8016	Research Methodology	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.					
ILO 8016	Research Methodology	20	20	20	80	03	--	--	100

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	**08**

	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	
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**
Total		39

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	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 8017	IPR and Patenting	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.					
ILO 8017	IPR and Patenting	20	20	20	80	03	--	--	100

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, Plant variety 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) active in 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 of getting a patent	07

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 Publication etc, Time frame and cost, Patent Licensing, Patent Infringement **Patent databases:** Important websites, Searching international databases	07
Total		39

Assessment:

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End Semester Theory Examination:
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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
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15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 8018	Digital Business Management	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.					
ILO 8018	Digital Business Management	20	20	20	80	03	--	--	100

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
Total		39

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.**

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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
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Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ILO 8019	Environmental Management	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.					
ILO 8019	Environmental Management	20	20	20	80	03	--	--	100

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
Total		39

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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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
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7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL801	Optical Communication and Networks Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Practical and Oral	Total
		Internal assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
ECL801	Optical Communication and Networks Laboratory	--	--	--	--	25	25	50

Course Objectives:

1. To make students understand and familiarize with different types of optical fibers.
2. To enable the students to measure the fundamental parameters such as numerical aperture, losses dispersion for single mode and multimode fibers
3. Expose the students to realize the dynamic change in the network performance when various sources, Amplifiers, detectors, components and fibers are incorporated.
4. In depth exposition to the point-to-point link, metro network,WDM network and DWDM Network
5. To understand the basic concepts and challenges in free space optical systems

Course Outcome:

On completion of this lab course the students will be able to:

1. Acquire proficiency in identifying the different types of fibers and understanding their properties.
2. To measure the losses, dispersion and compensation techniques in all optical network.
3. Learn to design all optical network with amplifiers and modern lasers for error free transmission.
4. To design or implement point to point optical fiber network, WDM or DWDM Network.
5. To design free space optical system with atmospheric impairments and propose mitigation technique for minimum BER.

Suggested Experiment List

- Calculation of Numerical aperture for SMF and MMF
- Calculation of dispersion for given fiber and its measurement
- Calculation of link Loss for given link
- Performance analysis of Single mode fiber
- Performance analysis of multimode fiber
- Performance Analysis of Optical Link with Different Sources
- Performance Analysis of Optical Link with Different Detectors
- Performance Analysis of Optical Amplifier

- Designing of point-to-point optical network using tools or software
- Designing of Metro network/WAN using tools or software
- Designing of WDM network using tools or software
- Designing of FSO using tools or software

Note: Small Project on implementation of indoor fiber optical network or free space optical network can be considered as a part of term-work.

Term Work:

At least 08 Experiments including 02 simulations covering entire syllabus must be given during the "Laboratory session batch wise". Computation/simulation-based experiments are also encouraged. The experiments should be students centric and attempt should be made to make experiments more meaningful, interesting and innovative. Application oriented one mini-project can be conducted for maximum batch of four students.

Term work assessment must be based on the overall performance of the student with every experiments/tutorials and mini-projects (if included) are 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.

The practical and oral examination will be based on entire syllabus.

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Pracs	Tutorial	Total
ECP 801	Major Project-II	--	12	--	--	6	--	6

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test2	Avg. Of Test 1 and Test 2					
ECP 801	Major Project-II	--	--	--	--	50	100	--	150

Objective: The primary objective is to meet the milestones formed in the overall project plan decided in Project - I. The idea presented in Project -I should be implemented in Project -II with results, conclusion and future work. The project will culminate in the production of a thesis by each individual student.

Guidelines:

Project Report Format:

At the end of the semester the student needs to prepare a project report which should be prepared as per the guidelines issued by the University of Mumbai. Along with the project report a CD containing: project documentation, Implementation code, required utilities, Software_s and user Manuals need to be attached.

Term Work:

Student has to submit weekly progress report to the internal guide and the internal guide has to keep a track on the progress of the project and also has to maintain the attendance report. This progress report can be used for awarding the term work marks. In case of industry projects, visit by internal guide will be preferred to get the status of project. Distribution of marks for term work shall be as follows:

a) Weekly Attendance on Project Day
b) Project work contributions as per objective
c) Project Report (Hard Bound)
d) Term End Presentation (Internal)

The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

Oral & Practical:

Oral & Practical examination of Project- II should be conducted by Internal and External examiners approved by University of Mumbai. Students have to give presentation and demonstration on the Project-II.