AC - 05-07-2022
Item No. 6.30 (R)

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)

AC - 05-07-2022
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UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Final Year in Bachelor of Electronics and Telecommunication Engineering**
2	Eligibility for Admission	**After Passing Third Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~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: 2022-2023**

Date 13-06-2022

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 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-2

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

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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):

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 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

Internal Assessment (20-Marks):

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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
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/

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 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

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 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

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 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.

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 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):

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 8012	Natural Language Processing	03	--	--	03	--	--	03

Course Code	Course Name	Examination Scheme							
		Theory Marks				Exam Duration (Hrs.)	Term Work	Practical and Oral	Total
		Internal Assessment			End Sem. Exam.				
		Test1	Test2	Avg.					
ECCDLO 8012	Natural Language Processing	20	20	20	80	03	--	--	100

Course Pre-requisite:

-

Course Objectives:

1. To understand natural language processing and to learn how to apply basic algorithms in this field.
2. To get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics.
3. To design and implement applications based on natural language processing

Course Outcomes:

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

1. Have a broad understanding of the field of natural language processing.
2. Understand the mathematical and linguistic preliminaries necessary for various processes in NLP
3. Be able to Design, implement and test algorithms for NLP problems
4. Perform Word-Level, Syntax-Level and Semantic-Level Analysis
5. Develop basic understanding of Pragmatics in NLP
6. Be able to apply NLP techniques to design real world NLP applications

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction to Natural Language Processing**	**06**
	1.1	The need of NLP. Generic NLP system, Levels of NLP	02
	1.2	Stages in building a Natural Language Processing System. Challenges and ambiguities in NLP Design	04
2.0		**Mathematical and Linguistic Preliminaries**	**06**
	2.1	Probability Theory, Conditional Probability and Independence, Bayes Rule, Random Variables, Probability Distributions, Statistics, Counting, Frequency, Mean and Variance	04
	2.2	English Grammar, Parts of Speech, Phrase Structures	02
3.0		**Word Level Analysis**	**06**
	3.1	Tokenization, Segmentation, Lemmatization, Edit Distance, Collocations, Porter Stemmer, N-gram Language Model	04
	3.2	Morphological Analysis, Derivational and Reflectional Morphology	02
4.0		**Syntax-Analysis**	**08**
	4.1	Tag set for English, Penn Tree bank, Introduction to Parts of Speech Tagging (POST)	02
	4.2	Markov Processes, Hidden Markov Models (HMM)	02
	4.2	Parts of Speech Tagging using Hidden Markov Models, Viterbi Algorithm	04
5.0		**Semantic Analysis**	**08**
	4.1	Lexical Semantics, ambiguous words, word senses, Relations between senses: synonym, antonym, reversives, hyponym, hypernym, meronym, structured polysemy, metonymy, zeugma	04
	4.2	Introduction to WordNet, gloss, synset, sense relations in WordNet. Cosine distance between documents. Word sense disambiguation.	04
6.0		**Pragmatics and applications of NLP**	**05**
	6.1	Reference resolution: Discourse model, Reference Phenomenon, Syntactic and Semantic Constraints on co reference	03
	6.2	Applications of NLP: Categorization, Summarization, Sentiment Analysis, Named Entity Recognition, Machine Translation, Information Retrieval, Question Answer System	02
		Total	**39**

Text Books:

1. Daniel Jurafsky, James H. Martin, Speech and Language Processing‖ Second Edition, Prentice Hall.
2. Christopher D. Manning 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):

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
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):

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
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

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 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):

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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. 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):

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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 (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):

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 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:

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.

REFERENCE BOOKS:

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell
6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,

12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi**,** IPR: Drafting, Interpretation of Patent Specifications and Claims**,** New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

Course Code	Course Name	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.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

References:

1. A textbook on E-commerce**,** Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002
3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, Vinocenzo Morabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective -DOI:10.1787/9789264221796-en OECD Publishing

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:
Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
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3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

REFERENCES:

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management, T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
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.