Shri Guru Gobind Singhji Institute of Engineering and Technology, Vishnupuri, Nanded

DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Curriculum Structure of B. Tech.
(With effective from 2021-2022)

Semester VII						
Course Code	**Name of the course**	**L**	**T**	**P**	**Credits**	
					Th	**Pr**
PCC-EC401	Microwave Engineering	03	--	02	03	01
PCC-EC402	Electronic Instrumentation	03	--	02	03	01
PEC-EC4** / OEC-EC4**	Elective-III	03	--	02	03	01
PEC-EC4** / OEC-**4**	Elective-IV	03	--	02	03	01
HMC-EC4**	Elective-V	02	--	--	02	--
SII-EC411	Industrial Training Seminar	--	--	02	--	01
	Total	**14**	--	**10**	**19**	
Semester VIII						
Course Code	**Name of the course**	**L**	**T**	**P**	**Credits**	
					Th	**Pr**
PRJ-EC412	Project	--	--	24	--	12
PEC-EC4**/ OEC-EC4**	Elective-VI	03	--	--	03	--
PEC-EC4**/ OEC-EC4**	Elective-VII	03	--	--	03	--
	Total	**06**	--	**24**	**18**	

L – No. of Lecture Hours/week, T – No. of Tutorial Hours/week, P – No. of Practical Hours/week

B.Tech.(EXTC)	Contact Hours	Credits
TOTAL	54	37

Elective-III, IV (Any TWO from the following)		**Elective-V (Any ONE from the following)**	
PEC-EC403	Data Communication and Networking	HMC-EC409	Entrepreneurial Economics
PEC-EC404	Analog and Mixed Signal VLSI Design	HMC-EC410	Patent Law for Engineers and Scientists
PEC-EC405	Embedded Operating System		
OEC-EC406	Wavelets and TF Decomposition		
OEC-EC407	Artificial Intelligence and Neural Networks		
OEC-EC408	Digital Image Processing		

Elective-VI, VII (Any TWO from the following)	
PEC-EC413	Mobile & Wireless Communication
PEC-EC414	Multimedia System
PEC-EC415	Optical Communication Engineering
OEC-EC416	Internet of Things
OEC-EC417	Machine vision and Learning
OEC-EC418	Data Mining And Data Warehousing

Note: *1. Elective-IV: Student can choose a course from Program Elective / Open Elective offered by department / Institute Open Elective (Offered by any other department).*
2. Elective-VI and VII will be operated in MOOC / Flipped Classroom mode.

SEMESTER VII

PCC-EC-401	Microwave Engineering (Cr-4, L-3,T-0 P-1)

Teaching scheme:		Examination scheme:
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	2 hrs/week	Mid Semester Examination : 30 Marks
Credit	4	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:

1.	Design and evaluate impedance matching networks.
2.	Analyze wave propagating properties of guided wave structures, coaxial line, parallel plate, micro strip, strip line, rectangular and circular waveguides, and coupled lines.
3.	Apply the Smith chart to evaluate microwave networks.
4.	Design, evaluate and characterize of different microwave devices.
5.	Design and analyze the linear and cross-filed microwave tubes.

Course Outcomes: On successful completion of this course, students will be able to

1.	Justify the importance of impedance matching.
2.	Perform the transmission line analysis.
3.	Compare and analyze the wave propagation from various transmission mediums.
4.	State the key features of the microwave devices.
5.	Visualize the architecture and understand the working principle of microwave tubes.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	12	11	10	12	10	-	-	-	-	-	-	-	15	13	10
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	**Introduction (02 hours)** History of Microwaves, Microwave frequency bands, Microwave devices, Microwave systems, General applications of microwaves.
Unit 2	**Microwave transmission lines (08 hours)** Introduction, transmission line equations and solutions, Reflection coefficient and transmission coefficient Standing wave and standing wave ratio, Line impedance and Admittance, Impedance matching using stub line, application of smith chart in solving transmission line problems.
Unit 3	**Electromagnetic plane waves (08 hours)** Introduction, Electric and magnetic wave equation, Poynting theorem, Uniform plane waves and reflection, Plane wave propagation in free space and lossless dielectric, plane wave propagation in lossy media.
Unit 4	**Microwave waveguide and components (08 hours)** Introduction, Rectangular waveguide and circular waveguide, Microwave cavities, Microwave hybrid circuits, Directional couplers, circulator and isolator. Introduction to strip lines, Micro strip lines, parallel strip lines, coplanar strip lines, shielded strip lines.
Unit 5	**Transferred electron devices (04 hours)** Gunn diode, RWH theory, Microwave generation and amplification, LSA diode.
Unit 6	**Avalanche transit time devices (04 hours)** Read diode, IMPATT diode, TRAPATT diode, BARITT diode.
Unit 7	**Microwave linear and crossed field tubes (06 hours)** Klystron, Reflex klystron, Helix Traveling-Wave Tubes (TWTs), Magnetron oscillators.
Text/Reference Books:	
1.	Samuel Y Liao, Microwave Devices and Circuits, Third Edition, Phil.
2.	David M Pozar, Microwave Engineering, Wiley Publication.
3.	Robert E. Collin, Foundations for microwave engineering, John Wiley & Sons Inc.

PCC-EC-402	Electronic Instrumentation (Cr-4, L-3,T-0 P-1)	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	2 hrs/week	Mid Semester Examination : 30 Marks
Credit	4	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
	To acquaint student with:
1.	Electronic measurement and its parameters.
2.	Types of sensors and transducers.
3.	Electrical parameter measurement using bridges
4.	Motivate students for verification of electronic systems using electronic measurement and instrumentation.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Electronic measurement methods and its parameters.
2.	Sensors and transducers and its applications.
3.	Students should able to design system to measure different physical quantities.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO (total)	7	6	5	7	6	-	-	-	-	-	-	-	9	8	6
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Measurement and error: Generalized Measurement System, Accuracy and Precision, Significant Figures, Types of Errors, Statistical Analysis, Probability of Errors, Limiting Errors, etc.
Unit 2	**Primary sensing elements and transducers:** Definition and Classification of Transducers, Characteristics and Choice of Transducers, Potentiometer, Strain Gauges, RTD, Thermister, Thermocouple, LVDT, RVDT, Capacitive Transducer, Piezo-Electric Transducer, Hall Effect Transducers, Photo Emissive Cell, Photoconductive Cell, Photovoltaic Cell, Photo Diode, Photo Transistor, Microphone, Loud Speaker and their Applications.
Unit 3	Electronic Instruments for Measurement of Basic Parameters: DC Meter, AC Voltmeter Using Rectifiers, True RMS Responding Volt-Meter, Electronic Multi-Meter, DVM, etc.
Unit 4	Bridge Measurement: Wheatstone Bridge, Kelvin Bridge, Maxwell Bridge, Hay Bridge, Schering Bridge, Wien Bridge, etc.
Unit 5	Oscilloscopes: Block Diagram of General Purpose Oscilloscope, Dual Beam Oscilloscope, Dual Trace Oscilloscope, Lissajous Patterns, Digital Storage

	Oscilloscope, etc.
Text/Reference Books:	
1.	Alan S. Morris, "Principles of Measurements & Instrumentation", PHI.
2.	A.D. Helfrick & W.D. Cooper, "Modern Electronic Instrumentation & Measurement Techniques", PHI.
3.	Oliver Cage," Electronic Measurement", McGraw Hills.
4.	Clyde F. Coombs, "Electronic Instruments Handbook", McGraw Hills.
5.	Hewlett Packard, Tektronics, Advantest, Aplab, "Application Notes on Measurement".
6.	A.K. Sawhney, "A course in Electrical and Electronic measurements and Instrumentation", Dhanpat Rai and Company.
NPTEL course:	
	https://onlinecourses.nptel.ac.in/noc19_ee44/preview

Program Electives / Open Electives – III, IV (Cr-4, L-3,T-0 P-1)
(Any Two from following)

PEC-EC-403	Data Communication and Networking	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	2 hrs/week	Mid Semester Examination : 30 Marks
Credit	4	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
1.	Understand the components and infrastructure that form the basis for most computer networks
2.	To know the technical aspects of data communications on the Internet
3.	Apply practical experience in network programming.
4.	Design networks based on case studies in colleges or other institutions
5.	Assess security issues in a network, Design and Evaluate short path algorithm.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Describe the components and infrastructure that form the basis for most computer networks
2.	Describe the technical aspects of data communications on the Internet
3.	Achieve practical experience in network programming.
4.	Propose network designs based on case studies in colleges or other institutions
5.	Recognize security issues in a network, Design and Evaluate short path algorithm.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	2	-	3	3	-	-	-	-	2	3	3	-	3
CO2	3	1	2	-	2	2	-	-	-	-	2	3	3	-	3
CO3	3	2	2	-	1	3	-	-	-	-	2	3	3	-	3
CO4	3	1	2	-	3	3	-	-	-	-	1	3	3	-	1
CO5	3	2	2	-	3	2	-	-	-	-	1	3	3	-	3
CO (total)	15	6	10	-	12	13	-	-	-	-	8	12	12	-	13
CO(avg)	3	1	2	-	2	2	-	-	-	-	1	2	2	-	2

Syllabus	
Unit 1	Introduction (2 hours) : Introduction to Data Communication and Networking: Uses of Computer Networks, Network Hardware, Network Software Internet Reference Models (OSI and TCP/IP)
Unit 2	Physical Layer (3 hours): Basis for Data Communication, Guided Transmission Media, Wireless Transmission Medium, Circuit Switching and Telephone Network, High Speed Digital Access.
Unit 3	Data Link Layer (4 hours): Data Link Layer Design Issues, Error Detection and Correction, Data Link Control and Protocols, Example Data Link Protocol
	Medium Access Layer (5 hours) : Channel Allocation Problem, Multiple Access,

Unit 4	CSMA, CSMA/CD, CSMA/CA.
Unit 5	Local Area Network (4 hours) : Ethernet, Fast Ethernet, Gigabit Ethernet, Wireless LAN, Blue tooth, Connecting devices:-Repeaters, Hub, Bridges, Switch, Router, Gateways, Virtual LAN, Example Networks: X.25, Frame Relay, ATM, ISDN
Unit 6	Network Layer (8 hours): Network Layer Design Issues, Routing Algorithms (Optimality principle, Static Routing Algorithms, Shortest Path, Flooding, Dynamic routing Algorithms, Distance Vector, Link State routing.), Congestion control Algorithms (Principles, Policies, Algorithms),Quality of Service (Requirements, Techniques, Integrated Services & Differentiated Services), Network Layer Protocols (IP Addressing , CIDR & NAT, IP layer protocols (ICMP, ARP, RARP, DHCP, BOOTP), IPv6)
Unit 7	Error Detection and Correction (2 hours): Introduction, Block Coding, Linear Block Codes, Cyclic Codes and Checksum.
Unit 8	Transport layer (4 hours): Transport Layer Service, Elements of Transport protocols, Internet protocols (UDP and TCP)
Unit 9	Application Layer (4 hours): DNS- Domain Name System, Electronic Mail, World Wide Web, Multimedia (Audio Compression, Streaming Audio, Voice over IP, Video Compression, Video on Demand)
Unit 10	Network Security (4 hours): Cryptography, Symmetric key Algorithms (DES, AES), Public key Algorithms-RSA, Digital Signatures, IPSec ,Firewall
Text/Reference Books:	
1.	Computer Networks by Andrew S. Tanenbaum (Fifth Edition), Pearson Education
2.	Data Communication and Networking by Behrouz A. Forouzan (Fourth Edition), Tata McGraw Hill

PEC-EC-404	Analog and Mixed Signal VLSI Design	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	2 hrs/week	Mid Semester Examination : 30 Marks
Credit	4	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
1.	To understand basics of analog devices.
2.	To explain different configurations of single stage amplifiers and their frequency response.
3.	To describe and analyze current mirrors.
4.	To represent noise in various analog circuits and its effects and removal techniques.
5.	To analyze and design OP-AMPs and other analog and mixed signal blocks and band gap references.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Basic building blocks like current/voltage sources and basic gain stages.
2.	Advanced analog circuits such as cascaded stages, cascade, differential amplifiers.
3.	OPAMPs, Band gap reference circuits.
4.	Mixed signal circuits such as S/H circuits, ADC, DAC, Sigma-Delta Converters, PLL/DLL.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ⇒ ⇓ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO (total)	9	8	8	9	8	-	-	-	-	-	-	-	12	11	8
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Introduction and Devices: Introduction to analog IC design, diode, BJT and MOSFET as analog devices, device models including parasitic capacitances.
Unit 2	Current Mirrors: Passive and active current mirrors, basic current mirrors, cascode current mirrors, active current mirrors, large and small signal analysis, common mode properties.
Unit 3	Amplifiers: Common source, source follower, common gate, cascade, folded cascode, basic differential pair, common mode response, single ended differential operation, differential pair with MOS loads, frequency response of all amplifiers, association of poles with nodes.
Unit 4	Noise and Feedback: Representation of noise in circuits, noise in single stage amplifiers and cascade stages, noise in differential pairs, noise bandwidth, general feedback considerations, feedback topologies, effect of loading, effect of feedback on noise.

Unit 5	Operational amplifiers: One stage and two stage op amps, gain boosting, common mode feedback, input range limitation, slew rate, power supply rejection, noise in op-amp, stability and frequency compensation, multi pole system, phase margin, frequency compensation, compensation of two stage op-amps, other compensation techniques.
Unit 6	Other Analog and Mixed Signal Blocks: Band gap references, supply independent biasing, temperature independent references, PTAT current generation, speed and noise issues, introduction to other analog blocks such as S/H circuits, ADC, DAC, Sigma-Delta Converters, PLL/DLL, etc.
Text/Reference Books:	
1.	Behzad Razavi, Design of Analog CMOS integrated circuits, Tata McGraw Hill Edition, 2002.
2.	Philip E Allen, Douglas R. Holberg, CMOS Analog Circuit Design, Oxford, 2002
3.	David A Johns, Ken Martin, Analog Integrated Circuit Design, Wiley Students edition, 2002.

PEC-EC-405	Embedded Operating System	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	2 hrs/week	Mid Semester Examination : 30 Marks
Credit	4	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
1.	To introduce about anatomy of Embedded operating system
2.	Acquainting about Real Time Systems and its Operating Systems.
3.	Teaching about basic Linux commands
4.	Enabling students to understand Task Managements
5.	Introducing about various scheduling policies
6.	Understand the Inter-task communication and perform Memory Management
7.	Able to understand usefulness of operating system in Embedded Applications
Course Outcomes: On successful completion of this course, students will be able to	
1.	Comprehend the basic elements of operating system
2.	Learn about the basic concepts of Real Time Operating Systems
3.	Acquire knowledge about task management
4.	Learn about IPC Synchronization
5.	Perform Memory Management in RTOS
6.	Get knowledge about tool-chain required for Embedded operating systems
7.	Learn about developing applications using Real time operating systems

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ⇒ ⇓ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO7	1	2	2	1	2	-	-	--	-	-	-	-	2	2	3
CO (total)	16	15	14	15	14	-	-	-	-	-	-	-	19	18	16
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	Embedded Linux Development Environment: Need of Linux, Embedded Linux Today, Open Source and the GPL, BIOS and Boot loader, Anatomy of an Embedded System, Storage Considerations, Embedded Linux Distributions, Processors for embedded Linux stand alone and integrated processors, Anatomy of embedded Linux setup, Booting and Initialization of Kernel. Storage considerations, Flash file systems, Execution contexts

Unit 2	Commercial embedded linux distributions, Embedded Development Environment, Cross-Development Environment, Development Tools, GNU Debugger, Tracing and Profiling Tools, Binary Utilities, Overview of Commands, File I/O (open, create, close, lseek, read, write), Process Control (fork, vfork, exit, wait, waitpid, exec),
Unit 3	Linux Kernel Construction: Linux Kernel Background, Linux Kernel Construction, Kernel Build System, Kernel Configuration, Role of a Bootloader, Bootloader Challenges. A Universal Bootloader: Das UBoot, Porting U-Boot, Device Driver Concepts, Module Utilities, Driver Methods, Linux File, System & Concepts
Unit 4	µCOS II: History and Definition of RTOS, Key Characteristics of RTOS, Features of µCOS II, Kernel structure, µCOS II RTOS services: Task management: Tasks, Task states and Control block, Task scheduling, task level context, switching, Idle task, Time management: Clock Tick, Implementing delay in RTOS, resuming the delayed task, getting system time, Placing task in ECB wait list, Removing a task from ECB, List of Free ECBs, Initializing an ECB, Making a Task Ready and wait for and event. Implementing timeout in RTOS
Unit 5	Inter-Task Communication and Synchronization: Semaphore, Creating/deleting a Semaphore, Waiting, signalling semaphore, Mutex, Creating/deleting and handling Mutex, Event flag management, Timer Interrupt Service Routines (ISR), Soft Timers, Mail box, sending / getting a message using mailbox as semaphore, message queue and its management, Memory control block. Case studies of uCOS based applications
Unit 6	Embedded Software Development, Testing Process and Tools: Embedded Software development process and tools, Host and Target Machines, Target System Tools and Image transfer, Embedded Loader, Monitor, linking and Locating Software, Getting Embedded Software into the Target System, Issues in Hardware- Software Design and Co-design. Testing on Host Machine, Simulators, Laboratory Tools, Case study of embedded system like Automatic Chocolate Vending Machine, Mobile Phone.
Text/Reference Books:	
1.	Real-Time Concepts for Embedded Systems Qing Li, Caroline Yao Elsevier
2.	Embedded Linux System Design and Development b P Raghvan, Amol Lad, Sriram Neelakandan, Auerbach Publications
3.	Jean Labrosse: MicroC/OS-II The Real Time Kernel: CMP Books, 2nd Edition
4.	Raj Kamal: Embedded Systems – Architecture: Programming and Design: TMH
5.	Operating System-Three Easy Pieces by Remzi Arpaci, Andreia Arpaci, 2015

OEC-EC-406	Wavelets and Time Frequency Decomposition

Teaching scheme:		Examination scheme:
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	2 hrs/week	Mid Semester Examination : 30 Marks
Credit	4	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:

1.	To understand the concepts and limitations of Fourier representations.
2.	Understand the terminology that are used in the wavelet literature.
3.	Explain the concepts, theory, and algorithms behind wavelets from an interdisciplinary perspective that unifies harmonic analysis (mathematics), filter banks (signal processing), and multiresolution analysis (computer vision).
4.	Understand how to use the modern signal processing tools using signal spaces, bases, operators and series expansions.
5.	Apply wavelets, filter banks, and multiresolution techniques to a problem at hand, and justify why wavelets provide the right tool.
6.	Think critically, ask questions, and apply problem-solving techniques.
7.	The objective of this course is to establish the theory necessary to understand and use wavelets and related constructions.
8.	A particular emphasis will be put on constructions that are amenable to efficient algorithms, since ultimately these are the ones that are likely to have an impact.
9.	Study the applications of wavelets in signal and image processing where time-frequency transforms like wavelets play an important role.

Course Outcomes: On successful completion of this course, students will be able to

1.	Understand the limitations of Fourier representation & terminology used in the wavelet literature.
2.	Understand the relation between MRA and filter bank
3.	Design the Haar and Daubechies wavelet
4.	Implement the discrete wavelet transform algorithms
5.	Implement the inverse discrete wavelet transform algorithms
6.	Understand and implement the wavepacket transform
7.	Able to identify where time-frequency transforms like wavelets play an important role.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	3	-	-	-	-	-	-	-	3	3	2
CO5	3	3	3	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	3	2	2	-	-	-	-	-	--	-	2	3	3
CO7	3	3	3	2	2	-	-	--	-	-	-	-	2	2	3

CO (total)	19	18	18	16	16	-	-	-	-	-	-	-	19	18	16
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	Introduction: The Origins of Wavelets-Are They Fundamentally New? Other Transforms. Why Wavelets? The concept of scale and resolution, uncertainty, History of wavelet from Morlet to Daubechies via Mallat, Different communities and family of wavelets. Fundamentals of Linear Algebra: Vector spaces, Bases, Orthogonality, Orthonormality, Projection, Functions and function spaces, Orthogonal functions, Orthonormal functions, Orthogonal basis functions.
Unit 2	Signal Representation in Fourier Fourier series, Orthogonality, Orthonormality and the method of finding the Fourier coefficients Complex Fourier series, Orthogonality of complex exponential bases, Mathematical preliminaries for continuous and discrete Fourier transform, limitations of Fourier domain signal processing. Short Time Fourier Transform (STFT) Signal representation with continuous and discrete STFT, concept of time-frequency resolution, Resolution problem associated with STFT, Heisenberg's Uncertainty principle and time frequency tiling, lacunas of STFT and why wavelet transform?
Unit 3	Discrete Wavelet Transform Haar scaling functions and function spaces, Translation and scaling of $\phi(t)$, Orthogonality of translates of $\phi(t)$, Function space V0 , Finer Haar scaling functions, Concepts of nested vector spaces, Haar wavelet function, Scaled and translated Haar wavelet functions, Orthogonality of $\phi(t)$ and $\psi(t)$, Normalization of Haar bases at different scales, Refinement relation with respect to normalized bases, Support of a wavelet system, Daubechies wavelets, Plotting the Daubechies wavelets,
Unit 4	Discrete Wavelet Transform and Relation to Filter Banks & MRASignal decomposition (Analysis), Relation with filter banks, Frequency response, Signal reconstruction: Synthesis from coarse scale to fine scale, Upsampling and filtering, Perfect reconstruction filters, QMF conditions, Computing initial sj+1 coefficients, Concepts of Multi-Resolution Analysis (MRA) and Multi-rate signal processing. Multiresolution decomposition and reconstruction of 1-D and 2-D signals. The concept of Time-Frequency filtering.
Unit 5	Designing Orthogonal Wavelet Systems-A Direct Approach Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Condition-1: Unit area under scaling function, Condition-2: Orthonormality of translates of scaling functions, Condition-3: Orthonormality of scaling and wavelet functions, Condition-4: Approximation conditions (Smoothness conditions), Designing Daubechies orthogonal wavelet system coefficients, Constraints for Daubechies' 6 tap scaling function.
Unit 6	Perfect Reconstruction: Alice cancellation and perfect reconstruction with 2-channel filter bank (Perfect reconstruction filter banks). Designing Orthogonal Wavelet Systems-A frequency domain approach: Designing 4-tap and 6-tap Daubechies wavelet coefficients. Conjugate

	Quadrature Filter Banks (CQF) and their design.
Unit 7	The wavepacket transform: Wavelet packet transform, the basis used. Signal representation using Wavelet Packet Analysis, Selection of best basis. Applications of Wavelets: An exploration of applications (this will be a joint effort between the instructor and the class). Applications of wavelets in biomedical signal and image processing and other related engineering Fields.
Unit 8	Introduction: The Origins of Wavelets-Are They Fundamentally New? Other Transforms. Why Wavelets? The concept of scale and resolution, uncertainty, History of wavelet from Morlet to Daubechies via Mallat, Different communities and family of wavelets. Fundamentals of Linear Algebra: Vector spaces, Bases, Orthogonality, Orthonormality, Projection, Functions and function spaces, Orthogonal functions, Orthonormal functions, Orthogonal basis functions.
Text/Reference Books:	
1.	K. P. Soman, K. I. Rmachandran, N. G. Resmi, "Insight into Wavelets: From Theory to Practice, (Third Edition)", PHI Learning Pvt. Ltd., 2010.
2.	C. S. Burrus, Ramose and A. Gopinath, Introduction to Wavelets and Wavelet Transform, Prentice Hall Inc.
3.	Rafael C. Gonzalez, Richard E. Woods "Digital Image Processing (Third Edition)", Pearson International Edition, 2009.
4.	John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Prentice Hall, 2007.
5.	Raghuveer M. Rao, Ajit S. Bopardikar, "Wavelet Transforms: Introduction to Theory and Applications", Pearson Education, (1998) Low Price Edition
6.	Barbara Burke Hubbard, "The World according to Wavelets – A Story of a Mathematical Technique in the making", Second Edition, Universities Press (Private) India Limited 2003, Mathematics, Copyright 1998, ISBN 81-7371-450-9, Published by Universities Press (India) Private Limited, 3-5-819, Hyderguda, Hyderabad 500 029 (AP), India.
MOOC/NPTEL Equivalent Course	
	Web Resources: http://users.rowan.edu/~polikar/WTtutorial.html http://www.wavelet.org/

OEC-EC-407	Artificial Intelligence and Neural Networks

Teaching scheme:		Examination scheme:
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	2 hrs/week	Mid Semester Examination : 30 Marks
Credit	4	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:

1.	To understand the fundamental theory and concepts of Artificial Intelligence.
2.	To provide knowledge of artificial neural network modeling, several artificial neural network paradigms, its applications and recent trends.
3.	To analyze feed forward and feedback artificial neural networks.
4.	To apply auto associative and recurrent neural networks for pattern storage and retrieval
5.	To analyze self-organizing maps

Course Outcomes: On successful completion of this course, students will be able to

1.	Understanding the basics of Artificial Intelligence, artificial neural network, their limitations, basic pattern analysis tasks such as classification and clustering, learning and adaptation using the learning rules, implementation of learning rule.
2.	Describe the concepts of feed forward neural networks using single layer and multilayer networks to solve classification problem, and its implementation, single layer feedback networks to study the concept of memory using neural networks.
3.	Analyze and implement the applications of neural networks in character recognition and control systems.
4.	Understand Auto associative neural networks, Pattern storage and retrieval, Hopfield model, recurrent neural networks
5.	Analyze Bayesian neural networks, Radial basis function networks
6.	Understand self-organizing maps and recent trends in neural networks

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO⇒ ⇓ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO (total)	16	13	12	14	12	-	-	-	-	-	-	-	17	16	13
CO(avg)	3	2	2	2	2	-	-	-	-	-	-	-	3	3	2

Syllabus	
Unit 1	Introduction to Artificial Intelligence, Brain Style Computing: Origins and Issues, Biological neural networks, Neuron Abstraction, Neuron Signal Functions, Mathematical Preliminaries, Artificial Neurons, Neural Networks and

	Architectures Pattern analysis tasks: Classification, Clustering, mathematical models of neurons, Structures of neural networks, Learning principles.
Unit 2	Feed forward neural networks: Pattern classification using perceptron, Multilayer feedforward neural networks (MLFFNNs), Pattern classification and regression using MLFFNNs, Error backpropagation learning.
Unit 3	Fast learning methods: Conjugate gradient method. Autoassociative neural networks, Pattern storage and retrieval, Hopfield model, recurrent neural networks Bayesian neural networks, Radial basis function networks: Regularization theory, RBF networks for function approximation, RBF networks for pattern classification.
Unit 4	Self-organizing maps: Pattern clustering, Topological mapping, Kohonen's selforganizing map.
Unit 5	Recent Trends in neural networks: Introduction to deep neural network, convolutional neural network, RNN, LSTM, etc.
Text/Reference Books:	
1.	Jacek Zurada, Introduction to Artificial Neural Networks, Jaico Publishing House, 1997.
2.	Satish Kumar, Neural Networks, A Classroom Approach, Tata McGraw-Hill, 2003
3.	S.Haykin, Neural Networks, A Comprehensive Foundation, Prentice Hall, 1998.
4.	C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
5.	Ian Goodfellow and Yoshua Bengio and Aaron Courville , Deep Learning, MIT Press, 2016

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	Deep Learning - Part 1 By Prof. Sudarshan Iyengar, Prof. Padmavati
1.		Artificial Neural Network and Applications	https://swayam.gov.in/nd1_noc20_cs50/preview

OEC-EC-408	Digital Image Processing	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	2 hrs/week	Mid Semester Examination : 30 Marks
Credit	4	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks
Course Objectives:		
1.	To study the image fundamentals and mathematical transforms necessary for image processing.	
2.	To study the image enhancement techniques	
3.	To study the image compression procedures	
4.	To study the image segmentation procedures	
5.	To study the Video coding and Segmentation procedures	
Course Outcomes: On successful completion of this course, students will be able to		
1.	Review the fundamental concepts of a digital image processing system and representation techniques	
2.	Analyze images in the frequency domain using Fourier and Wavelet transforms	
3.	Evaluate the techniques for image enhancement.	
4.	Categorize various compression techniques and interpret Image compression standards	
5.	Evaluate the techniques for video segmentation	

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	2	2	1	2	1	1	1	2	-	2	2	3	3	2
CO2	3	2	2	3	2	1	-	1	2	-	2	2	3	2	2
CO3	3	3	2	3	2	2	-	1	2	-	2	2	3	3	2
CO4	3	2	3	2	2	2	-	1	2	-	2	2	3	3	2
CO5	2	3	3	2	2	2		2	2		2	2	3	3	2
CO (total)	13	12	12	12	10	8	1	6	10	0	10	10	15	14	10
CO(avg)	3	2	2	2	2	2	1	1	2	0	2	2	3	3	2

Syllabus	
Unit 1	Digital Image Fundamentals-Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.
Unit 2	Image Enhancements and Filtering-Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.
Unit 3	Color Image Processing-Color models–RGB, YUV, HSI; Color transformations–formulation, color complements, color slicing, tone and color corrections; Color image smoothing and sharpening; Color Segmentation.

Unit 4	Image Segmentation- Detection of discontinuities, edge linking and boundary detection, thresholding – global and adaptive, region-based segmentation
Unit 5	Wavelets and Multi-resolution image processing- Uncertainty principles of Fourier Transform, Time-frequency localization, continuous wavelet transforms, wavelet bases and multi-resolution analysis, wavelets and Sub band filter banks, wavelet packets.
Unit 6	Image Compression-Redundancy–inter-pixel and psycho-visual; Lossless compression – Predictive, entropy; Lossy compression- predictive and transform coding; Discrete Cosine Transform; Still image compression standards – JPEG and JPEG-2000.
Unit 7	Fundamentals of Video Coding- Inter-frame redundancy, motion estimation techniques – full search, fast search strategies, forward and backward motion prediction, frame classification – I, P and B; Video sequence hierarchy – Group of pictures, frames, slices, macro-blocks and blocks; Elements of a video encoder and decoder; Video coding standards – MPEG and H.26X.
Text/Reference Books:	
1.	R.C. Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education 3rd edition 2008
2.	Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India.2ndedition 2004
3.	Murat Tekalp , Digital Video Processing" Prentice Hall, 2nd edition 2015
MOOC/NPTEL Equivalent Course	
	Digital Image Processing, Prof. P.K. Biswas, Department of Electrical Engineering IIT Kharagpur https://onlinecourses.nptel.ac.in/noc20_ee75/preview

HS/BS Elective- V (Cr-2, L-2,T-0 P-0)
(Any One from following)

HMC-EC-409	Entrepreneurial economics	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	0 hrs/week	Mid Semester Examination : 30 Marks
Credit	2	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
1.	Understand entrepreneurship
2.	Know examples of entrepreneurship
3.	Apply practical experience and traits of an entrepreneur
4.	Understand the importance of the entrepreneur's role in society
5.	Assess examples of how to serve needs in their own community through entrepreneurial action.
6.	Recognize opportunities to be entrepreneurial in their daily lives
Course Outcomes: On successful completion of this course, students will be able to	
1.	Define entrepreneurship
2.	Identify examples of entrepreneurship
3.	Articulate the traits of an entrepreneur
4.	Describe the importance of the entrepreneur's role in society
5.	Provide examples of how to serve needs in their own community through entrepreneurial action

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ⇒ ⇓ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	2	-	3	3	-	-	-	-	2	3	3	-	3
CO2	3	1	2	-	2	2	-	-	-	-	2	3	3	-	3
CO3	3	2	2	-	1	3	-	-	-	-	2	3	3	-	3
CO4	3	1	2	-	3	3	-	-	-	-	1	3	3	-	1
CO5	3	2	2	-	3	2	-	-	-	-	1	3	3	-	3
CO (total)	15	6	10	-	12	13	-	-	-	-	8	15	15	-	13
CO(avg)	3	1	2	0	2	2	-	-	-	-	1	3	3	0	3

Syllabus	
Unit 1	WHAT IS ENTREPRENEURSHIP? The Heroic Entrepreneur, Key Traits of an Entrepreneur, Discovering an Opportunity, Serving a Need, The Entrepreneurial Society,Entrepreneurship Defined
Unit 2	WHAT IS THE ENTREPRENEUR'S ROLE IN CREATING VALUE? Value is in the Eye of the Beholder, Value Must Be Produced, Creating Value and Serving Others, Shareholder vs. Stakeholder Value, Economic Growth and the Entrepreneur
	HOW CAN ENTREPRENEURS USE ECONOMICS TO MAKE BETTER

Unit 3	DECISIONS? Scarcity, Choice, Tradeoffs, Thinking at the Margin, Opportunity Cost, Decision-Making Techniques for Entrepreneurs, Using Economics to Make Better Decisions
Unit 4	HOW DOES TRADE CREATE WEALTH? Gains from Trade, Why We Exchange, Division of Labor and Specialization, Competition as Cooperation, Economic Freedom and Prosperity
Unit 5	WHAT DO PROFIT AND LOSS TELL US? Role of Prices, How Market Prices Emerge, The Function of Profits, The Importance of Loss, Profits: A Sign of Serving Others Well
Unit 6	WHAT INSTITUTIONAL FACTORS ENCOURAGE ENTREPRENEURSHIP? The Marvel of the Market,When Order Emerges, The Rules of the Game, Incentives Matter, Entrepreneurship Stifled
Unit 7	WHAT ARE THE LINKS BETWEEN ENTREPRENEURSHIP, PERSONAL CHARACTER, AND CIVIL SOCIETY? Virtue and Entrepreneurship, Connected by Commerce, Markets and Morality, Individualism & Civil Society, Business Ethics
Unit 8	MODULE 8 – HOW DO I BECOME AN ENTREPRENEUR? Getting Started, Developing Your Business Model, Advice for Young Entrepreneurs, Learning From Failure, Tools for Building Your Business
Text/Reference Books:	
1.	**THE ECONOMICS OF ENTREPRENEURSHIP-**Facilitator Guide Compiled by: Marianna Brashear Ruby Clohessy Jason Riddle William Smith
2.	**The Rising Indiapreneur: Instilling Entrepreneurial Skills Published On :** 2004, Satish Khanna
MOOC/NPTEL Equivalent Course	
	https://nptel.ac.in/courses/110/105/110105067/#

HMC-EC-410	Patent Law for Engineers and Scientists	
Teaching scheme:		**Examination scheme:**
Lecture	2 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	0 hrs/week	Mid Semester Examination : 30 Marks
Credit	2	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
1.	Understand that Intellectual property is the product or creation of the mind
2.	Understand how to protects their invention from being copied or imitated without their consent
3.	Understand Patentable subject matter
Course Outcomes: On successful completion of this course, students will be able to	
1.	File an application for patent
2.	Appear for Indain Patent Agent examination
3.	Enabled to be patent examiners and scientists

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ⇒ ⇓ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	-	-	-	1	-	3	-	1	3	3	3	-	-
CO2	3	-	-	-	-	2	-	3	-	2	3	3	3	-	-
CO3	3	-	-	-	-	1	-	3	-	3	3	3	3	-	-
CO (total)	9	-	-	-	-	4	-	9	-	6	9	9	9	-	3
CO(avg)	3	-	-	-	-	1	-	3	-	2	3	3	3	-	3

Syllabus	
Unit 1	Importance of Indian Patent Act in the field of R & D and innovation.
Unit 2	IP is an important element of the institutional fabric of an efficiently organized society. Indian Patent Act is an attempt to safeguard the rights of original contributor of ideas, concept, and creativity of individuals.
Unit 3	Indian Patent Act are regarded as a source of national wealth and mark of an economic leadership in the context of global market scenario. Created internal vigilance and enlightenment among students to generate new ideas.
Unit 4	Indian Patent Act protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.
Text/Reference Books:	
1.	THE INDIAN PATENT ACT - 1970
2.	Feroz Ali, The Law of Patents, LexisNexis
3	Ronald D. Slusky, Invention Analysis and Claiming – A Patent Lawyer's Guide, Second Edition, American Bar Association, 2012.
MOOC/NPTEL Equivalent Course	

	https://onlinecourses.nptel.ac.in/noc19_hs65/preview

SII-EC-411 Industrial Training/Seminar (Cr-2, L-0,T-0 P-2)

Based on the industrial training for duration of one month after sixth semester examination, the student shall submit a report regarding industrial training, duly certified by the authorities from industry. The assessment of the students will be based on the confidential feedback from the industry and the seminar presented by the student.

SEMESTER VIII

PRJ-EC-412 Project (Cr-12, L-0,T-0 P-24)

A project batch may consist of two or three students. At the end of semester, students will have to submit a **Project report.** Students must maintain a **Project diary** duly signed by their guides **weekly**. It is mandatory on the part of the students to submit the project diary during the internal end semester evaluation.

Program Electives / Open Electives – VI, VII (Cr-3, L-3, T-0, P-0)

(Any Two from following)

PEC-EC-413	**Mobile & Wireless Communication**	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	0 hrs/week	Mid Semester Examination : 30 Marks
Credit	3	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
1.	An understanding on functioning of various example wireless communication systems, their evolution and standards.
2.	An understanding on cellular communication system, architecture, functioning, various standards.
3.	An understanding on signal propagation in cellular environment.
4.	An ability to explain multiple access techniques for Wireless Communication
5.	An understanding on architecture, functioning, protocols, capabilities, and application of various wireless communication networks.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Demonstrate an understanding on functioning of various example wireless communication systems, their evolution, and standards.
2.	Demonstrate an understanding on cellular communication system, architecture, functioning, various standards
3.	Demonstrate an understanding on signal propagation in cellular environment.
4.	Demonstrate an ability explain multiple access techniques for Wireless Communication
5.	Demonstrate an understanding on architecture, functioning, protocols, capabilities, and application of various wireless communication networks.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2

CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	17	15	15	16	14	-	-	-	-	-	-	-	19	18	16
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	**Introduction to Wireless Communication (02 hours)** Evolution of Wireless Communication, Advantages and Disadvantages, Wireless Network Generations, Different Types of Wireless Systems, Evolution to Next-Generation Wireless Networks, and Applications.
Unit 2	**Cellular Concept (08 hours)** Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Trunking and Grade of Service, Improving Coverage and Capacity in Cellular Systems.
Unit 3	**Mobile Radio propagation (Large-Scale Path Loss) (08 hours)** Introduction to Radio Propagation, Free Space Propagation Model, The Basic Propagation Mechanisms, Reflection, Ground Reflection (Two-Ray) Model, Diffraction, Scattering, Practical link budget design using path loss model. Outdoor Propagation Models, Indoor Propagation Models.
Unit 4	**Mobile Radio propagation (Small-Scale Fading and Multipath) (08 hours)** Small-Scale Multipath Propagation, Parameters of Mobile Multipath Channels, Types of Small-Scale Fading, Rayleigh and Ricean Distribution.
Unit 5	**Equalization and diversity (06 hours)** Fundamentals of Equalizers, Linear equalizers, Non-linear equalizers, Decision feedback equalizers, MLSE. Diversity Techniques, Types of diversity.
Unit 6	**Multiple Access Techniques for Wireless Communication (06 hours)** Frequency division multiple access (FDMA), Time division multiple access (TDMA), Spread spectrum multiple access, Space division multiple access (SDMA), Packet radio, Capacity of cellular systems.
Unit 7	**Emerging Wireless Network Technologies (02 hours)** IEEE 802.11 WLAN Technology, ETSI HIPERLAN Technology, IEEE 802.15 WPAN Technology, IEEE 802.16 WMAN Technology, and Mobile Adhoc Network (MANET).
Text/Reference Books:	
1.	Theodore S Rappaport, Wireless Communications, second edition, Pearson Education
2.	Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005
3.	T L Singal, Wireless Communications, Tata McGraw Hill Education
4.	Jochen Schiller, Mobile Communications, Pearson Education

PEC-EC-414	Multimedia Systems	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	0 hrs/week	Mid Semester Examination : 30 Marks
Credit	3	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
1.	To understand multimedia information representation and relevant signal processing aspects, multimedia networking and communications, and multimedia standards especially on the audio, image and video compression.
2.	To achieve a basic understanding of multimedia systems.
3.	To evaluate more advanced or future multimedia systems.
4.	To motivate students towards developing their career in the area of multimedia and internet applications.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Understand different types of multimedia data and basics of image and video.
2.	Understand color models of image and video.
3.	Analyze and design different compression algorithms.
4.	Analyze and implement different compression standards for image and video.
5.	Understand the transmission of multimedia data over communication networks.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ➡ ⬇ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	3	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	3	3	2	-	-	-	-	-	-	-	2	3	2
CO4	2	3	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	17	16	16	16	15	-	-	-	-	-	-	-	18	18	16
CO(avg)	3	2	2	2	2	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	Introduction to multimedia and data representation: Introduction to multimedia: what is multimedia?, multimedia and hypermedia, world wide web, overview of mu1timedia software tools, fundamentals of audio, image and video processing, graphics and image data representations: graphics image data types, popular file formats, color in image and video: color science, color models in images, color models in video, fundamental concepts in audio and video.
Unit 2	Multimedia data compression: Lossless compression algorithms: introduction, basics of information theory, run-length coding, variable-length coding (VLC), dictionary-based coding, arithmetic coding, and lossless image compression.
	Lossy compression algorithms: Introduction, distortion measures, the rate-distortion theory, quantization, transform coding, wavelet-based coding, wavelet

Unit 3	packets, embedded zerotree of wavelet coefficients, set partitioning in hierarchical trees (SPIHT).
Unit 4	Image compression standards: The JPEG Standard, JPEG2000 standard, JPEG-LS standard, bilevel image compression standards
Unit 5	Basic video compression techniques: Introduction to video compression, video compression based on motion compensation, H.261, H.263, MPEG video coding I - MPEG-1 and 2: overview, MPEG-1, MPEG-2
Unit 6	Multimedia communication and retrieval: Computer and multimedia networks: basics of computer and multimedia networks, multiplexing technologies, LAN and WAN, access networks, common peripheral interfaces. content-based retrieval in digital libraries: - how should we retrieve images?, C-BIRD - a case study, synopsis of current image search systems.
Text/Reference Books:	
1.	Zi-Niam Li and Mark Drew, Fundamentals of Multimedia, Pearson, 2004.
2.	Khalid Sayood, Data Compression, PHI

PEC-EC-415	Optical Communication Engineering

Teaching scheme:		Examination scheme:
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	0 hrs/week	Mid Semester Examination : 30 Marks
Credit	3	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
1.	To learn the basic concepts of optical communication, elements of optical fiber transmission link, fiber modes configurations and structures.
2.	To understand the different kind of losses, signal distortion, SM fibers.
3.	To study the various optical sources, materials and fiber splicing.
4.	To learn the fiber optical receivers and noise performance in photo detector.
5.	To study nonlinear effects, WDM, Solitons and SONET/SDH network.
Course Outcomes: On successful completion of this course, students will be able to	
1.	Demonstrate an understanding of optical fiber communication link, structure, propagation and transmission properties of an optical fiber.
2.	Estimate the losses and analyze the propagation characteristics of an optical signal in different types of fibers.
3.	Describe the principles of optical sources and detectors.
4.	Study of the characteristics of fiber optic receivers.
5.	Design a fiber optic link based on budgets.
6.	Assess nonlinear effects.
7.	Understand, Time division multiplexed systems, Important WDM components.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ↦ ⇩ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	1	1	1	-	3	1	1	1	1	1	2	2	2
CO2	2	3	2	3	1	-	-	1	1	-	1	-	3	2	2
CO3	3	3	3	3	1	-	-	1	1	1	1	1	3	3	2
CO4	2	2	3	2	3	-	-	-	1	-	1	1	3	3	2
CO5	2	3	1	3	2	-	-	1	1	1	1	1	3	2	2
CO6	3	2	3	2	2	-	-	-	1	1	1	-	2	3	3
CO7	3	3	3	2	2	-	-	1	1	1	1	1	2	2	3
CO (total)	17	18	16	16	12	-	-	-	-	-	-	-	18	17	16
CO(avg)	2	2	2	2	1	-	-	-	1	-	1	-	2	2	2

Syllabus	
Unit 1	Overview of Optical Fiber Communication: Forms of communication systems, Electromagnetic spectrum, Evolution of optical fiber systems, Elements of optical fiber transmission link, Introduction to vector nature of light, Importance of optical fiber for communication.
Unit 2	General digital communication system, Line coding, Digital modulation formats: ASK, PSK, and QAM

Unit 3	Optical Sources: Light-emitting diodes, Laser diodes, Modal, partition and reflection noise, Power Launching and Coupling, Source to fiber power launching, lensing schemes for coupling improvement, fiber-to-fiber joints, LED coupling to single-mode fibers, fiber splicing, optical fiber connectors.
Unit 4	Photo detectors: Physical principles of photodiodes, Review of PIN diode: structure and performance, hetero-junction diode - materials systems, avalanche photodiodes, Photodetector noise, Detector noise, Detector response time, Avalanche multiplication noise
Unit 5	Optical fiber modes, Single and multimode fibers single and multi- core fibers, attenuation and dispersion.
Unit 6	Optical Receiver Operation: Optical receiver principles, Fundamental receiver operation, Digital receiver performance calculation, Pre-amplifier types, Analog receivers.
Unit 7	Nonlinear effects (SPM, XPM, FWM), Multiplexing: Polarization, Wavelength, and Time division multiplexed systems, Important WDM components
Text/Reference Books:	
1.	J. Gowar, Optical communication systems, Prentice Hall India, 1987.
2.	G. Agrawal, Nonlinear fiber optics, Academic Press, 2nd Ed. 1994.
3.	G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 1992

OEC-EC-416	Internet of Things	
Teaching scheme:		**Examination scheme:**
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	0 hrs/week	Mid Semester Examination : 30 Marks
Credit	3	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
1.	To understand the architectural overview of IoT
2.	To understand the various sensors, actuators, and embedded platforms
3.	To understand various Internet protocols for IoT
4.	To understand different cloud platform services
5.	To understand real world IoT Applications and design constraints
Course Outcomes: On successful completion of this course, students will be able to	
1.	Recognize various devices, sensors and IoT applications.
2.	Apply design concept to IoT Solutions and IoT architectures
3.	Analyse basic protocols in wireless sensor network.
4.	Design IoT applications in different domain and able to analyse their performance.
5.	Design and implementation of IoT solutions using embedded boards, sensors, actuators.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ⇒ ⇓ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	2	2	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	3
CO (total)	16	15	15	15	14	-	-	-	-	-	-	-	18	17	17
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	Introduction to IoT: Introduction, Definition and characteristics of IoT, IoT Architecture, Physical and Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The identification of Iot, About the Internet in IoT, IoT framework
Unit 2	M2M to IoT: Machine to Machine, Difference between IoT and M2M, Software defined Networks
Unit 3	Internet Communication: TCP/IP protocol suit, IP addresses, Static IP address assignment, MAC addresses, TCP/UDP ports, Application Layer protocol: HTTP
	Sensor Networks:

Unit 4	Definition, Types of sensors, Sensor characteristics, Types of actuators, Examples and working, RFID principles and components, Wireless Sensor networks: History and context, The node, connecting node, Networking nodes, WSN and IoT
Unit 5	Communication Protocols: WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, 6Low PAN, Wireless HART, NFC, Z-Wave, BLE, Bacnet, Modbus CAN, I2C,USB
Unit 6	IP based Protocols for IoT:IPV6, RPL,REST, MQTT,SMQTT, CoAP, AMQP
Unit 7	Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry pi board, Implementation of IoT with Raspberry Pi/Beagle Black board/
Unit 8	Introduction to SDN, SDN for IoT, Data Handling and Analytics, Cloud Computing, Sensor-Cloud, Fog computing, Fog Computing
Text/Reference Books:	
1.	Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Handbook-on Approach, VPT, 2014
2.	Waltenegus Dargie, Chistain Poellabauer: Fundamnetals of Wireless Sensor Network: Theory and Practice
3.	Francis daCosta, Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Apress Pub, 2013

List of Equivalent Subjects from SWAYAM/NPTEL for Credit Transfer

Sr.	Institute Course		Details of Course from SWAYAM/NPTEL
	Course Code	Title of the Course	Deep Learning - Part 1 By Prof. Sudarshan Iyengar, Prof. Padmavati
1.		**Internet of Things**	**https://nptel.ac.in/courses/106/105/106105166/**

OEC-EC-417	Machine Vision and Learning

Teaching scheme:		Examination scheme:
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	0 hrs/week	Mid Semester Examination : 30 Marks
Credit	3	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
1.	To understand Machine Vision and Learning aspects
2.	To understanding low, mid and high level Machine vision systems.
3.	To understand concepts of Machine Learning.
4.	To evaluate more advanced or future Machine Vision and Learning systems
5.	To motivate students towards developing their career in the area of Machine Vision and Learning and its applications for solving the real-world problems

Course Outcomes: On successful completion of this course, students will be able to	
1.	Students should have the skills and knowledge to develop computer vision applications using some common machine learning methods
2.	Moreover, they will be able to analyze and make objective comparison between different approaches from the state of the art
3.	Understand different types of Machine Vision systems and basics of image and video and motion analysis.
4.	Understand feature extractions of image and video
5.	Analyze and design different computer Vision Systems
6.	Understand different types of Machine Learning approaches

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ⇒ ⇓ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	2	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	2	3	2	-	-	-	-	-	-	-	3	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO6	3	2	2	2	2	-	-	-	-	-	--	-	2	3	3
CO (total)	15	13	12	14	12	-	-	-	-	-	-	-	17	16	13
CO(avg)	2	2	2	2	2	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	**Introduction:** Introduction to CV, low level and high level CV, applications of computer vision.
Unit 2	**Low and Mid-Level Machine Vision** : Image preprocessing, Noise Removal, Scale in image processing, canny edge detection, parametric edge models, edge in multi spectral image, other local preprocessing operators, adoptive neighborhood preprocessing
	Feature Extraction

Unit 3	Feature Extraction, Feature Selection, Texture and Colour, Shape representation and description, Region identification, contour based shape representation and description, region based shape representation and description, shape classes
Unit 4	Machine Learning: Knowledge representation, Machine learning approaches, Machine Learning Cycle, Supervised Learning, Statistical pattern recognition, Bays classifier, KNN classifier, Support Vector Machine, Unsupervised learning, hierarchical and nonhierarchical approach, clustering, Dimensionality Reduction, Syntactic pattern recognition, recognition as a graph matching, recognition by using neural network.
Unit 5	**Motion Analysis:** Differential motion analysis methods, optical flow analysis based on correspondence of interest points, Kalman filters.
Unit 6	**Case Studies:** Application of machine vision and learning in biomedical imaging, digital libraries, Biometrics, Surveillance.
Text/Reference Books:	
1.	Milan Sonka, V. Hlavac and Roger Boyle, "Image Processing, Analysis and Machine Vision" –Second edition, Thomson Asia Pvt. Ltd., ISBN -981 -240-061 -3.
2.	Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer Publication.
3.	R. Jain, "Computer Vision" –TMH.

OEC-EC-418	Data Mining and Data Warehousing

Teaching scheme:		Examination scheme:
Lecture	3 hrs /week	Theory
Tutorial	0 hrs/week	In Semester Evaluation : 20 Marks
Practical	0 hrs/week	Mid Semester Examination : 30 Marks
Credit	3	In Semester Evaluation after Mid Term : 20 Marks
		End Semester Examination : 30 Marks

Course Objectives:	
1.	To identify the scope and essentiality of Data Warehousing and Mining.
2.	To analyse data, choose relevant models and algorithms for respective applications.
3.	Apply data pre-processing techniques.
4.	Discover associations and correlations in given data.
5.	To develop research interest towards advances in data mining.

Course Outcomes: On successful completion of this course, students will be able to	
1.	Discuss basic concepts of Data Warehouse fundamentals, data analytics, data mining using professional language associated with data analytics and data mining.
2.	Design data warehouse with dimensional modelling and apply OLAP operations.
3.	Pre- process the data so that it can be analysed further using sophisticated data analytics and mining algorithms.
4.	Identify appropriate data mining algorithms to solve real world problems
5.	Benefit the user experiences towards research and innovation integration.

Course Articulation Matrix: Mapping of Course outcome and Program outcome

PO/PSO ⇒ ⇓ CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	3	-	-	-	-	-	-	-	3	3	2
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	2
CO3	2	3	3	3	2	-	-	-	-	-	-	-	2	3	2
CO4	2	3	3	2	2	-	-	-	-	-	-	-	3	3	2
CO5	3	3	2	3	2	-	-	-	-	-	-	-	3	2	2
CO (total)	17	16	16	16	15	-	-	-	-	-	-	-	18	18	16
CO(avg)	3	2	2	2	2	-	-	-	-	-	-	-	3	3	3

Syllabus	
Unit 1	Data Warehouse: Introduction, a Multi-dimensional data model, Data Warehouse Architecture, Data Warehouse Implementation.
Unit 2	Data Mining: Introduction, Data Mining, on what kind of Data, Data Mining Functionalities, Classification of Data Mining Systems, Major issues in Data Mining.
Unit 3	Data Preprocessing: Data cleaning, Data Integration & Transformation, Data Reduction, Discretization & Concept Hierarchy Generation, Data Mining Primitives

Unit 4	Mining Association roles in large databases: Association rule mining, mining single-dimensional Boolean Association rules from Transactional Databases, Mining Multi-dimensional Association rules from relational databases & Data Warehouses.
Unit 5	Classification & Prediction: Introduction, Classification by Decision tree induction, Bayesian Classification.
Unit 6	Other Classification Methods, Classification by Back propagation, Prediction, Classifier accuracy.
Unit 7	Cluster Analysis: Introduction, Types of data in Cluster analysis, A categorization of major clustering methods, partitioning methods, Hierarchical methods, Density-Based Methods: DBSCAN, Gridbased Method: STING; Model-based Clustering Method: Statistical approach, Outlier analysis.
Text/Reference Books:	
1.	Data Mining Concepts & Techniques, Jiawei Han Micheline Kamber, Morgan Kaufmann Publishers.
2.	Data Warehouse Toolkit, Ralph Kinball, John Wiley Publishers.
3.	Data Mining, Introductory and Advanced Topics, Margaret H.Dunham, Pearson Education.
4.	Data warehousing in the real world, A Practical guide for Building decision support systems, Sam Anahory, Dennis Murray, Pearson Education.