SCHEME OF INSTRUCTION AND EXAMINATION

B. E. (ECE)

VII–Semester

SNo	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	PC701EC	Microwave Techniques	3	-	-	3	3	40	60	3
2	PC702EC	Cellular and Mobile Communication	3	-	-	3	3	40	60	3
3	PC703EC	GRNSS and Augmentation System	3	-	-	3	3	40	60	3
4	**Professional Elective-IV**		3	-	-	3	3	40	60	3
	PE711EC	Testing and testability								
	PE712EC	Artificial Neural Networks								
	PE713EC	Wireless Sensor Networks								
5	OE70X ##	Open Elective-II	3	-	-	3	3	40	60	3
Practicals										
6	PC751EC	Antenna and Microwave Lab	-	-	2	2	3	25	50	1
7	PW761EC	Project Work - I	-	-	6	6	-	50	-	3
8	PW762EC	Summer Internship *	-	-	-	-	-	50	-	2
		Total	**15**	**-**	**08**			**325**	**350**	**21**

*Students have to undergo summer internship of 6 Weeks duration at the end of semester VI and Evaluation will be done in VII - Semester

List of Open Electives

Subject Code	Title of the subject
OE 701 BM	Basic Medical Equipment
OE 702 BM	Artificial Intelligence In Health Care
OE 701 CE	Green Building Technology
OE 702 CE	Plumbing Technology
OE 701 CS	Cloud Computing
OE 702 CS	Data Base Management Systems
OE 701 EC	Fundamentals of Embedded Systems
OE 702 EC	Basics of IoT
OE 701 EE	Optimization Techniques
OE 702 EE	Non Conventional Energy Sources
OE 701 ME	Nano Technology
OE 702 ME	Startup Entrepreneurship

SCHEME OF INSTRUCTION AND EXAMINATION

B. E. (ECE)

VIII–Semester

SNo	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	MC 801 CE	Environmental Science	3	-	-	3	3	40	60	0
2	MC 80X HS	Mandatory Course–II	3	-	-	3	3	40	60	0
3	MC 80X HS	Mandatory Course–III	3	-	-	3	3	40	60	0
Practical's										
4	PW861EC	Project Work – II	-	-	12	**12**	-	50	100	6
		Total	**9**	**-**	**12**	**21**	**9**	**170**	**280**	**6**

Mandatory Course List

S.No.	Subject Code	Subject Title
1	MC 802 HS	Intellectual Property rights
2	MC 803 HS	English for technical paper writing
3	MC 804 HS	Constitution of India
4	MC 805 HS	Essence of Indian Traditional Knowledge
5	MC 806 HS	Yoga

Note : Students are required to do any **TWO MANDATORY COURSES** from the above list to fulfill the requirements for the award of degree.

PC 701 EC	MICROWAVE TECHNIQUES					
Pre-requisites	PC 403 EC- Electromagnetic Waves and Transmission Lines		**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

	Course Objectives:
	The course is taught with the objectives of enabling the student to:
1	To learn field calculations between parallel planes.
2	To analyze and study rectangular and circular wave guides using field theory.
3	To Understand the operation of passive waveguide components.
4	To Analyze microwave circuits using scattering parameters.
5	To study the construction and to understand principal of amplification/Oscillation at microwave frequency.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand electromagnetic wave propagation in parallel plane waveguides.
CO-2	Understand electromagnetic wave propagation in rectangular and circular waveguides and resonators.
CO-3	Understand the formulation of Scattering Matrix and define them for various microwave components.
CO-4	Learn principle of operation and applications of specialized microwave vacuum tubes.
CO-5	Distinguish between transfer electron devices from ordinary low frequency semiconductor devices and learn basic modes of operation of Gunn Diode and its applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	3	2	-											
CO-2	2	3												
CO-3	3	-	3		1	1	1	1						
CO-4	2	2				1			1			1		
CO-5	2	2					1	1						

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I
Introduction, Microwave Spectrum and Bands, Advantages and Applications of Microwaves, Waves between parallel planes, TE, TM, TEM Waves characteristics, Velocity of propagation, Group and Phase velocity, Wave Impedance, Attenuation in parallel plate guides.

UNIT–II
Rectangular Waveguides: Rectangular waveguides, TM and TE waves, Impossibility of TEM wave in waveguides, Wave Impedance, Attenuation in Rectangular waveguides, Circular Waveguides: Solution of wave equations in cylindrical coordinates, Characteristics of TM and TE modes. Microwave Cavities: Rectangular and Circular Cavity Resonators, Quality factor and applications of cavity resonators.

UNIT–III
Microwave circuit concepts, Introduction to scattering parameters. Properties and S-parameters of reciprocal components – E and H Plane Tees, Magic Tee, Directional Coupler. Non-Reciprocal Components: Ferrites – Composition and Faraday Rotation; Ferrite Components – Isolators, Gyrators and Circulators. S- Parameters of Isolator and Circulator.

UNIT-IV
High Frequency limitations of conventional tubes, Two cavity Klystron, Bunching by velocity modulation, Small signal theory of bunching, Effect of grid interception and de-bunching. Tran‘s admittance, Reflex Klystron, Mathematical theory of bunching, Admittance spiral and condition of oscillation. Principle of operation, construction and characteristics of TWT Amplifier, Backward wave oscillator (qualitative treatment only).

UNIT – V
Principle of operation, construction and characteristics of multi-cavity magnetron, Microwave Solid-state devices: Introduction, Classification and Applications. TEDs — Introduction, Gunn Diode — Principle, RWH Theory, Characteristics, Basic Modes of Operation, Oscillation Modes, Introduction to Avalanche Transit-Time Devices.

SUGGESTED READING:

1	Samuel Y. Liao , Microwave Devices and Circuits, 3rd Edition(2013), Prentice Hall of India, New Delhi.
2	R.E.Collin, Foundations for Microwave Engineering, 2nd Edition(2011), Mc Graw Hill.
3	Annapurna Das and Sisir K Das “Microwave Engineering” 1st Edition(2000), Tata McGraw-Hill.
4	Rizzi P, “Microwave Devices and Circuits”, 3rd Edition(2003), Pearson Education.
5	M. L. Sisodia, G. S. Raghuvanshi, Microwave Circuits and Passive Devices 1st Edition(1995), Wiley Eastern Ltd. and New Age International Publishers Ltd.

PC 702 EC	CELLULAR AND MOBILE COMMUNICATIONS					
Pre-requisites	Communication Theory		**L**	**T**	**P**	**C**
			3	**-**	**-**	**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Understand basics of Cellular systems, their generations and Characteristics of Mobile Communications.
2	Understand the Frequency reuse mechanism for Mobile operations and Co-Channel interference concepts
3	Understand the Mobile signal Coverage in different terrains and Lee models
4	Understand the working of Antennas at Cell-site and at Mobile units.
5	Understand the various Handoff mechanisms and Concept of Dropped calls

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Able to analyze the various operational features of Mobile Communication Systems
CO-2	Able to deal with the Mobile communication system designs of Frequency re-use and Interference Factors
CO-3	Able to carry out the Design aspects of Mobile signal coverage over different terrains
CO-4	Able to analyze the different Cell-site and Mobile antennas for different applications
CO-5	Able to characterize the Handoffs mechanisms

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	2	2	3	2	3	2	-	-	-	-	-	-		
CO-2	3	2	3	3	3	2	-	-	-	-	-	-		
CO-3	3	3	3	3	3	2	-	-	-	-	-	-		
CO-4	3	3	2	2	3	2	-	-	-	-	-	-		
CO-5	3	3	3	2	3	2	-	-	-	-	-	-		

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction to Cellular Mobile Communications: History of Mobile cellular: AMPS system (First-generation systems), Second-generation System, 3G Systems, 4G Systems, 5G Systems, mm-wave mobile communications for 5G cellular, Pico-cells and micro-cells in mobile technology. Other Cellular-like Systems, Spectrum Efficiency Considerations.

Basic Cellular systems, Circuit-Switched and Packet-Switched Systems, Performance criteria, Voice quality, Data quality, Picture quality, Service quality.

Uniqueness of Mobile Radio Environment, Description of Mobile Radio Transmission Medium, Model of Transmission Medium, Delay spread and Coherence Bandwidth..

UNIT–II

Frequency Reuse Concept and Cellular system Components: Concept of Frequency reuse channels, Frequency reuse schemes, Frequency reuse distance, Number of Customers in the System, Co-Channel Interference Reduction Factor, Desired C/I from a Normal case in an Omni-directional antenna System, Handoff mechanism, Cell splitting, Consideration of the Components of Cellular Systems, Antennas, Switching equipment and Data Links.

UNIT–III

Cell Coverage: General Introduction, Ground Incident angle and Ground Elevation angle, Ground Reflection angle and Reflection point, Obtaining the Mobile Point-to-Point Model (Lee Model), A standard condition, Obtain Area-to-Area Prediction model, The Phase difference between a direct path and ground-reflected path, A general formula for Mobile Radio Propagation, Propagation over water or Flat open area, Between Fixed stations, Land-to-Mobile transmission over water, Obtain Path loss from a Point-to-Point Prediction Model in Non-obstructive condition and obstructive condition, Form of a Point-to-Point Model, General Formula and its Merit

UNIT-IV

Cell-Site and Mobile Antennas: Antennas at Cell-site, Omni-directional antennas, Directional antennas, Location antennas, Set-up Channel antennas, Space Diversity Antennas at cell site, Umbrella-Pattern Antennas, Interference reduction antennas, Smart antennas, types and applications, MIMO system, SDMA technology.

Mobile Antennas, Roof-mounted antenna, Glass-Mounted antenna, High-gain antenna, Horizontally and Vertically oriented Space-Diversity Antennas.

UNIT – V

Handoff and Dropped Calls: Value of Implementing Handoffs, Types of Handoff, Prioritizing handoff, Umbrella cell approach, Initiation of Hard Handoff, Delaying a Handoff, Forced Handoffs. Cell-site Handoff only, Intersystem Handoff.

Introduction to Dropped Call Rate and Soft Handoffs.

SUGGESTED READING:

1	William C.Y. Lee, "Wireless and Cellular Telecommunications", 3rd International edition, McGraw Hill, 2006
2	Theodere S. Rappaport, "Wireless Communications, Principles and Practice", 2nd edition, Prentice Hall, 2003.
3	Gordon L. Stuber. "Principles of Mobile Communications", 3rd edition, Springer Publications, 2011.

PC 703 EC	GRNSS AND AUGMENTATION SYSTEM					
Pre-requisites			**L**	**T**	**P**	**C**
			3	**-**	**-**	**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To explain the basic principle of GPS and its operation
2	To make the students to understand signal structure, errors, coordinate systems
3	To make the students understand the GPS navigation and observation files.
4	Highlight the importance of integrating GPS with other systems.
5	To demonstrate the principle of DGPS and to facilitate the various augmentation systems.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand the principle and operation of GPS.
CO-2	Frame various coordinate systems for estimating position.
CO-3	Estimate the various errors and their effect on position estimation
CO-4	Use GPS in various fields such as navigation, GIS etc.
CO-5	Apply DGPS principle and can also analyze various augmentation systems.

Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	2	-	1	-	-	-	-	-	-	-	-	-		
CO-2	2	-	1	-	-	-	-	-	-	-	-	-		
CO-3	2	3	3	3	-	-	-	-	-	-	-	-		
CO-4	2	3	3	3	2	-	-	-	-	-	-	-		
CO-5	2	3	3	3	2	-	-	-	-	-	-	-		

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

GPS fundamentals: Trilaiteration, Transit, GPS Principle of Operation, Architecture: Space, Control and User Segments, Operating frequencies, Orbits, Keplerian elements.

UNIT–II

GPS and UTC Time, Signal structure, SPS and PPS services, C/A and P-Codes, Geometry of ellipsoid, geodetic reference system, Geoid and Ellipsoid and Regional datum: Earth Centered Earth Fixed (ECEF) and Earth Centered Inertial (ECI) Coordinate systems and World Geodetic System (WGS 84) datum, Types of receivers, Spoofing and Anti-spoofing.

UNIT–III
GPS Error Models: Ionospheric error, Tropospheric error, Ephemeris error, Clock errors, Satellite and receiver instrumental biases, Multipath; GPS Navigation and Observation data formats, Various DOPS.

UNIT-IV
GPS Modernization: Future GPS satellites, New signals and their benefits, New Control Segment, Principle of operation of DGPS, architecture and limitations, GPS Applications: Surveying Mapping Marine, air and land Navigation, Military and Space Application. GPS Integration with Geographic Information System (GIS), Inertial Navigation System (INS), Pseudolite and Cellular.

UNIT – V
Other GRNSS: GLONASS, GALILEO, QZNSS, CNSS and IRNSS System. Relative advantages of SBAS, SBAS features and Principle of operation of Wide area augmentation system (WAAS), GPS Aided GEO Augmented Navigation (GAGAN) and Ground Based Augmentation System (GBAS), Local Area Augmentation System (LAAS).

SUGGESTED READING:

1	Ahmed El-Rabbany, "Introduction to GPS", Artech House Publishers, 2/e, Boston 2006.
2	Elliot D Kaplan and Christopher J Hegarty, "Understanding GPS principles and applications", Artech House Publishers, 2/e Boston & London 2005.
3	B.Hofmann-Wellenhof, H.Lichtenegger, and J.Collins, "GPS Theory and Practice, Springer Verlog, 5/e, 2008.

PE 711 EC	TESTING AND TESTABILITY (PE-IV)					
Pre-requisites	Digital system Design, Integrated Circuits		**L**	**T**	**P**	**C**
			3			**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To represent physical faults with logical faults and understand fault modeling methods.
2	To understand the concept of fault detection in combinational and sequential circuits
3	To understand designing for testability and its standards.
4	To understand the requirements for a circuit to be self checking .
5	To understand BIST concepts and methods to improve fault coverage

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Able to understand fault and their modeling in digital circuits thoroughly.
CO-2	Able to derive test vectors for given faults in combinational and sequential circuits.
CO-3	Apply testability techniques.
CO-4	Able to understand various self checking methods used in digital systems
CO-5	Understand various TPGs, ORAs and methods to enhance fault coverage in circuits

Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-2	2	2	3	-	-	-	-	-	-	-	-	-	2	-
CO-3	2	-	2	-	-	-	-	-	-	-	-	-	2	1
CO-4	2	2	-	-	-	-	-	-	1	-	-	-	2	-
CO-5	2	1	1	-	-	-	-	-	1	-	-	-	2	1

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Basics Of Testing And Fault Modeling

Introduction to Testing - Faults in digital circuits - Modeling of faults - Logical Fault Models – Fault detection - Fault location - Fault dominance - Logic Simulation - Types of simulation - Delay models - Gate level Event-driven simulation.

UNIT–II

Fault Detection: Fault detection and redundancy in combinational and sequential circuits, Fault Simulation- Applications and general techniques. Testing for single stuck faults.

UNIT–III
Design For Testability Design for Testability - Ad-hoc design – observability and controllability by use of Scan Registers, Generic scan based design - Classical scan based design – JTAG Boundary scan standard.

UNIT-IV
Self Checking Design: Basic concepts, application of error-Detecting and Error-correcting codes, checking circuits and self checking, self checking checkers- m/n code checkers and Berger code checkers, self checking combinational and sequential circuits.

UNIT – V
BIST and TPG: BIST concepts, Testing types and Test pattern generation for BIST, Output response analysis, Fault coverage enhancement with test point insertion, mixed mode BIST and Hybrid BIST.

SUGGESTED READING:

1	M. Abramovici, M. Breuer, A. Friedman, ―Digital *System Testing and testable design*‖, Jaico Publications
2	Samuel C Lee―*Digital Circuits and Logic Design*. PHI Pvt. Ltd, 2000
3	Zvi Kohavi―Switching*andFiniteAutomataTheory*‖,TMH.2ndedition
4	Laung-Terng Wang, Chen-Wen Wu, Xiaoqing Wen., "VLSI test principles and Architectures", Morgan Khauffmann publishers, 2006

PE 712 EC	ARTIFICIAL NEURAL NETWORKS (PE- IV)					
Pre-requisites	-		**L**	**T**	**P**	**C**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Understand the biological neural network and to model equivalent neuron models.
2	Learn different training algorithms in training neural networks
3	Know the issues of various feed forward neural networks.
4	Understand the concepts of Back Propagation
5	Know the issues of various feedback neural networks

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand the similarity of Biological networks and Neural networks.
CO-2	Identify different types of models of artificial neural networks.
CO-3	Understand and analyze the concepts of feed forward neural networks.
CO-4	Apply the concepts of backward propagation.
CO-5	Understand and analyze the concepts of feedback neural networks

Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	2	-	2		
CO2	2	-	-	-	-	-	-	-	-	2	-	-		
CO3	-	2	-	-	-	-	-	-	-	2	-	-		
CO4	-	3	-	-	-	-	-	-	-	3	-	-		
CO5	-	2	-	-	-	2	2	-	2	2	-	-		

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I
Basics of Artificial Neural Networks: Characteristics of Neural Networks, Historical Development of Neural Network Principles, Artificial Neural Networks: Terminology, Models of Neuron: McCulloch-Pitts model, Perceptron and Adaline neuron, Topology, Basic Learning Laws: Hebb's law, Perceptron, Delta , Widrow and Hoff LMS, Correlation, Instar (winner-take-all) and outstar learning.

UNIT–II
Activation and Synaptic Dynamics: Introduction, Activation Dynamics Models: Additive,

shunting and stochastic activation models, Synaptic Dynamics Models: Requirements of learning laws, Distinction between the activation and synaptic dynamics model, Learning Methods, Recall in Neural networks.

UNIT–III

Feed-forward Neural Network: Introduction, Analysis of Pattern Association Networks: Linear Associative Network, Analysis of Pattern Classification Networks: Perceptron, Pattern classification problem, Perceptron learning law, Perceptron convergence theorem, Perceptron representation problem.

UNIT-IV

Back Propagation: Back propagation learning rule, Features of Back propagation, and limitations of and extensions of Back Propagation rule.

UNIT – V

Feedback Neural networks: Linear auto associative feed forward and feedback networks. Hopfield network, capacity and energy analysis of Hopfield neural network. Stochastic neuron, Boltzmann machine, Boltzman learning law, Issues in Implementation of Boltzman learning law.

SUGGESTED READING:

1	B. Yegnanarayana, Artificial Neural Networks, Prentice Hall, New Delhi, 2007.
2	J. A. Freeman and D.M. Skapura, Neural Networks Algorithms, Applications and Programming Techniques, Addison Wesley, New York, 1999.
3	Simon Haykin, Neural Networks (A Comprehensive Foundation), McMillan College Publishing Company, New York, 1994.
4	Kevin L. Priddy, Paul E. Keller – Artificial neural networks: An Introduction - SPIE Press, 2005.

PE 713 EC	WIRELESS SENSOR NETWORKS (PE-IV)					
Pre-requisites	-		**L**	**T**	**P**	**C**
			3	**-**	**-**	**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To understand the fundamentals of wireless sensor networks and its application to critical real time scenarios.
2	To study the protocols at various layers and its differences with traditional protocols.
3	To understand the issues pertaining to sensor networks and the challenges involved in managing a sensor network.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	To understand the state-of-the-art in network protocols, architectures and applications
CO-2	To Explain the Fundamental Concepts and applications of ad hoc and wireless sensor Networks
CO-3	To Describe the MAC protocol issues of Adhoc and sensor networks
CO-4	To Discuss the WSN routing issues by considering QoS measurements
CO-5	To understand the state-of-the-art techniques and protocols in QoS and Energy management for wireless sensor networks.

Articulation Matrix

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	PO11	**PO12**	**PSO1**	**PSO2**
CO-1	3	3	2	2	1	1	1	-	-	-	-	1		
CO-2	3	3	2	2	1	1	1	-	-	-	-	1		
CO-3	3	3	2	2	3	1	1	-	-	-	-	1		
CO-4	3	3	2	2	3	1	1	-	-	-	-	1		
CO-5	3	3	2	2	3	1	1	-	-	-	-	1		

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I
Introduction: Fundamentals of wireless communication technology, the electromagnetic spectrum radio propagation, characteristics of wireless channels, modulation techniques, multiple access techniques, wireless LANs, PANs, WANs, and MANs, Wireless Internet.

UNIT–II
Introduction to adhoc/sensor networks: Key definitions of adhoc/ sensor networks, unique

constraints and challenges, advantages of ad-hoc/sensor network, driving applications, issues in adhoc wireless networks, issues in design of sensor network, sensor network architecture, data dissemination and gathering.

UNIT–III
MAC Protocols : Issues in designing MAC protocols for adhoc wireless networks, design goals, classification of MAC protocols, MAC protocols for sensor network, location discovery, quality, other issues, S-MAC, IEEE 802.15.4.

UNIT-IV
Routing Protocols: Issues in designing a routing protocol, classification of routing protocols, table driven, on-demand, hybrid, flooding, hierarchical, and power aware routing protocols.

UNIT – V
QoS and Energy Management : Issues and Challenges in providing QoS, classifications, MAC, network layer solutions, QoS frameworks, need for energy management, classification, battery, transmission power, and system power management schemes.

SUGGESTED READING:

1	C. Siva Ram Murthy, and B. S. Manoj, *"AdHoc Wireless networks* ", Pearson Education - 2008.
2	Feng Zhao and Leonides Guibas, *"Wireless sensor networks* ", Elsevier publication - 2004.
3	Jochen Schiller, *"Mobile Communications"*, Pearson Education, 2nd Edition, 2003.
4	William Stallings, *"Wireless Communications and Networks "*, Pearson Education – 2004
5	Holger Karl and Andreas Willing, ―*Protocols and Architectures for Wireless Sensor Networks*‖, John Wiley and Sons, 2005.
6	Waltenegus Dargie and Christian Poellabauer, ―Fundamentals of Wireless Sensor Networks:Theory and Practice‖, First Edition, John Wiley and Sons, 2010.

List of Open Elective Subjects

Subject Code	Title of the subject
OE 701 BM	Basic Medical Equipment
OE 702 BM	Artificial Intelligence In Health Care
OE 701 CE	Green Building Technology
OE 702 CE	Plumbing Technology
OE 701 CS	Cloud Computing
OE 702 CS	Data Base Management Systems
OE 701 EC	Embedded Systems Design
OE 702 EC	Basics of IoT
OE 701 EE	Optimization Techniques
OE 702 EE	Non Conventional Energy Sources
OE 701 ME	Nano Technology
OE 702 ME	Startup Entrepreneurship

OE701 BM	BASIC MEDICAL EQUIPMENT					
Pre-requisites			**L**	**T**	**P**	**C**
			3			**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To make the students understand the need for several Biomedical equipment.
2	To make the students understand the operating principles of a wide range of Biomedical Equipment
3	To familiarize students with the design and functional aspects of medical imaging systems and therapeutic devices.
4	To develop the ability to assess the appropriate biomedical equipment needed for specific clinical and therapeutic applications.
5	To enable students to understand the operating principles and clinical use of therapeutic devices like pacemakers, dialysis machines, and lithotripters.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Learn about various physiological parameters, monitoring and recording.
CO-2	Assess the need and operating principle of equipment used in physiotherapy
CO-3	Interpret the working principle and operating procedure and applications of Medical Imaging equipment.
CO-4	Perceive the governing principles and functions of critical care equipments.
CO-5	Learn about the various Therapeutic Equipment used for different applications

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Medical Monitoring and recording: Patient monitoring: System concepts, bedside monitoring systems, central monitors, heart rate and pulse rate measurement. Temperature measurement Blood pressure measurement: Direct and indirect methods. Respiration rate measurement: Impedance pneumograph, Apnoea detectors. Ambulatory monitoring: Arrhythmia monitor

UNIT–II

Physiotherapy and Electrotherapy Equipment: Diathermy machines: Short wave diathermy, Microwave diathermy and ultrasonic diathermy Electro diagnostic/Therapeutic apparatus: Nerve muscle stimulator, Functional electrical stimulator.

UNIT–III

Medical Imaging Equipment:

X-Ray machines: Properties and production of X-Rays, X-ray machine, Image Intensifier. X-ray computed tomography: basic principle and construction of the components. Ultrasonic Imaging: Physics of ultrasonic waves, medical ultrasound, and basic pulse echo apparatus. Magnetic Resonance Imaging: Principle, Image reconstruction techniques, Basic NMR components, Biological effects, Merits.

UNIT-IV

Critical Care Equipment:

Ventilators: Mechanics of respiration, artificial ventilators, Positive pressure ventilator, Types and classification of ventilators. Drug delivery system: Infusion pumps, basic components, implantable infusion system, closed-loop control in infusion pump. Cardiac Defibrillators: Need for defibrillators, DC defibrillator, Implantable defibrillators, Defibrillator analyzer.

UNIT – V

Therapeutic Equipment:

Cardiac pacemakers: Need for cardiac pacemakers, External and implantable pacemakers, types.

Dialysis Machine: Function of the kidney, artificial kidney, Dialyzers, Membranes, Hemodialysis machine. Lithotripters: The stone disease problem, Modern Lithotripter systems, extra corporeal shockwave therapy.

SUGGESTED READING:

1	R.S. Khandpur, Hand book of Biomedical Instrumentation, Tata McGraw-Hill, Second Edition, 2014.
2	John G.Webster, Medical Instrumentation Application and design, Wiley India Edition, 2009.
3	**Leslie Cromwell,**Biomedical Instrumentation and Measurements, *2nd Edition*, *Prentice Hall of India*,

OE 702 BM	ARTIFICIAL INTELLIGENCE IN HEALTH CARE					
Pre-requisites			**L**	**T**	**P**	**C**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To introduce students to the fundamentals of Artificial Intelligence (AI) with a focus on healthcare applications.
2	To explore AI techniques in clinical diagnostics and decision-making.
3	To understand the role of AI in medical imaging, disease prediction, patient monitoring, and personalized medicine.
4	To examine ethical, legal, and regulatory considerations in the deployment of AI in healthcare.
5	To enable students to design and evaluate AI-based healthcare solutions for improving patient outcomes and operational efficiency

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand and explain the fundamental AI concepts and techniques relevant to healthcare.
CO-2	Apply machine learning and deep learning methods to analyze medical data and assist in clinical decision-making.
CO-3	Analyze AI-based diagnostic tools used in medical imaging and disease prediction.
CO-4	Evaluate the implementation challenges and ethical implications of AI in healthcare systems.
CO-5	Design AI-driven healthcare applications and propose data-driven solutions to real-world health problems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I
Introduction to Artificial Intelligence: Definition. AI Applications, AI representation. Properties of internal Representation, General problem solving, production system, control

strategies: forward and backward chaining. Uninformed and informed search techniques. A* and AO* Algorithm

UNIT–II

Machine Learning and Deep Learning for Healthcare: Supervised, unsupervised, and reinforcement learning. Classification and regression techniques in clinical datasets. Neural networks, CNNs, RNNs and their applications.Case studies: Diabetes prediction, cancer classification, readmission prediction. Model evaluation: accuracy, precision, recall, ROC curves.

UNIT–III

AI in Medical Imaging and Diagnostics: Image processing fundamentals and feature extraction. AI in radiology: X-rays, CT, MRI, Ultrasound. Computer-aided diagnosis systems. Deep learning for medical image segmentation and classification. Real-world tools: Google DeepMind, IBM Watson Health.

UNIT-IV

Natural Language Processing in Healthcare: Basics of NLP and its significance in healthcare**.** Clinical text mining and named entity recognition (NER).Chatbots and virtual health assistants. AI in Electronic Health Record (EHR) processing. Case study: Predictive analysis from clinical notes.

UNIT – V

Ethical, Legal, and Future Perspectives. Ethical concerns: bias, transparency, and ability. Data privacy and security in AI systems. Regulatory aspects: FDA, HIPAA, CDSCO. Human-AI collaboration in clinical settings. Future directions: AI in genomics, telemedicine, and wearable technologies.

SUGGESTED READING:

1	Eugene, Charniak, Drew Mcdermott: Introduction to artificial intelligence.
2	Elaine Rich and Kerin Knight, Nair B., “Artificial Intelligence (SIE)”, Mc Graw Hill-2008.
3	Mathias Goyen, *Artificial Intelligence in Healthcare: Past, Present and Future*, Elsevier, 2021.
4	Eric Topol, *Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again*, Basic Books, 2019
5	Parashar Shah, *AI in Healthcare: A Practical Guide*, BPB Publications, 2021.

OE 702 CE	GREEN BUILDING TECHNOLOGY					
Pre-requisites	-		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks		**CIE**	40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Exposure to the green building technologies and their significance.
2	Understand the judicial use of energy and its management.
3	Educate about the Sun-earth relationship and its effect on climate.
4	Enhance awareness of end-use energy requirements in the society.
5	Develop suitable technologies for energy management.

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Understand concept of Energy in Buildings, factors on energy usage and Management.
CO-2	Environmental, Air conditioning and Auditory requirement indoors
CO-3	Climate, radiation, wind in connection with Energy
CO-4	End use energy requirements in buildings, concepts of heat gain and thermal performance
CO-5	Energy audit, energy management.

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	3	3	3	2	1	2	1	3	1	1
CO2	3	2	3		1		3	2	2	2		3	1	2
CO3	2	1	3	1	1	2	3	2	3	1	1	2	1	1
CO4	2	2	3	1	1	3	2	2	2	2			2	2
CO5	3	3	3	2	1	3	3	2	2	2	2	1	2	2

Correlation rating: Low/ Medium/High:1/2/3 respectively

UNIT-I

Overview of the significance of energy use and energy processes in building: Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

UNIT-II

Indoor environmental requirement and management: Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement – Auditory requirement.

UNIT-III

Climate, solar radiation and their influences: Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT-IV

End-use, energy utilization and requirements: Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building - Heat gain and thermal performance of building envelope - Steady and non-steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope-Evaluation of the overall thermal transfer

UNIT-V

Energy management options: Energy audit and energy targeting - Technological options for energy management.

Suggested Readings:

1. Michael Bauer, Peter Mösle and Michael Schwarz, *"Green Building–Guide book for Sustainable Architecture"*, Springer, Heidelberg, Germany, 2010.
2. Norbert Lechner, *"Heating, Cooling, Lighting-Sustainable Design Methods for Architects",* Wiley, New York, 2015.
3. Mike Montoya, *"Green Building Fundamentals* ‖,Pearson, USA, 2010.
4. Charles J.Kibert, *"Sustainable Construction-Green Building Design and Delivery*‖, John Wiley & Sons, New York, 2008.
5. Regina Leffers, *"Sustainable Construction and Design*‖, Pearson / Prentice Hall, USA 2009
6. James Kachadorian, *"The Passive Solar House: Using Solar Design to Heat and Cool Your Home",* Chelsea Green Publishing Co., USA, 1997.

OE 704 CE	PLUMBING TECHNOLOGY					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1.	Understand plumbing components for various systems such as water supply, waste water, high rise buildings
2.	Study various plumbing fixtures materials, tools and equipment
3.	Study the codes and standards in the building industry for plumbing

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Understand and identify the various plumbing related systems, component and types
CO-2	Ability to understand various plumbing terminology for water supply
CO-3	Ability to understand various plumbing fixtures materials, tools and equipment.
CO-4	Understand about different pumping systems available.
CO-5	Comprehend the importance of codes, the key responsibilities of a plumbing sector and plumber

Articulation matrix of Course outcomes with PO's:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1		1	3	-	2					1	
CO2	2	2	1		1	3	-	2					1	
CO3	2	1		1	1		1	1					1	
CO4	2	1		1	1		1	1					1	
CO5	1	1		1		2	2							

Correlation rating: Low/ Medium/High:1/2/3 respectively.

UNIT – I

Building Plumbing - Introduction to Plumbing Systems, components of plumbing systems, and basic physics as related to plumbing. Various types of home plumbing systems for water

supply and waste water disposal, high rise building plumbing, Pressure reducing valves, Break pressure tanks, Storage tanks, Building drainage for high rise buildings, various kinds of fixtures and fittings used.

UNIT – II

Plumbing Terminology: Definitions, use/purpose of Plumbing Fixtures - accessible, readily accessible, aerated fittings, AHJ, bathroom group, carrier, flood level rim, floor sink, flushometer valve, flush tanks, lavatories, macerating toilet, plumbing appliances, plumber.

Traps: indirect waste, vent, blow off, developed length, dirty arm, FOG, indirect waste, receptors, slip joints, trap, and vent.

Water supply: angle valve, anti-scald valve, backflow, bypass, check valve, cross connection, ferrule, gate valve, gray water, joints

UNIT– III

Plumbing Fixtures and Fittings: Definitions of plumbing fixtures, fittings, appliances and appurtenances; maximum flow rates, water closets, bidets, urinals, flushing devices, washbasins, bath/shower, toilets for differently abled, kitchen sinks, water coolers, drinking fountain,clotheswasher,dishwasher,mopsink,overflows,strainers,prohibitedfixtures,floor drains, floor slopes, location of valves, hot water temperature controls, installation standard dimensions in plan and elevation.

UNIT – IV

Pumping Systems : Terminology, pump heads, types of Pumps, applications, pump selection, pump characteristics, pumps and motors, pump efficiency, motor efficiency, Hydro Pneumatic Systems(HPS), Zoning, Storm Water and Drainage Pumps, introduction to starters and control panels.

UNIT – V

Codes and Standards: Scope, purpose; codes and standards in the building industry, UIPC-I, NBC and other codes, Local Municipal Laws, approvals, general regulations, standards, water supply, protection of pipes and structures, waterproofing.

Introduction to the Sector and the Job Role:

Overview of the Plumbing Sector- Importance and scope of plumbing in construction and maintenance, career opportunities in plumbing.

Understanding the Job Role of a Plumber – Duties and responsibilities of a plumber, Skills and attributes required for a plumber.

Safety Measures and Regulations –Importance of safety in plumbing, Basic safety regulations and practices.

Tools and Equipment – Introduction to basic plumbing tools and equipment, Proper use and handling of plumbing tools.

Reference books and codes:

1. Uniform Illustrated Plumbing Code-India (UIPC- I) published by IPA and IAPMO (India)
2. National Building Code (NBC) of India
3. IS17650 Part1 and Part2 for Water Efficient Plumbing Products
4. Water Efficient Products-India (WEP-I) published by IPA and IAPMO (India)
5. Water Efficiency and Sanitation Standard (WE. Stand) published by IPA and IAPMO (India)
6. Water Pollution, Berry, CBS Publishers.
7. 'A Guide to Good Plumbing Practices', a book published by IPA.
8. Elements of Water Pollution Control Engineering, O.P.Gupta, Khanna Book Publishing, New Delhi
9. Plumbing Engineering.Theory,DesignandPractice,S.M.Patil,1999
10. Water supply and sewerage system– G. Birdie

Learning Website:

1. www.nptel.co.in
2. https://ndrfandcd.gov.in/Cms/NATIONALBUILDINGCODE.aspx

OE 701 CS	CLOUD COMPUTING					
Pre-requisites	-		**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
1	To introduce basic concepts cloud computing and enabling technologies
2	To learn about Auto-Scaling, capacity planning and load balancing in cloud
3	To introduce security, privacy and compliance issues in clouds
4	To introduce cloud management standards and programming models

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the basic approaches and Core ideas of Cloud Computing.
CO-2	Understand the Challenges and approaches in the management of the Cloud environments.
CO-3	Familiarize with advanced paradigms and solutions necessary for building and managing modern Cloud environments.
CO-4	Envision use of Cloud environment in Enterprise.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												
CO4												
CO5												

UNIT– I
Introduction, Benefits and challenges, Cloud computing services, Resource Virtualization, Resource pooling sharing and provisioning.

UNIT – II
Scaling in the Cloud, Capacity Planning, Load Balancing, File System and Storage,

UNIT – III
Multi-tenant Software, Data in Cloud, Database Technology, Content Delivery Network, Security Reference Model, Security Issues, Privacy and Compliance Issues

UNIT – IV
Portability and Interoperability Issues, Cloud Management and a Programming Model Case Study, Popular Cloud Services

UNIT –V
Enterprise architecture and SOA, Enterprise Software , Enterprise Custom Applications, Workflow and Business Processes, Enterprise Analytics and Search, Enterprise Cloud Computing Ecosystem.

Suggested Reading:

1	Cloud Computing - Sandeep Bhowmik, Cambridge University Press, 2017.
2	Enterprise Cloud Computing - Technology, Architecture, Applications by Gautam Shroff, Cambridge University Press, 2016.
3	Kai Hwang, Geoffrey C.Fox, Jack J.Dongarra, ―Distributed and Cloud Computing From Parallel Processing to the Internet of Things‖, Elsevier, 2012.
4.	https://aws.amazon.com/about-aws/
5.	https://cloud.google.com/why-google-cloud?hl=en
6.	https://azure.microsoft.com/en-gb/

OE702 CS	DATA BASE MANAGEMENT SYSTEM					
Pre-requisites			**L**	**T**	**P**	**C**
			3			**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To introduce three schema architecture and DBMS functional components.
2	To understand the principles of ER modeling and design.
3	To learn query languages of RDBMS.
4	Tofamiliarizetheoryofserializablityandimplementationofconcurrencycontrol,and recovery.
5	To study different file organization and indexing techniques

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Understand the mathematical foundations on which RDBMS are built.
CO-2	Model a set of requirements using the Entity Relationship Model (ER), transform into a relational model, and refine the relational model using theory of Normalization.
CO-3	Develop Database application using SQL and Advanced SQL.
CO-4	Understand the working of concurrency control and recovery mechanisms in RDBMS.
CO-5	Use the knowledge of indexing and hashing to improve database application performance.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												
CO4												
CO5												

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction to DBMS:

Introduction: Database System Applications, Purpose of Database Systems, View of Data, Database Languages, Database Design, Database Engine, Database and Application Architecture, Data Base Users and Administrators.

Introduction to the Relational Model: Structure of Relational Databases, Database Schema, Keys, Schema Diagram, Relational Query Languages, The Relational Algebra

UNIT–II

Data Models and Database Design:

Entity-Relationship (ER) Model: The Entity-Relational Model, Complex Attributes, Mapping Cardinalities, Primary key, Removing Redundant Attribute in Entity Set, Reducing E-R diagrams to Relational Schemas, Extended E-R features, Entity-Relationship Design Issues, Alternative Notations for Modelling Data.

Relational Model: Features of Good Relational Designs, Decomposition Using Functional Dependencies, Normal Forms, Functional-Dependency Theory, algorithms for Decomposition using Functional Dependencies, Decomposition Using multivalued Dependencies, Atomic Domains and First Normal Form, Database-Design process, Modelling Temporal Data

UNIT–III

SQL and Querying: SQL Basics: Data definition, data manipulation, and data control languages. functions in sql (single row and multi row& conversion functions), Creating Tables, keys, integrity constraints (column level and table level)

Advanced SQL: Joins, subqueries, aggregate functions, and views. Synonyms

Stored Procedures and Triggers: Concepts and usage.

UNIT-IV

Transaction Management and Concurrency Control:

Transaction Concepts: Transaction Concept, transaction states, A simple transaction Model, Implementation of Atomicity and Durability, Implementation of Isolation, Serializability (view Serializability, conflict serializability)

Concurrency Control: Locking mechanisms, Lock-based protocol, Timestamp-Based Protocol, Validation Based Protocol, Multiple Granularity, deadlock handling.

Recovery Techniques: Failure Classification, Storage Structure, Recovery and Atomicity, Recovery Algorithm, Buffer Management, Failure with Loss of Non-Volatile Storage, High Availability Using Remote Backup Systems, ARIES, Early Lock Release and Logical Undo Operations, Recovery in Main-memory Databases.

UNIT – V

Indexing and Hashing:

Database-System Architectures: Centralized Database Systems, Server System Architectures, Parallel Systems, Distributed Systems, Transaction Processing in Parallel and Distributed Systems, Cloud-Based Services.

Introduction to Big Data: Big Data Storage Systems, The Map Reduce Paradigm, Beyond Map Reduce, Algebraic Operations, Streaming Data, Graph Databases

SUGGESTED READING:

1	Database System Concepts Seventh Edition Abraham Sliberschantz, Henry f. Korth,S. Sudarshan, 7th Edition, 2024
2	Rama krishnan, Gehrke, "*Database Management Systems"*, McGraw-Hill International Edition, 3rd Edition, 2003
3	Elma sri, Nava the, Somayajulu, "*Fundamentals of Database Systems"*Pearson Education, 4th Edition, 2004

OE 701 EC	EMBEDDED SYSTEM DESIGN					
Pre-requisites	Microprocessors and Microcontrollers		**L**	**T**	**P**	**C**
			3	**-**	**-**	**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

	Course Objectives:
1	To understand the processor selection criteria for Embedded System Design.
2	To provide a clear understanding of role of firmware, operating systems in correlation with hardware systems.
3	To gain the knowledge of tool chain for embedded systems.
4	To understand the importance of RTOS in building real time systems
5	To gain knowledge on internal working procedure of RTOS

	Course Outcomes:
	On completion of this course, the student will be able to :
1	Understand the working of a simple embedded system and embedded system applications
2	Design an Embedded System firmware
3	Use Embedded Software Development Tools for Designing Embedded System Applications
4	Understand RTOS and its use in Embedded environment
5	Understand RTOS concepts like Task Communication and Task Synchronization.

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1	-	-	-	1	-	1	1	1
CO2	3	1	2	2	-	1	-	1	-	2	1	1
CO3	3	1	2	2	1	1	-	1	-	2	1	1
CO4	3	1	2	1	1	1	-	1	-	1	1	1
CO5	3	2	2	1	-	1	-	1	-	1	1	1

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction to Embedded Systems:

Embedded systems Vs General computing systems, History of Embedded systems, classification, Characteristics and quality attributes of Embedded Systems Challenges in Embedded System Design, Application and Domain specific Embedded Systems.

UNIT–II
Embedded firmware and Design and Development: Embedded Firmware Design Approaches and Development languages and Programming in Embedded C

UNIT–III
Embedded Software Development Tools: Host and Target Machines, Cross Compilers, Cross Assemblers, Tool Chains, Linkers/Locators for Embedded Software, Address Resolution, Locator Maps. Getting Embedded Software Into Target System: PROM programmer, ROM emulator, In Circuit- Emulators, Monitors, Testing on Your Host Machine - Instruction Set Simulators, Logic Analyzers.

UNIT-IV
Introduction to Real Time Operating Systems: Tasks and task states, tasks and Data, Semaphores and shared data. Operating system services: Message queues, mailboxes and pipes, timer functions, events, memory management, Interrupt routines in an RTOS environment.

UNIT – V
TASK COMMUNICATION: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

SUGGESTED READING:

1	Shibu, K.V., Introduction to Embedded Systems, 1st Ed., TMH, 2009
2	Raj Kamal, Embedded Systems – Architecture, Programming and Design, 2nd Edition, TMH, 2008
3	An Embedded Software Primer - David E. Simon, Pearson Education.
4	Jean.J.Labrosse, MicroC/OS-II, Taylor & Francis, 2002

OE 702 EC	BASICS OF IOT					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	To understand the concepts of the Internet of Things and be able to build IoT applications
2	To learn the programming and use of Arduino and Raspberry Pi boards Design And detail the deep beams.
3	To study about various IoT case studies and industrial applications.
Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Known basic protocols in sensor networks.
CO-2	To Know the Architecture and Protocols of IoT.
CO-3	Python programming and interfacing for Raspberry Pi.
CO-4	Interfacing sensors and actuators with different IoT architectures.
CO-5	Compare IOT Applications in Industrial &real world

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	1
CO2	3	2	2	-	2	-	2	-	-	-	1	1	1	2
CO3	2	3	3	2	3	-	-	-	-	-	-	-	-	3
CO4	3	3	2	2	2	-	-	-	-	-	-	-	1	3
CO5	-	-	2	-	-	-	-	-	-	-	-	-	-	3

UNIT–I
Introduction to the Internet of Things, Characteristics of IoT, Physical design of IoT, Functional blocks of IoT, Sensing, Actuation, Basics of Networking, Communication Protocols.

UNIT–II
IoT Architecture: Physical and Logical design of IoT, IoT frameworks, IoT Protocols – MQTT, COAP, 6LOWPAN

UNIT–III
Introduction to Python programming, Introduction to Raspberry Pi, Interfacing Raspberry Pi with basic peripherals, Implementation of IoT with Raspberry Pi..

UNIT–IV
IoT applications in home, Infrastructures, Buildings, Security, Industries, Home appliances, other IoT electronic equipments.

UNIT–V
Prototyping and Programming for IoT: Sensors, Actuators, Micro Controllers, SoC, Choosing a platform, prototyping hardware platforms- Arduino, Raspberry Pi, Prototype in Physical design- Laser Cutting, 3D-Printing, CNC milling, techniques for writing Embedded code

Suggested Reading:

1	Raj Kamal, "Internet of Things – Architecture and Design Principles", McGraw Hill Education Pvt. Ltd., 2017
2	"Makesensors":Terokarvinen,kemo,karvinenandvilleyvaltokari,1stedition, maker media, 2014.
3	IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, Cisco Press, 2017
4	Internet of Things – A hands-on approach, ArshdeepBahga, Vijay Madisetti, Universities Press, 2015
5	Rao, M. (2018). Internet of Things with Raspbery Pi 3: Leverage the power of Raspberry Pi 3 and JavaScript to build exciting IoT projects. Packt Publishing Ltd
6	Internet of Things and Data Analytics, HwaiyuGeng, P.E, Wiley Publications, 2017

OE 701 EE	OPTIMIZATION TECHNIQUES					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

	Course Objectives:
	The course is taught with the objectives of enabling the student to:
1	To understand the need and basic concepts of operations research and classify the optimization problems.
2	To study about the linear programming and non-linear programming concepts and their applications.
3	To understand various constrained and un-constrained optimization techniques and their applications.
4	To understand the concepts and implementation of Genetic Algorithms to get the optimum solutions.
5	To study the concepts of Metaheuristics Optimization techniques.

Course Outcomes:	
On completion of this course, the student will be able to:	
CO-1	Analyze any problem of optimization in an engineering system and able to formulate a mathematical model to the problem and solving it by the techniques that are presented.
CO-2	Solve problems of L.P. by graphical and Simplex methods.
CO-3	Apply various constrained and un-constrained optimization techniques for the

	specific problems.
CO-4	Implement the Genetic Algorithms to solve the for optimum solution.
CO-5	Understand the concepts to use the Metaheuristics Optimization techniques.

Articulation matrix of Course Outcomes with POs:

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I
Introduction: Definitions, Characteristics, Objective function, Classification of optimization problems, Engineering applications and limitations. Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality Constraints and Multivariable Optimization with Inequality Constraints: Kuhn–Tucker Condition.

UNIT–II
Linear Programming: Definitions and Formulation of the LPP, Construction of L.P. Models, Slack and surplus variables, Standard form, Canonical form and matrix form of LP Problems. Artificial Variables, solution by the Big-M method, Duality principle, Dual problems and numerical problems.

UNIT–III
Random Search Methods Concepts: Direct Search Methods - Univariate Method, Gradient of a Function, Indirect Search Methods - Gradient of a Function, Steepest Descent (Cauchy) Method, Newton's Method.

UNIT-IV
Binary Genetic Algorithm: Genetic Algorithms Natural Selection on a Computer, Components of a Binary Genetic Algorithm. Selecting the Variables and the Cost Function. Variable Encoding and Decoding, The Population, Natural Selection, Selection, Mating.

Mutations, the Next Generation and Convergence, Components of a Continuous Genetic Algorithm.

UNIT – V
Meta-heuristics Optimization: Concepts of Simulated Annealing, Theoretical approaches, Advantages and disadvantages, applications, Ant Colony Algorithms - Introduction, Collective behavior of social insects, Formalization and properties of ant colony optimization.

Suggested Reading:

1	Rao, S.S. (2009). "Engineering Optimization: Theory and Practice." John Wiley & Sons, Inc.
2	Taha, H.A. (2008). "Operations Research, Pearson Education India." New Delhi, India.
3	Randy L. Haupt and Sue Ellen Haupt, "Practical genetic algorithms" second edition, a John Wiley & sons, inc., publication -2004.
4	Sharma J.K. (2013). "Operation Research: Theory and Applications." Fifth Edition, Macmillan Publishers, New Delhi, India.
5	J. Dreo A. Petrowski, P. Siarry E. Taillard. "Metaheuristics for Hard Optimization" Springer.

OE 702 EE	NON CONVENTIONAL ENERGY SOURCES					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	3
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To understand the different types of energy sources.
2	To understand the need of non-conventional energy sources and their principles.
3	To understand the limitations of non-conventional energy sources.
4	To outline division aspects and utilization of renewable energy sources for diriment application.
5	To analyze the environmental aspects of renewable energy resources.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	e different energy resources and need of renewable energy resources.
CO-2	nd the concepts of working of fuel cell systems along with their applications.
CO-3	Describe the use of solar energy and the various components and measuring devices used in the energy production and their applications.
CO-4	Appreciate the need of Wind Energy and their classification and various components

	used in energy generation and working of different electrical wind energy system.
CO-5	Understand the concept of OTEC technology, Biomass energy resources and different types of biogas Plants used in India.

Articulation matrix of Course Outcomes with POs:

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I
Review of Conventional and Non-Conventional energy sources, Need for non-conventional energy sources Types of Non-conventional energy sources, Fuel Cells, Principle of operation with special reference to H2O2 Cell, Classification and Block diagram of fuel cell systems, Ion exchange membrane cell, Molten carbonate cells, Solid oxide electrolyte cells, Regenerative system, Regenerative Fuel Cell, Advantages and disadvantages of Fuel Cells, Polarization, Conversion efficiency and Applications of Fuel Cells.

UNIT–II
Solar energy, Solar radiation and its measurements, Solar Energy collectors, Solar Energy storage systems, Solar Pond, Application of Solar Pond, Applications of solar energy.

UNIT–III
Wind energy, Principles of wind energy conversion systems, Nature of wind, Power in the

Wind, Basic components of WECS, Classification of WECS, Site selection considerations, Advantages and disadvantages of WECS, Wind energy collectors, Wind electric generating and control systems, Applications of Wind energy, Environmental aspects.

UNIT–IV
Energy from the Oceans, Ocean Thermal Electric Conversion (OTEC) methods, Principles of tidal power generation, Advantages and limitations of tidal power generation, Ocean waves, Wave energy conversion devices, Advantages and disadvantages of wave energy, Geo-thermal Energy, Types of Geo-thermal Energy Systems, Applications of Geo-thermal Energy.

UNIT–V
Energy from Biomass, Biomass conversion technologies / processes, Photosynthesis, Photosynthetic efficiency, Biogas generation, Selection of site for Biogas plant, Classification of Biogas plants, Details of commonly used Biogas plants in India, Advantages and disadvantages of Biogas generation, Thermal gasification of biomass, Biomass gasifies.

Suggested Reading:

1	Rai G.D, Non-Conventional Sources of Energy, Khandala Publishers, New Delhi, 1999.
2	M.M.El-Wakil, Power Plant Technology. McGraw Hill, 1984.

OE 701 ME	NANO TECHNOLOGY					
Pre-requisites			**L**	**T**	**P**	**C**
			3	**-**	**-**	**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

	Course Objectives:
1	To familiarize Nano materials and technology.
2	To understand Nano structures, fabrication and special Nano materials
3	
4	
5	

	Course Outcomes:
	On completion of this course, the student will be able to :
1	
2	
3	
4	
5	

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1														
CO2														
CO3														
CO4														
CO5														

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I
Introduction: Nanoscale, Properties at Nanoscale, advantages and disadvantages, importance of Nano Technology, Bottom-up and Top-down approaches, challenges in Nano Technology

UNIT–II
Materials of Nano Technology: Introduction-Si-based materials, Ge-based materials, Smart materials, metals, Ferroelectric materials, Polymer materials, GaAs & InP (III-V) group materials, Nano tribology and Materials, Principles and analytical techniques of XRD, SEM, TEM and STM/AFM

UNIT–III
Nano Structures: Zero dimensional Nano structure (Nano Particles)- Synthesis procedure, characterization techniques, properties and applications of Nano Particles One dimensional Nano structures (Nano Wires, Nano Tubes)- Various Synthesis procedure, characterization procedure and principles involved, properties and applications of Nano Wires, Types of Nano Tubes, Synthesis procedure, characterization properties and applications of Nano Tubes.

UNIT-IV
Nano Fabrication: Introduction, Basic fabrication techniques (Lithography, thin film deposition, and doping) MEMS fabrication techniques, Nano fabrication techniques (E-beam Nano-imprint fabrication, Epitaxy and strain engineering, Scanned probe techniques)

UNIT – V
Special Nano Materials: Nano Composites: Introduction, Synthesis procedures, various systems (metal-polymer, metal- ceramics and polymer-Ceramics), Characterization procedures, applications. Nano Biomaterials: Introduction, Biocompatibility, anti-bacterial activity, principles involved, applications**.**

SUGGESTED READING:

1	A.K.Bandyopadyay, Nano Materials, New Age Publications, 2007.
2	T. Pradeep, Nano: The Essentials: Understanding Nanoscience and Nanotechnolgy, Tata McGraw-Hill, 2008.
3	Carl. C. Koch, Nano Materials Synthesis, Properties and Applications, Jaico Publishing House,2008.
4	Willia Illsey Atkinson, NanoTechnology, Jaico Publishing House, 2009.

OE 701 EC	START UP ENTREPRENEURSHIP					
Pre-requisites			**L**	**T**	**P**	**C**
			3	**-**	**-**	**3**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
1	To motivate students to take up entrepreneurship in future
2	To learn nuances of starting an enterprise & project management
3	To understand the behavioral aspects of entrepreneurs and time management

Course Outcomes:	
On completion of this course, the student will be able to :	
1	Understand the behavioral aspects of entrepreneurs and time management
2	Creative thinking and transform ideas into reality
3	Importance of innovation in new business opportunities
4	Create a complete business plan and workout the budget plan.
5	Write a project proposal with budget statement

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												
CO4												
CO5												

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Creativity & Discovery: Definition of Creativity, self test creativity, discovery and delivery skills, The imagination threshold, Building creativity ladder, Collection of wild ideas, Bench marking the ideas, Innovative to borrow or adopt, choosing the best of many ideas, management of tradeoff between discovery
and delivery, Sharpening observation skills, reinventing self, Inspire and aspire through success stories

UNIT–II

From Idea to Startup : Introduction to think ahead backward, Validation of ideas using cost and strategy, visualizing the business through value profile, activity mapping, Risks as opportunities, building your own road map.

UNIT–III

Innovation career lessons : Growing & Sharing Knowledge, The Role of Failure In Achieving Success, Creating vision, Strategy, Action & Resistance: Differentiated Market Transforming

Strategy; Dare to Take Action; Fighting Resistance; All About the startup Ecosystem; Building a Team; Keeping it Simple and Working Hard.

UNIT-IV

Action driven business plan: Creating a completed non-business plan (a series of actions each of which moves your idea toward implementation), including a list of the activities to be undertaken, with degrees of importance (scale of 1 to 3, where 1 is 'most important'). A revision of the original product or service idea, in light of information gathered in the process, beginning to design the business or organization that will successfully implement your creative idea. Preparing an activity map**.**

UNIT – V

Startup financing cycle: Preparing an initial cash flow statement, showing money flowing out (operations; capital) and flowing in. Estimate your capital needs realistically. Prepare a bootstrapping option (self financing). Prepare a risk map. Prepare a business plan comprising five sections: The Need; The Product; Unique Features; The Market; Future Developments. Include a Gantt chart (project plan –detailed activities and starting and ending dates); and a project budget**.**

SUGGESTED READING:

1	Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 1997
2	Prasanna Chandra, "Project – Planning , Analysis, Selection, Implementation and Review", TataMcGraw-Hill Publishing Company Ltd., 1995
3	B. Badhai, "Entrepreneurship for Engineers", Dhanpath Rai & Co., Delhi, 2001.
4	Stephen R. Covey and A. Roger Merrill, "First Things First", Simon and Schuster, 2002
5	Robert D. Hisrich and Michael P.Peters, " Entrepreneurship", Tata McGRaw Hill Edition, 2002

PC 751 EC	ANTENNA & MICROWAVE LABORATORY					
Pre-requisites			**L**	**T**	**P**	**C**
					2	**1**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To define the range of frequencies for operation in microwave engineering.
2	To discover the functions of microwave components.
3	To verify the various characteristics of active passive microwave devices practically.
4	To Measure Different parameters of an antenna.
5	To find the Transmission Line characteristics practically.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Study the characteristics of microwave sources.
CO-2	Estimate the guide wave length and free space wave length of a wave.
CO-3	Analyze the characteristics of antenna and microwave devices.
CO-4	Plot the radiation characteristics of UHF and microwave antennas.
CO-5	Analyze the characteristics of Transmission Line.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	2	-	-	-	-	-	-	-	-		
CO2	3	3	1	2	-	-	-	-	-	-	-	-		
CO3	3	3	2	2	1	-	-	-	-	-	-	-		
CO4	2	3	2	3	1	1	-	-	-	-	-	-		
CO5	3	3	2	2	-	-	-	-	-	-	-	-		

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

Microwave Source Characteristics
Reflex Klystron characteristics, Gun diode characteristics.

Waveguide Component characteristics
Measurement of standing wave pattern, VSWR measurement, Low &High VSWR measurements Measurement of unknown load characteristics of windows.. Measurement of Frequency, Wavelength, group and phase velocity. Directional Coupler characteristics, Coupling, Directivity and Isolation Measurements. E plane, H plane and Magic Tee characteristics. Characteristics of Circulator, Isolator, Measurement of S-parameters through insertion loss and isolation.

Antenna Measurements
Plot Radiation pattern of all Wired Antenna. Plot Radiation pattern of all Aperture Antenna. Plot Radiation pattern of all Reflector Antenna. Plot Radiation pattern of all Array Antenna. Measurement in co-polarization and cross polarization. Circularly polarized antenna.

Transmission Line Measurements
Measure the characteristics of Standing Wave. Measure the characteristics of OPEN &SHORT LOAD. Measurement of S-parameters (S11, S12, S21, S22).

SUGGESTED READING:

1	Samuel Y. Liao, "Microwave Device and Circuits",PH1,3rd Edition.1994.
2	Pozar D.M., "Microwave Engineering", John Wiley & Sons 3rd Edition,2005.

PW 761 EC	Project Work –I					
Pre-requisites			L	T	P	C
					6	3
Evaluation	SEE	-	CIE		50 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To enhance practical and professional skills.
2	To familiarize tools and techniques of systematic Literature survey and documentation
3	To expose the students to industry practices and team work.
4	To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems
CO-2	Evaluate different solutions based on economic and technical feasibility
CO-3	Effectively plan a project and confidently perform all aspects of project management
CO-4	Demonstrate effective written, oral/ presentation and communications kills
CO-5	Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	1	-	-	1		2
CO2	1	-	3	2	-	-	-	1		-	-	-		2
CO3	-	1	2	1	3	-	-	-	2	-	-	-	2	2
CO4	-	-	-	1	-	-	-	-	2	-	-	1	2	
CO5	-	1	1	1	-	-	-	1	1	-	1	1	2	2

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:

1. Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)

2. Grouping of students (max 3 in a group)
3. Allotment of project guides.
4. Preparation of seminar schedules and conducting the same

The aim of project work should be to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the department may arrange special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions during first 4 weeks of VII semester. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide

Seminar schedule will be prepared by the coordinator for all the students from the 6^{th} week to the last week of the semester which should be strictly adhered to.

Each group will be required to**:**

1. Submit a one page synopsis at least 1 week before the seminar for display on notice board.
2. Give a 30 minutes presentation followed by 10 minutes discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of Sessional marks which will be on the basis of performance of the student in literature survey, presentation and technical write up preparation and knowledge in the chosen topic.

Thus the seminar presentation should include the following components related to the project:

1. Problem definition and specifications
2. Literature survey
3. Broad knowledge of available techniques to solve a particular problem.
4. Planning of the work, preparation of bar (activity)charts
5. Presentation-oral and written.

PW 762 EC	SUMMER INTERSHIP*					
Pre-requisites			L	T	P	C
						2
Evaluation	SEE	-	CIE		50 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To give an experience to the students in solving real life practical problems with all its constraints.
2	To give an opportunity to integrate different aspects of learning with reference to real life problems.
3	To enhance the confidence of the students while communicating with industry engineers and give an opportunity for useful interaction with them and familiarize with work culture and ethics of the industry

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Able to design/develop a small and simple product in hardware or software.
CO-2	Able to complete the task or realize a pre-specified target, with limited scope, rather than taking up a complex task and leave it.
CO-3	Able to learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to pre-specified criteria.
CO-4	Able to implement the selected solution and document the same
CO-5	Able to design/develop a small and simple product in hardware or software.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	-	-	1	-	-	1	-	1
CO2	1	-	3	2	-	-	-	1		-	-	-	-	1
CO3	-	1	2	1	3	-	-	-	2	-	-	-	1	1
CO4	-	-	-	1	-	-	-	-	2	-	-	1	1	-
CO5	-	1	1	1	-	-	-	1	1	-	1	1	1	2

Summer Intern ship is introduced as part of the curricula for encouraging students to work on problems of interest to industries. A batch of two or three students will be attached to a person from an Electronics Industry / R& D Organization / National Laboratory/Any other program approved by the department for a period of 6-8 weeks. This will be during the summer vacation following the completion of the VI semester course. One faculty member will act as an internal guide for each batch to monitor the progress and interacts with the industry guide.

After the completion of the project, students will submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the department. Award of Sessional marks are to be based on the performance of the student at the work place to be judged by industry guide and internal guide (25 Marks) followed by presentation in front of the committee constituted by the department (25 Marks). One faculty member to co-ordinate the overall activity of Summer Internship.

***Students have to undergo summer intern ship of 6 Weeks duration at the end of semester VI and credits will be awarded after evaluation in VII semester**

SCHEME OF INSTRUCTION AND EXAMINATION

B. E. (ECE)

VIII–Semester

SNo	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	MC 801 CE	Environmental Science	3	-	-	3	3	40	60	0
2	MC 80X XX	Mandatory Course–II	3	-	-	3	3	40	60	0
3	MC 80X XX	Mandatory Course–III	3	-	-	3	3	40	60	0
Practical's										
4	PW861EC	Project Work – II	-	-	12	**12**	-	50	100	6
		Total	**9**	**-**	**12**	**21**	**9**	**170**	**280**	**6**

Mandatory Course List

S.No.	Subject Code	Subject Title
1	MC 802 HS	Intellectual Property rights
2	MC 803 HS	Communicative English
3	MC 804 HS	Constitution of India
4	MC 805 HS	Essence of Indian Traditional Knowledge
5	MC 806 HS	Stress Management by Yoga

Note: Students are required to do any **TWO MANDATORY COURSES** from the above list to fulfill the requirements for the award of degree.

MC 801 HS	ENVIRONMENTAL SCIENCE					
Pre-requisites	--		L	T	P	C
			3	0	0	3
Evaluation	SEE	60 Marks	CIE		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To know the Natural resources and their importance.
2	To understand and realize significance of Ecosystems and Biodiversity.
3	To understand the types of pollution, abatement practices and Disaster Management.
4	To sensitize the students, about the global issues, mitigation techniques.
5	To built the awareness regarding sustainable future.

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Rational utilization of natural resource can be expected.
CO-2	Protection and conservation of ecosystems and biodiversity.
CO-3	Development of New technologies for the abatement of pollution.
CO-4	Mitigative techniques will come from the students.
CO-5	Sustainability can be achieved.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1												
CO-2												
CO-3												
CO-4												
CO-5												

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I
Environmental studies: Definition, scope and importance, need for public awareness. Natural resources: Water resources use and exploitation of Surface and Ground water. Floods, Drought,

Conflicts over water, Dams-merits and demerits. Land Resources: Land as a resource, Effects of modern Agriculture, Fertilizer-pesticide problems, Water logging and Salinity, land degradation, soil erosion and Desertification. Energy resources: Growing energy needs, renewable and non-renewable energy resources.

UNIT–II

Ecosystems and Biodiversity: Concept of Ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in ecosystem, food chains, food web, ecological pyramids, aquatic ecosystem (ponds, lakes, streams, rivers, oceans, estuaries) Biodiversity: Genetic species and ecosystem diversity, bio-geographical classification of India. Value of biodiversity, threats to biodiversity, endangered and endemic species of India, conservation of biodiversity.

UNIT–III

Environmental Pollution: Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, Thermal pollution. Solid waste management, Municipal solid waste management, Biomedical waste management and, hazardous waste management. Disaster management: Types of disasters, impact of disasters on environment, infrastructure, and development.

UNIT-IV

Environmental protection and Global issues: Environmental protection acts: Air, Water, Forest and wild life Acts, enforcement of Environmental legislation. Water conservation, watershed management, and Environmental ethics. Climate change, Global warming, acid rain, ozone layer depletion.

UNIT – V

Sustainable future: Concept of Sustainable Development, Sustainable development goals, Population and its explosion, Crazy Consumerism, Urban Sprawl, Environmental Education, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style

SUGGESTED READING:

1	De A.K., "Environmental Chemistry", Wiley Eastern Ltd., 1989.
2	Odum E.P., "Fundamentals of Ecology", W.B. Sunders Co., USA,1975..

3	G.L. Karia and R.A. Christian, Waste Water Treatment, Concepts and Design Approach, Prentice Hall of India, 2005.
4	Benny Joseph, Environmental Studies, Tata McGraw Hill,2005.
5	V.K.Sharma, Disaster Management, National Centre for Disaster Management, IIPE, Delhi,1999. 6. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi

MC 802 HS	INTELLECTUAL PROPERTY RIGHTS					
Pre-requisites		**L**	**T**	**P**	**C**	
		3	-	-	3	
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Acquaint the students with basics of intellectual property rights with special reference to Indian Laws and its practices.
2	Compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
3	Provide an overview of the statutory, procedural, and case law underlining these processes and their interplay with litigation.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	Understand the concept of intellectual property rights.
CO-2	Develop proficiency in trademarks and acquisition of trade mark rights.
CO-3	Understand the skill of acquiring the copy rights, ownership rights and transfer.
CO-4	Able to protect trade secrets, liability for misappropriations of trade secrets.
CO-5	Apply the patents and demonstration of case studies.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Chapter – I

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Chapter – II

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

Chapter – III

Law of copy rights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer**.**

Chapter – IV
Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of publicity, false advertising.

Chapter –V
New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Suggested Reading:

1	Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
2	"Mayall, "Industrial Design", McGraw Hill,1992
3	"Niebel, "Product Design", McGraw Hill,1974.
4	"Asimov, "Introduction to Design", Prentice Hall,1962.
5	"Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age",2016.
6	T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand,2008

MC 803 HS	ENGLISH FOR RESEARCH PAPER WRITING					
AUDIT COURSE-II						
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Objectives:

1. *Understand that how to improve your writing skills and level of readability*
2. *Understand the nuances of language and vocabulary in writing a Research Paper.*
3. *Develop the content, structure, format of writing a research paper and produce original research papers without plagiarism*

Outcomes: *At the end of this course, students will be able to:*

1. *Interpret the nuances of research paper writing.*
2. *Differentiate the research paper format and citation of sources.*
3. *To review the research papers and articles in a scientific manner.*
4. *Avoid plagiarism and be able to develop their writing skills in presenting the research work.*
5. *Create a research paper and acquire the knowledge of how and where to publish their original research papers*

Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

UNIT – I
Academic Writing: Meaning& Definition of a research paper– Purpose of a research paper – Scope – Benefits, Limitations – outcomes.

UNIT – II
Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

UNIT – III
Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.
UNIT – IV

Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft – Revising/Editing - The final draft and proof reading.

UNIT – V
Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications – Advantages/Benefits *Presentation Skills:* Developing Persuasive Presentations, Structure of Presentation, Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establish credibility.

References:

1	C. R Kothari, Gaurav, Garg, "*Research Methodology Methods and Techniques*", 4/e, New Age International Publishers.
2	Day R, "*How to Write and Publish a Scientific Paper**",*** Cambridge University Press, 2006
3	"*MLA Hand book for writers of Research Papers*", 7/e, East West Press Pvt. Ltd, New Delhi
4	Lauri Rozakis, Schaum's, "*Quick Guide to Writing Great Research Papers"*, Tata McGraw Hills Pvt. Ltd, New Delhi.

MC 804 HS	CONSTITUTION OF INDIA					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-	-	0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Objectives:

1.	*Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective*
2.	*To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role*
3.	*Entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*

Outcomes: *At the end of this course, students will be able to:*

1.	*Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.*
2.	*Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.*
3.	*Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru*
4.	*The eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.*
5.	*Discuss the passage of the Hindu Code Bill of 1956.*

Program Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

UNIT – I

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT – II

Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT – III
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions.

UNIT – IV
Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayat raj: Introduction, PRI: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT – V
Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

References:

1	*"The Constitution of India",* 1950 (Bare Act), Government Publication.
2	Dr. S. N. Busi, *"Dr. B. R. Ambedkar framing of Indian Constitution",* 1st Edition, 2015.
3	M. P. Jain, "*Indian Constitution Law",* 7th Edn., Lexis Nexis, 2014.
4	D.D. Basu, *"Introduction to the Constitution of India",* Lexis Nexis, 2015.

MC 805 HS	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE					
Pre-requisites	--		**L**	**T**	**P**	**C**
			3			**0**
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	Comprehend the Basic fundamental aspects of Society, Culture and Heritage.
2	Understand the significant aspects of Traditional Hindu Social Organization and vedic literature both at individual level and societal level.
3	Inculcate a philosophical insight through shad darshanas and a spiritual outlook through Yoga Sutras.
4	Realize the significance and the utilitarian aspect of the traditional knowledge system through case studies.
5	Appreciate the significance and necessity for the preservation of traditional knowledge system

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Know the fundamental concepts of Society with regard to values, norms, cultural and nature of Indian culture.
CO-2	Understand the connect between the vedic literature and the traditional structural organization guiding at the various phases of life of an individual.
CO-3	Recognize the importance of Darshanas and significance of Yoga sutra in building up a holistic life perspective.
CO-4	To inculcate a pursuit of looking deeper into IKS for addressing the multi faceted contemporary issues both at local and global platform.
CO-5	Analyze the significance and the measures for the preservation of Traditional Knowledge System

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1												
CO2												
CO3												
CO4												

CO5												

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Fundamental Concepts : Society , Definition and its Characteristics; Values- Norms, Role-Status, Order and Stability, Habits, Custom; Understanding difference between Belief and Ritual, Tradition and Heritage; Culture : Definition and its Characteristics; Characteristics of Indian Culture; Concept of Unity in Diversity

UNIT–II

Indian Traditional System :
Traditional Hindu Organization : Purusharthas, Varna Dharma and Ashrama Dharma.
Indian Traditional Scriptures and their Classification; General Understanding of Vedas : Rig veda, Sama veda, Yajur Veda, and Atharva veda, Upanishads; Smritis : Itihasa, Puranas, Agamas, Upvedas, and Vedangas

UNIT–III

Traditional Philosophies / School of thoughts:
Darshanas : Philosophies of 6 Schools : Nyaya, Vaisheshika, Samkhya, Yoga, Mimamsa and Vedanta; Nastika School of Philosophy : Charvaka, Jainism and Bhuddhism; Yoga and Spirituality

UNIT-IV

Traditional Knowledge System : Definition of Traditional knowledge, Indigenous Knowledge System; Case studies of Ancient traditional Knowledge System Astronomy, Vastu-Shatras, Wootz Steel lost technology of IKS, Water Management, and Agriculture

UNIT – V

Protection of Traditional Knowledge: Significance and Need of Protection of Traditional Knowledge and measure for protection of TK, Role of the Government to harness TK. Documentation and Preservation of IKS , Approaches for conservation and Management of nature and bio-resources, Approaches and strategies to protection and conservation of IKS.

SUGGESTED READING:

1	Siva Rama krishna (Ed.). Cultural Heritage of Lndia-Cou rse Material, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014
2	Swami Jirntman and. Modern Physics and Vedant, Bharati ya V idya Bhavan
3	Fritzof Capra. Tao of Physics

4	Fritzof Capra, The wave of Life
5	V N Jba (Eng. Trans.). Tarkasangraha of Annam Bhana, lnernational Chinmay Foundation, Velliamad. Amaku.am
6	Yoga Sutra of Patanjali, Ramakrishna Mission. Kolkatta
7	GN Jha(Eng. Trans.) Ed. R N Jha, Yoga-darshanam with VyasaBhashya. Vidyanidhi Prakasham, Delhi, 2016
8	RN Jha. Science of Consciousness Psychotherapy and Yoga Practices. Vidya nidhi Prakasham, Delhi. 2016
9	P R Sha.min (English translation). Shodashang Hridayam

MC 806HS	STRESS MANAGEMENT BY YOGA					
Pre-requisites			**L**	**T**	**P**	**C**
			3	-		0
Evaluation	**SEE**	60 Marks	**CIE**		40 Marks	

Course Objectives :	
The course is taught with the objectives of enabling the student to:	
1	Creating awareness about different types of stress and the role of yoga in the management of stress.
2	Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
3	Prevention of stress related health problems by yoga practice.

Course Outcomes :	
On completion of this course, the student will be able to :	
CO-1	To understand yoga and its benefits.
CO-2	Enhance Physical strength and flexibility.
CO-3	Learn to relax and focus.
CO-4	Relieve physical and mental tension through Asanas
CO-5	Improve work performance and efficiency.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

UNIT – I
Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

UNIT – II
Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT – III
Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

UNIT – IV
Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

UNIT – V
Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama – Kapalabhati- Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.
Meditation techniques: Om Meditation - Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT).

Suggested Reading:

1	"Yogic Asanas for Group Training - Part-I": Janardhan Swami Yogabhyasi Mandal, Nagpur
2	"Rajayoga or Conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
3	Nagendra H.R nad Nagaratna R, "Yoga Perspective in Stress Management", Bangalore, Swami Vivekananda Yoga Prakashan

Web resource:

1	https://onlinecourses.nptel.ac.in/noc16_ge04/preview
2	https://freevideolectures.com/course/3539/indian-philosophy/11

PW 861 EC	PROJECT WORK-II					
Pre-requisites	--		**L**	**T**	**P**	**C**
					12	**6**
Evaluation	**SEE**	100 Marks	**CIE**		50 Marks	

Course Objectives:	
The course is taught with the objectives of enabling the student to:	
1	To enhance practical and professional skills.
2	To familiarize tools and techniques of systematic Literature survey and documentation
3	To expose the students to industry practices and team work.
4	To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes:	
On completion of this course, the student will be able to :	
CO-1	Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems
CO-2	Evaluate different solutions based on economic and technical feasibility
CO-3	Effectively plan a project and confidently perform all aspects of project management
CO-4	Demonstrate effective written and oral communications kills
CO-5	Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to real-world problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	-	-	1	-	1	-	1	1		2
CO2	1	-	3	2	1	-	2	1		-	2	-		2
CO3	-	1	2	1	3	2	-	-	3	-	-	-	2	2
CO4	-	-	-	1	-	1	-	2	1	3	-	1	2	
CO5	-	1	1	1	-	-	-	1	1	-	1	1	2	2

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

The aim of project work –II is to implement and evaluate the proposal made as part of project – I. Students can also be encouraged to do full time internship as part of project work-II based on the common guidelines for all the departments. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:

1. Re-grouping of students -deletion of inters hip candidates from groups made as part of project work-I
2. Re-Allotment of internship students to project guides

3. Project monitoring at regular intervals

All re-grouping/re-allotment has to be completed by the 1nd week of VIIIth semester so that students get sufficient time for completion of the project.

All projects (internship and departmental) will be monitored at least twice in a semester through student presentation for the award of Sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for 25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction.

Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.