

OPEN ELECTIVE COURSES (OEC)

Curriculum for Under Graduate Courses in Engineering as approved in the
UG Council Meeting dated on 24.11.2020, Resolution No. 2



THE UNIVERSITY OF BURDWAN
RAJBATI - 713104

Common Open Elective Courses (OEC)

Sl. No.	Paper code	Semester	Slot	Name of the paper	Page No.
1.	OEC-HU 521(a)	5th	I	Sanskrit for Technical Knowledge	3
2.	OEC-PH 521(b)	5th	I	Material Science	4
3.	OEC-EC 521(c)	5th	I	Bio Medical Electronics	6
4.	OEC-CS 521(d)	5th	I	Introduction to Object Oriented Technology & Python	7
5.	OEC-EI 521(e)	5th	I	Optical Instrumentation	9
6.	OEC-HU 621(a)	6th	I	History of Science & Engineering in India	11
7.	OEC-HU 621(b)	6th	I	Infrastructure Finance	13
8.	OEC-EC 621(c)	6th	I	Microprocessors & Its Applications	15
9.	OEC-EI 621 (d)	6th	I	Microprocessors & Its Programming	17
10.	OEC-M 621(e)	6th	I	Computational Methods	18
11.	OEC-HU 721(a)	7th	I	Introduction to Comparative literature	20
12.	OEC-HU 721(b)	7th	I	Economic Policies in India	21
13.	OEC-M 721(c)	7th	I	Mathematical Formulation & Approximations	24
14.	OEC-HU 721(d)	7th	I	Soft Skills & Interpersonal Communication	25
15.	OEC-EI 721(e)	7th	I	MEMS	27
16.	OEC-EC 721(f)	7th	I	Nano Electronics	29
17.	OEC-EE 722(a)	7th	II	Renewable Energy	31
18.	OEC-ME 722(b)	7th	II	Modern Manufacturing Practice	33
19.	OEC-ME 722(c)	7th	II	Thermal Engineering & Fluid Machinery	35
20.	OEC-M 821(a)	8th	I	Advanced Operations Research	38
21.	OEC-EE 821(b)	8th	I	Advanced Topics in Power Systems	39
22.	OEC-HU 821(c)	8th	I	Quality Control & Management	41
23.	OEC-HU 821(d)	8th	I	Cyber Law and Computer Ethics	43
24.	OEC-EC 821(e)	8th	I	Satellite Communication	45
25.	OEC-EE 821(f)	8th	I	Energy Audit & Management	46
26.	OEC-HU 822(a)	8th	II	Digital Marketing	48
27.	OEC-HU 822(b)	8th	II	Human Resource Development & Organizational Behavior	50
28.	OEC-EC 822(c)	8th	II	Machine Learning	52
29.	OEC-EI 822(d)	8th	II	Sensor Technology	54
30.	OEC-EE 822(e)	8th	II	Automotive Control & Robotics	55
31.	OEC-ME 822(f)	8th	II	Power Plant Engineering	57

DETAILED SYLLABUS

Course code	OEC-HU 521(a)				
Category	Open Elective Course (OEC)				
Course title	Sanskrit for Technical Knowledge				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Alphabets in Sanskrit	5L
2	Past/Present/Future Tense	5L
2.	Simple Sentences	4L
3.	Order, Introduction of roots,	8L
4.	Technical information about Sanskrit Literature,	8L
5	Technical concepts of Engineering-Electrical, Mechanical, Civil, Architecture, Mathematics, Computer Science, Electronics.	12L
	Total:	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

Books: Text and/or Reference:

1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. Teach Yourself Sanskrit” Prathama Deeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi.

Course outcomes:

On completion of the course students will be able to:

- Understand the basic Sanskrit language.
- Learn Ancient Sanskrit literature about science & technology.
- Improve brain functioning as Sanskrit being a logical language.
- Explore the knowledge from ancient literature.

Course code	OEC-PH 521(b)				
Category	Open Elective Course (OEC)				
Course title	Material Science				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)					

Detailed contents:

Module	Detailed Description	Lecture / Tutorial Period
1.	Electronic Materials: Fermi energy and Fermi–Dirac distribution function – Variation of Fermi level with temperature in intrinsic and extrinsic semiconductors – Hall effect – Dilute Magnetic Semiconductors (DMS) and their applications Superconducting Materials: Normal and High temperature superconductivity – Applications.	5L
2	Photonic Materials: LED – LASER – Photo conducting materials – Photo detectors- Photodiode materials – Photonic crystals and applications – Elementary ideas of Non-linear optical materials and their applications.	6L
3	Magnetic Materials: Classification of magnetic materials based on spin – Hard and soft magnetic materials – Ferrites, garnets and magnetoplumbites – Magnetic bubbles and their applications – Magnetic thin films – Spintronic and devices (Optically tunable magneto resistance(OTMR), Giant magneto resistance(GMR), Tunnel magneto resistance(TMR) and Colossal magneto resistance(CMR)).	6L
4	Dielectric Materials: Polarization mechanisms in dielectrics – Frequency and temperature dependence of polarization mechanism – Dielectric loss – Dielectric waveguide and dielectric resonator antenna – Piezoelectric, pyroelectric and ferroelectric materials and their applications.	4L
5	Modern Engineering Materials: Smart materials – Shape memory alloys – Chromic materials (Thermo, Photo and Electro) – Rheological fluids – Metallic glasses – Advanced ceramics – Composites.	3L
6	Biomaterials: Classification of bio-materials (based on tissue response) – Comparison of properties of some common biomaterials – Metallic implant materials (stainless steel, cobalt-based and titanium-based alloys) –	6L

	Polymeric implant materials (Polyamides, polypropylene, Acrylic resins and Hydrogels) – Tissue replacement implants – Soft and hard tissue replacements – Skin implants – Tissue engineering – Biomaterials for organ replacement (Bone substitutes) – Biosensor.	
7	Introduction To Nanoscience And Nanotechnology: Basic concepts of Nanoscience and Nanotechnology – Quantum wire – Quantum well – Quantum dot – fullerenes – Graphene – Carbon nanotubes – Material processing by chemical vapor deposition and physical vapor deposition – Principle of SEM, TEM, AFM, Scanning near-field optical microscopy (SNOM) – Scanning ion-conducting microscopy (SCIM) – Potential uses of nanomaterials in electronics, robotics, computers, sensors, sports equipment, mobile electronic devices, vehicles and transportation – Medical applications of nanomaterials.	6L
8	Materials Characterization: X-ray diffraction, Neutron diffraction and Electron diffraction– X-ray fluorescence spectroscopy – Fourier transform Infrared spectroscopy (FTIR) – Ultraviolet and visible spectroscopy (UV-Vis) – Thermogravimetric Analysis (TGA) – Differential Thermal Analysis (DTA) – Differential Scanning Calorimetry (DSC).	6L
	Total	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

Books: Text and/or Reference:

1. Materials Sciences- Thiruvadigal, J. D., Ponnusamy, S., Sudha.D. and Krishna Mohan M., Vibrant Publication, Chennai, 2013
2. Materials Science- Rajendran.V, Tata McGraw- Hill, New Delhi, 2011

Reference Books

1. Electronic Properties of Materials- Rolf E. Hummel, 4th ed., Springer, New York, 2011.
2. Photonic Crystals: Theory, Applications, and Fabrication- Dennis W. Prather, John Wiley & Sons, Hoboken, 2009.
3. Scientific Charge-Coupled Devices- James R. Janesick, Published by SPIE - The International Society for Optical Engineering, Bellingham, Washington, 2001.
4. Microwave Engineering- David M. Pozar, 3rd ed., John Wiley & Sons, 2005.
5. Biocompatibility: Interactions of Biological and Implantable Materials- Silver.F, and Dillion.C, VCH Publishers, New York, 1989.
6. Polymeric Biomaterials- SeverialDumitriu, Marcel Dekker Inc, CRC Press, Canada 2001.
7. Nanostructures and Nanomaterials: Synthesis, Properties and Applications- Cao.G, Imperial College Press, 2004.
8. A Text Book of Nanoscience and Nanotechnology- Pradeep.T, Tata McGraw Hill, New Delhi, 2012.
9. Materials Characterization Techniques- Sam Zhang, CRC Press, 2008.

Course outcomes

After completing the course the students will be able to-

- Acquire basic understanding of advanced engineering materials, their functions and properties for technological applications in different rapidly evolving field of material science
- Use information in different materials selection for the design process
- Understand the principal classes of bio-materials and their functionalities in modern medical science
- Acquire basic understanding about the new concepts of Nano Science and Technology
- Acquire basic understanding in the basics of instrumentation, measurement, data acquisition, interpretation and analysis

Course code	OEC-EC 521 (c)				
Category	Open Elective Course (OEC)				
Course title	Bio Medical Electronics				
Scheme and Credits	L	T	P	Credits	Semester –V
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 401, PCC-EC 302				

Theory Syllabus:

Unit No.	Detailed Description	Lecture/ Tutorial Period
1.	Biomedical Instruments and Transducers: Introduction of biomedical instrumentation and techniques. Biometrics. Components of a man-instrument system and evoked problems. Basic Transducer Principle- Active and Passive Transducers. Their applications in biomedical instrumentation.	9L
2.	Bioelectric Potentials and Instruments: resting and action potentials, propagation and action potentials and bioelectric potentials. Electrodes- Electrodes theory. ECG, EMG and EEG instruments, their working principles and associated electronic circuits.	12L
3.	Noninvasive Diagnostic Instrumentation: Measurement of blood pressure, blood flow, Cardiac output and Heart sound. Measurements of the respiratory system, Plethysmography. Temperature measurement, Principles of Ultrasonic Measurement and Ultrasonic Diagnosis.	16L

4.	Automation and Safety Measurements: Application of computer in bio-instrumentation, Bio-telemetry, bio-sensors-techniques and applications. Safety and precautions of biomedical equipment's.	5L
	Total:	42L
	Total Week Required:	14
	No. of Week Reserved:	02

Text and/or Reference Books:

1. L. Cromwell, "Biomedical Instrumentation and Measurements", Pearson Education.
2. J.J. Carr, "Introduction to Biomedical Equipment Technology", Pearson Education.
3. R.S.Khandpur, "Handbook of Biomedical Instrumentation", TMH, New Delhi.
4. N.Pandey, "Bio-Medical Electronics and Instrumentation", Katson books, New Delhi.

Course Outcomes:

At the end of the syllabus students will be able to

1. Characterize the nature of signals of human anatomy
2. Compare the physiological parameters of different bio medical signals
3. Identify and measure of non-electrical parameters
4. Use the sensors for corresponding purposes
5. Use and analyze the multimedia tools for better diagnostics and therapy.

Course code	OEC-CSE 521(d)				
Category	Open Elective Course				
Course title	Introduction to Object Oriented Technology and Python				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	ESC-CSE 101				

Objectives of the course: Throughout the course, students will be expected to demonstrate their understanding of Introduction to Object Oriented Technology and Python by being able to do the following:

- Introduce the principles of object-oriented programming in a higher-level programming language, such as Python.

- Analyze a problem statement to develop a model of objects necessary to create software architecture.
- Utilize object-oriented programming to frame software architectures, with care towards separation of concerns and abstraction.
- Gain skills in designing, and programming software for reuse of code.

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	Introduction: Fundamental Principles of Object Oriented Programming, Paradigms and Idea, Benefits of OOP, Limitation of OOP, Object-oriented languages. Class and Object: Class fundamentals, Declaring objects, Variables, Methods, Constructors, Destructor, Overloading, Using Objects as Parameters, Returning Objects,	10L
2.	Operator Overloading and Inheritance: Concept of operator overloading, Different types of operator Overloading, Concept of inheritance, Different types of inheritance in derived classes and implementation. Polymorphism: Concept of Polymorphism, Different types of Polymorphism, Advantages and limitation of it.	10L
3.	File Operations and Exception Handling: Different mode of File access, Different I/O methods for file, Concept of Exception Handling, Components of Exception Handling. Packaging and Testing: Concept of Module, Idea and Implementation of Package, Importance of Testing, Implementation of it.	10L
4.	Introduction of Python: History, Features, Python Compiler, Variable and Data Types, Operators, Looping, Conditional and Control Statements, String Manipulation, List, Tuple, Dictionary. Python Implementation of OO Programming: Class, Object, Instance and Class Attribute, Inspecting and Overriding, Function, Decorator, Lambda, Inheritance, Composition, Module, Package, Testing, Exception Handling, Real life Problem Solving.	12L
	Total	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

Books: Text and/or Reference:

1. "Programming in an Object-Oriented Environment", Raimund K. Ege, Academic Press.
2. "Introduction to Object Oriented Programming", S. Sureshkumar, Educreation Publishing.
3. "The Fundamental Concepts of Object-Oriented Programming ", Dimitrios Kalemis , CreateSpace.
4. "Python Programming - Using Problem Solving Approach", Thareja Reema, OUP India.
5. "Mastering Object-Oriented Python ", Lott Steven F, Packt Publishing Limited.
6. "Hands-on Python Tutorial, Release 2.0", Andrew N. Harrington.

Course Outcomes:

On completion of the syllabus, students will be able to:

- Develop understanding of writing object-oriented programs that combine functions and data.
- Analyze a problem statement to develop a model of objects necessary to create software architecture.
- Combine previously written code into larger programs.
- Translate abstract concepts into Class's in software.
- Apply the object-oriented programming language to develop software, including programs utilizing multiple Classes'.
- Instruct others in the use of the object-oriented programming language.

Course Code	OEC-EI 521 (e)				
Category	Open Elective Course (OEC)				
Course Title	Optical Instrumentation				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)	Industrial Instrumentation				

Course Objectives:

1. To introduce to the different aspects of optical phenomenon.
2. To acquaint with optical concepts of interference, deflection, polarization, and holography.
3. To study the devices viz. LASER, LED and optical detectors.
4. To learn about the measurement of different parameters using optical sensors and detectors.
5. To expose to the basic concepts of optical fibers, their properties and communication through them.

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	<p>Introduction to Radiometry & Photometry: EM spectrum, Wave Particle Duality. Laws related to black body radiation Plank's Law, Wien Displacement Law, Stefan's Law, Beer Lambert Law, Wave front, Group Index, Group velocity, Phase velocity,</p> <p>Optical Phenomena: Reflection, Refraction, Interference, Diffraction, Polarization, Dispersion, Scattering - Principles and Devices to measure the Phenomena. Interferometer – Principle, Types.</p> <p>Optical Modulators: Kerr Effect; Pockel Effect; Phase & Polarization Modulator; Mach-Zehnder Modulator, Coupled Waveguide Modulator, Acoustic Optic Modulator.</p>	11 L
2.	<p>LASER: Principle and Sources, Lasing Mechanism, Basic Properties, Spontaneous emission, Stimulated emission, Absorption, Einstein's Assumptions, Population Inversion, 3 – level, 4 – level, Metastable state, Laser pumping, Semiconductor based lasers - Double hetero-junction broad area laser, Stripe geometry DH laser, Q – switching, Mode locking, Ruby Laser, CO2 Laser, Ga-As Laser, Modes, Resonant Cavity Types.</p> <p>Holography – Generation & Reconstruction.</p>	10 L
3.	<p>LED: Characteristics, Principle, Basic Structure, Electro luminescence, pn junction principles, LED materials, Power & efficiency, Fermi level, Compensation doping, Energy Band diagram, Hetero-junction high intensity LED.</p> <p>Photo-detectors: LDR, Principle of pn junction photodiode, PIN photodiode, Avalanche photodiode, Silicon APD, InGaAs APD, Phototransistor, Hetero-junction PD, Schottky PD, Noise in PD, Noise Equivalent Power, SNR of PDs. Opto-isolators, Opto-couplers.</p>	11 L
4	<p>Fibre Optics: Materials, Construction, Operational Modes, Step Index, Graded Index, Numerical Aperture, Ray propagation, Dispersion, Attenuations, Scattering, Fibre Losses. Joint loss, Splices, connectors, Fibre Manufacturing, Fibre Coupling, Encoding based position sensor.</p> <p>Optical Measurements: Temperature, Displacement, Pressure; Liquid-level; Optical Time Domain Refractometer, Charge Coupled Devices. Optical Gyroscopes, Velocity meter.</p> <p>Optical Instrument Applications: Optical Coherence Tomography, Endoscopy, Lithographic System, Microscopy, Telescope. Spectral Imaging System.</p>	10 L
	Total	42 L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. P. Bhattacharjee, Semiconductor Optoelectronic Devices, Pearson.
2. W. Hawkes, Optoelectronics- An Introduction, PHI.
3. C. K. Sarkar, Optoelectronics and Fiberoptics communication, New Age International.
4. Kasap, Optoelectronics and Photonics: Principles and practices, Allied Publishers Limited, Chennai, 2001.
5. Optical Semiconductor Devices, Allied Publishers Limited, Chennai, 1999.
6. Fukuda Culshaw B and Dakin J (Eds.), Optical Fibre Sensors I, Vols. I, II and III, Artech House, 1989.

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

- CO1: Elucidate the phenomena of optics, and methods ds of interferometry.
 CO2: Delineate the basic concepts of optical transmitting and receiving.
 CO3: Describe different optical devices.
 CO4: Delineate the selection of the appropriate optical sensors for industrial and medical application.

Course Code	OEC-HU 621(a)				
Category	Open Elective Course				
Course title	History Of Science & Engineering In India				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	<p>Concepts And Perspectives:</p> <p>Meaning of History</p> <p>Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history.</p> <p>Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism.</p> <p>Science and Technology-Meaning, Scope and importance, Interaction of science, technology & society, Sources of history on science and technology in India.</p>	8L

2.	Historiography Of Science And Engineering In India:- Introduction to the works of D.D. Kosambi, Dhanupal, Debiprasad Chattopadhyay, Rebman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.	8L
3.	Science And Engineering In Ancient India: Technology in pre-historic period. Beginning of agriculture and its impact on technology. Science and Technology during Vedic and Later Vedic times. Science and technology from I st century AD to C-1200.	8L
4	Science And Engineering In Medieval India: Legacy of technology in Medieval India, interactions with Arabs. Development in medical knowledge, interaction between Unani and Ayurveda and Alchemy. Astronomy and Mathematics: interaction with Arabic Sciences. Science and Technology on the eve of British conquest.	8L
5.	Science And Engineering In Colonial India: Science and the Empire. Indian response to Western Science. Growth of techno-scientific institutions.	4L
6.	Science And Engineering In A Post-Independent India: Science, Technology and Development discourse. Shaping of the Science and Technology Policy. Developments in the field of Science and Technology. Science and technology in globalizing India. Social implications of new technologies like the information Technology and Biotechnology	6L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. History of Science and Technology in India: K. Kumudamani
2. Science and Technology Volume 5 of History of Science and Technology in India: Eds. G. Kuppuram, K. Kumudamani I Sundeep Prakashan, 1990.
3. O. P. Jaggi, History of Science and Technology in India: Science and technology in mediaeval India-Medicine .Atma Ram, 1981
4. History of Science and Technology in Ancient India: The beginnings- Science. D. Chattopadhyay Firma KLM, 1986.
5. History of Science and Technology in India: G. Kuppuram, K. Kumudamani Geology Sundeep Prakashan, 1990.

Course outcomes: After completion of the course, students will be able to:

- Develop the concepts and perspectives of history of Science and Engineering including sources, generalization and moral judgment, scope and importance, interaction of science, technology & society in India.

- Learn the contribution of the some well-known scholars in the field of Science and Engineering
- Trace the gradual developments in Science and Engineering from ancient to post –independent India.
- Understand the development of sustainable and locally adaptable technologies and traditional scientific knowledge of India.
- Comprehend the socio-cultural and philosophical context in which the various scientific and technological ideas got developed in India and thereby help in repositioning India's contribution in Science and Engineering.

Course Code	OEC-HU 621(b)				
Category	Open Elective Course (OEC)				
Course title	Infrastructure Finance				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Course Content	Lecture / Tutorial Period
1	<p>Infrastructure Development – Introduction Definition of infrastructure; Multiplier effects of infrastructure development on economic development of the nation Sources of financing infrastructure projects: Traditional and private investments; Various financial instruments. Limitations of traditional procurement system of infrastructure; Legal frameworks and Incentives for private sector participation in infrastructure development.</p> <p>Public Private Partnerships – Procurement Process Introduction to infrastructure development through PPP route; Benefits of PPP mode of procurement; Types of PPP Models and their contractual structure. Stakeholders' perspectives: Granting authority, Funders and Concessionaire Government's role in successful PPP projects. Financial and Economic Appraisal of BOT Projects; VFM evaluation PPP procurement process; Lifecycle of PPP projects, Contractual package of PPP project; Bankable concession agreement. Case studies- Procurement process of Indian PPP projects</p>	12L

2	Concession – Design and Award Introduction to concession design and award Concession Design: Price setting; Price adjustment; Specific performance targets; Penalties and bonuses; Public parties" security rights; Duration, termination, and compensation; Force majeure and other unforeseen changes; Dispute settlement Concession Award: Competitive bidding; Direct negotiations and unsolicited proposals; Competitive negotiations; Prequalification and shortlisting; Bid structure and evaluation; Bidding rules and procedures Case study – Model concession agreements of highways projects in India	8L
3.	Risk Management of Infrastructure Projects Risks associated with various infrastructure projects; Introduction to risk management concept Risk analysis techniques, Risk mitigation strategies, Risk allocation frameworks of major infrastructure projects procured through various PPP modes Case study – Risk allocation frameworks of Indian PPP projects	9L
4.	Project Finance Introduction to project financing concept Analysis of project viability Designing security arrangements, Preparing the project financing plan Case study – Financial structure and infrastructure project finance Credit Rating of Infrastructure Projects Introduction to credit rating of infrastructure projects and role of credit ratings in financing infrastructure projects Rating frameworks of various national and international credit rating agencies for infrastructure projects in various sectors.	13L
	Total	42L
	No. of Weeks Required	14
	No. of Weeks in Hand	2

Text/Reference Books:

- 1) Public-Private Partnerships - Managing risks and opportunities: Akintoye, A., Beck, M., & Hardcastle, C. (Eds.). (2003)Oxford: Blackwell Science Limited.
- 2) Project financing - Asset-based financial engineering: Finnerty, J. D. (1996). New York: John Wiley & Sons, Inc.
- 3) Financing infrastructure projects (First ed.): Merna, T., &Njiru, C. (2002). London: Thomas Telford.
- 4) Project financing (7 ed.). Nevitt, P. K., &Fabozzi, F. J. (2000): London, UK: Euro money Books.
- 5) Infrastructure Development and Financing Towards a Public-Private Partnership: Raghuram, G.,Jain,R.,Sinha, S.,Pangotra,P.,&Morris,S.(2000).MacMillan

Course outcomes:

After completion of the course, the student will able to:

- Get knowledge about infrastructure and its development procedures.
- Analysis of different types of infrastructure and its impact in connecting supply chains and efficiently movement of goods and services across borders. .
- Understand deeply the role of PPP allowing the Government to leverage private capital for meeting the widening demand-supply gap in the provision of infrastructure services.
- Develop knowledge of different types of concessions and awards available to private sector to ensure their participation in infrastructure through the use of these concession contracts with private operators and developers.
- Know and become enable to identify and analyze risks associated with the infrastructure projects and find strategies to mitigate the risks.
- Develop the concept of project financing, ability of analyzing project viability and project financing plan.
- Get knowledge about different credit rating agencies and their role in developing new credit rating framework for infrastructure projects that would facilitate greater participation by long-term investors.

Course code	OEC-EC 621(c)				
Category	Open Elective Course (OEC)				
Course Title	Microprocessors and Its Applications				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	ESC-CSE 302				

Theory Syllabus:

Unit No.	Detailed Description	Lecture/ Tutorial Period
1.	Introduction and Architecture of 8085: Introduction to microprocessors, 8085 Architecture – Instruction set – Addressing modes – Timing diagrams – Assembly language programming – Counters – Time Delays – Interrupts – Memory interfacing – Interfacing, I/O devices.	5L
2.	Interfacing: Interfacing Serial I/O (8251) - parallel I/O (8255) – Keyboard and Display controller (8279) – ADC/DAC interfacing – Inter Integrated Circuits interfacing (I2C Standard) - Bus: RS232C-RS485-GPIB.	10L

3.	Architecture of 8086: Intel 8086 Internal Architecture – 8086 Addressing modes- Instruction set- 8086 Assembly language Programming–Interrupts.	10L
4	Microcontrollers: 8051 Micro controller hardware- I/O pins, ports and circuits- External memory –Counters and Timers-Serial Data I/O- Interrupts-Interfacing to external memory and 8255.ARM, PIC, AVR Microcontrollers.	10L
5.	Peripherals: 8051 instruction set – Addressing modes – Assembly language programming – I/O port programming -Timer and counter programming – Serial Communication – Interrupt programming –8051 Interfacing: LCD, ADC, Sensors, Stepper Motors, Keyboard and DAC.	7L
	Total	42 L
	Total Week Required	14
	No. of Week Reserved	02

Text and/or Reference Books:

1. Gaonkar Ramesh S, “Microprocessor Architecture, Programming and application with 8085”, 4th Edition, Penram International Publishing, New Delhi, 2000. (Unit I, II)
2. Uffenbeck John, “The 80x 86 Families, Design, Programming and Interfacing”, Third Edition. Pearson Education, 2002.
3. Mazidi Mohammed Ali and Mazidi Janice Gillispie, “The 8051 Microcontroller and Embedded Systems”, Pearson Education Asia, New Delhi, 2003. (Unit IV, V)
4. Ray A.K. and Burchandi K.M., “Intel Microprocessors Architecture Programming and Interfacing”, McGraw Hill International Edition, 2000
5. Ayala Kenneth J, “The 8051 Microcontroller Architecture Programming and Application”, 2nd Edition, Penram International Publishers (India), New Delhi, 1996.
6. Quazzaman M. Rafi, “Microprocessors Theory and Applications: Intel and Motorola” prentice Hall of India, Pvt. Ltd., New Delhi, 2003

Course Outcomes:

After completion of the course student will be able to learn about the following:

1. Describe the architecture of 8085, 8051 and 8086.
2. Illustrate the organization of registers and memory in microprocessors.
3. Differentiate Minimum and Maximum Mode bus cycle.
4. Identify the addressing mode of an instruction.
5. Develop programming skills in assembly language.
6. Compare the CISC and RISC processors.

Course code	OEC-EI 621 (d)				
Category	Open Elective Course (OEC)				
Course title	Microprocessors & Its Programming				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	Digital Logic				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction: Generic-8-bit microprocessor and its architecture, 8085 functional blocks, Memory mapping, Memory interfacing, addressing modes, instruction cycle, timing diagram, different machine cycles-fetch and execute operations. Interrupts: Different types of Interrupts, Interrupt service routine. Design of programs using interrupts.	6L
2.	Programming the 8085: Assemblers and Cross-compilers. Assembly language Programming - Instruction format, Instruction set, delay programs, flowcharts, Stack and subroutine.	10L
3	16 bit microprocessor (8086): Architecture of 8086 Microprocessor-functions of general purpose registers-flags and flag register, Memory segmentation and memory organization concepts, Instruction set, assembly language programming concepts.	10L
4	8bit microcontroller (8051): Architecture of 8051, Internal block diagram, SFRs, Clock and RESET circuits, Stack and Stack Pointer, I/O ports, memory structures, Data and Program memory, Timing diagrams and execution cycles, addressing modes, Instruction syntax, Data types, role of microcontrollers in embedded Systems. 8051 Instruction set, Instruction timings. Assembly language programs, Assemblers and compilers. Programming and debugging tools.	10L
5	Data Transfer Schemes & Interfacing: Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, timers, memory devices.	6L
	TOTAL:	42L
	Total Weeks Required:	14
	No. of Weeks Reserved:	02

Text/Reference Books:

1. Microprocessor Architecture Programming & Applications with 8085 /8080: Ramesh S Gaonkar.
2. Digital Computer Electronics An Introduction to Microcomputers : Malvino.
3. Advanced Microprocessor: Roy and Bhurchandi.
4. Assembly Language Programming : Lance A. Lventahl.
5. Microprocessors Theory & Applications : M Rafiquzzaman.
6. Microcomputer Systems The 8086 / 8088 family Architecture, Programming & Design : Liu & Gibson
7. Microprocessor & Interfacing Programming & Hardware: Douglas V. Hall
8. The Intel Microprocessors: Barry B. Brey.
9. M. A.Mazidi, J. G. Mazidi and R. D. McKinlay, "The8051Microcontroller and Embedded Systems: Using Assembly and C",Pearson Education, 2007.
10. K. J. Ayala, "8051 Microcontroller", Delmar Cengage Learning, 2004.

Course outcomes:

After completion of the course, the student will able to:

CO1: Apply assembly language programming.

CO2: Interface with memory devices.

CO3: Design interfacing circuit with peripherals like I/O, A/D, D/A, timer etc.

CO4: Develop systems using different microprocessors.

CO5: Develop microcontroller based embedded systems.

Course code	OEC-M 621(e)				
Category	Open Elective Course (OEC)				
Course title	Computational Methods				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)	Basic Knowledge of Differential and Integral Calculus				

Detailed Contents:

Module	Detailed Description	Lecture / Tutorial Period
1.	Laplace Transform Properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by Direct method, using Tables, Series method, Method of Differential Equation, Differentiation with respect to parameter. Convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs and PDEs by Laplace Transform method.	12L

2.	Fourier Transforms, Half range sine and cosine series, Parseval's theorem, its applications. Z-Transform and Wavelet Transforms: properties, methods, inverses and their applications	8L 6L
3.	Partial Differential Equation Solution of partial differential equations of first and second order, Classification and Canonical forms; Applications, Fourier series; separation of variables; solutions of one-dimensional diffusion equation; first and second order one-dimensional wave equation and two-dimensional Laplace equation.	8L
4.	Introduction to Data Science Network Theory and Random Graphs (Erdős–Rényi model), Watts–Strogatz model, the small-world phenomenon; Basic applications of Linear Algebra and Probability in Machine Learning; Basic applications of Probability and Statistics in Exploratory Data Analysis.	8L
	Total	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

Text / References:

1. Advanced Engineering Mathematics: Erwin Kreyszig, 9th Edition, John Wiley & Sons, 2006.
2. A text book of Engineering Mathematics: N.P. Bali and Manish Goyal Laxmi Publications, Reprint, 2010.
3. Higher Engineering Mathematics: B.S. Grewal Khanna Publishers, 35th Edition, 2000.
4. Engineering Mathematics: Veerarajan T., Tata McGraw-Hill, New Delhi, 2008.
5. Differential Equations: S. L. Ross 3rd Ed., Wiley India, 1984.
6. Differential equations with special functions: J N Sharma and R K Gupta, 20th Edition, Krishna Prakashan Mandir, 1991.
7. Ordinary Differential equations: Garrett Birkhoff, John Wiley & Sons; 4th Edition (1989)

Course Outcomes:

After completing the course the students will be able to

- Comprehend the concept and application of Integral transform in order to solve different ordinary and partial differential equations arising in the real life engineering problems.
- Understand the governing rules and properties of Partial Differential Equations.
- Identify the effective mathematical tools for the solutions of different partial differential equations that model physical processes
- Understand the application of Combinatorics, Linear Algebra, Probability and Statistics in Network Theory, Random Graph, Machine Learning and Exploratory Data Analysis.

Course Code	OEC-HU 721(a)				
Category	Open Elective Courses				
Course Title	Introduction to Comparative Literature				
Scheme and credits	L	T	P	Credits	Semester—VII
	3	0	0	3	
Pre-requisites (if any)	Concept of literature				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Concept of Literature and Comparative Literature: Definition, Emergence, Scope and Development	5L
2.	Concept of Literary Terms: Poetry, Lyric, Sonnet, Epic, Hymn, Drama, Tragedy, Comedy, Fiction, Narrative, Essay, Short story, Play, Plot, Theme, Character, Text, Metaphor, Image, Symbol, Kavya	8L
3.	Tools of Comparative Literature: Literature, Indian Literature, National Literature, World Literature, Global Literature, Literary Periodization, Cultural study	6L
4.	Schools of Comparative Literature: French, German, American and Asian School	7L
5.	Methodology of Comparative Literature: Thematology, Genology, Historiography, Reception, Translation, Inter-literary Studies	7L
6.	Literary Theory: Structuralism, Post Structuralism, Reader Response Theory, Marxism, Gender Discourse, Theory of Translation, New Historicism, Post colonialism, Multiculturalism, Theory of Rasa-Theory of Dhvani	9L
	Total	42L
	Total week required	14
	No. of week reserved	02

Text Books/ Reference Books:

1. Comparative Literature: A Critical Introduction, Susan Basnett Blackwell, Oxford: 1993.
2. Beginning Theory: An Introduction to Literary and Cultural Theory. Peter Barry Viva Books, New Delhi: 2015.
3. Hand Book of Critical Approaches to Literature: Wilfred Guerin, Earle Labor, Lee Morgan, Jeanne C. Reesman, John R. Willingham. An Oxford University Press, New Delhi: 2010.

4. Comparative Literature in India: CLCWeb: Comparative Literature and Culture. Dev, Amiya Purdue University Press, 2.4 (2000)
5. Comparative Literature: Theory, Method, Application: Library Series, CLCWeb: Comparative Literature and Culture, Tötösy de Zepetnek, Steven Purdue University Press, 2011.

Course Outcomes:

On completion of the course students will be able to:

- Demonstrate the basic concept of literature, comparative literature, and history of comparative literature.
- Acquire fundamental knowledge in literary terms in the interdisciplinary field of comparative literature.
- Gather general knowledge on Literature, Indian Literature, National Literature, World Literature, Global Literature, Literary Periodization, Cultural study.
- Evaluate theory in two or more literary traditions, in a comparative framework, which is to say regional, across national, and disciplinary boundaries.
- Analyse critically different texts with the acquired knowledge of various theories and methodologies of comparative literature.
- Exhibit particular expertise in two or more literary traditions.

Course Code	OEC-HU721(b)				
Category	Open Elective Course (OEC)				
Course title	Economic Policies in India				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Economic Development and its Determinants: Approaches to economic development and its measurement – sustainable development; Role of State, market and other institutions; Indicators of development – PQLI, Human Development Index (HDI), gender development indices.	6L

2.	Planning in India: Objectives and strategy of planning; Failures and achievements of Plans; Developing grass-root organizations for development – Panchayats, NGOs and pressure groups.	6L
3.	Demographic Features, Poverty and Inequality Broad demographic features of Indian population; rural-urban migration; Urbanization and civic amenities; Poverty and Inequality.	5L
4	Resource Base and Infrastructure Energy; social infrastructure– education and health; Environment; Regional imbalance; Issues and policies in financing infrastructure development.	5L
5.	The Agricultural Sector Institutional Structure– land reforms in India; Technological change in agriculture– pricing of agricultural inputs and output; industry; Agricultural finance policy; Agricultural Marketing and Warehousing; Issues Terms of trade between agriculture and in food security– policies for sustainable agriculture. Section– II Industrial policy; Public Sector enterprises and their performance; Problem of sick units in India; Privatization and disinvestment debate; Growth and pattern of industrialization; Small- scale sector; Productivity in industrial sector; Exit policy– issues in labour market reforms; approaches for employment generation.	8L
6	Public Finances Fiscal federalism – Centre-State financial relations; Finances of central government; Finances of state governments; Parallel economy; Problems relating to fiscal policy; Fiscal sector reforms in India.	4L
7	Money, Banking and Prices Analysis of price behavior in India; Financial sector reforms ;Interstate policy; Review of monetary policy of RBI; Money and capital markets; Working of SEBI in India.	4L
8	External Sector Structure and direction of foreign trade; Balance of payments; Issues in export-import policy and FEMA; Exchange rate policy; Foreign capital and MNCs in India; The progress of trader forms in India. Economic Reforms Rationale of internal and external reforms; Globalization of Indian economy; WTO and its impact on the different sectors of the economy; Need for and issues in good governance; Issues in competition and safety nets in Indian economy	4L

	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. India's Economic Reforms and Development(Essays in honour of Manmohan Singh): Ahluwalia,I.J. and I.M. DLittle(Eds.)(1999),Oxford University Press, New Delhi.
2. The Political Economy of Development in India: Bardhan, P. K. (9th Edition)(1999), Oxford University Press, New Delhi.
3. Structural Changes in Indian Economy: Bawa,R.S. and P.S. Raikhy(Ed.)(1997)Guru Nanak Dev University Press, Amritsar.
4. Development Experience in the Indian Economy: Inter-State Perspectives, Brahmananda,P.R. and V. R.Panchmukhi(Eds.) (2001),Bookwell, Delhi.
5. Development Planning: The Indian Experience, Chakravarty, S. (1987), Oxford University Press, New Delhi.
6. Dilemmas of Growth :The Indian Experience, Dantwala, M.L.(1996),Sage Publications, New Delhi.
7. Second Generation Economic Reformsin India: Datt,R. (Ed.)(2001),Deep & Deep Publications, New Delhi.
8. Government of India, Economic Survey (Annual), Ministry of Finance, New Delhi.
9. Economic Planning in India, Jain, A.K. (1986), Ashish Publishing House, New Delhi.
The Indian Economy– Problems and Prospects: Jalan,B. (1992), Viking, New Delhi.
10. INDIA'S ECONOMIC POLICY: Jalan Bimal, PENGUIN, UK.
11. Resurgent India: Politics, Economics and Governance. :Bimal Jalan, HARPER COLLINS PUBLISHERS

Course outcomes:

After completion of the course, the student will able to:

- Get knowledge about Economic Policies in India and its relation with sustained growth , high employment and stable prices in the economy.
- Have general comprehension of different Determinants of economic development of a country and how to take care of these factors in decision making as a professional.
- Develop cognition about economic planning and its importance to make effective decisions about how to allocate the resources in a way that will enable the organization to maximize productivity by minimizing wastes of resources.
- Grow perception about demographic Features and its relation with Poverty and Inequality and between demographic change and economic outcomes.
- Get knowledge about the infrastructure and its role as a economic base in decision making of a concern as a part of whole implementation of economic policies of a country.
- Create awareness about importance of agriculture sector and different policies to remove the major problems of agricultural sector for sustainable development.

- Develop the concept of public finance, monetary policy and fiscal policy and its impact on business environment and decision making.
- Know the role of foreign trade and its impact on exchange rate policy and importance of economic reforms to generate higher growth, higher revenue, and higher productivity.

Course Code	OEC-M 721(c)				
Category	Open Elective Course (OEC)				
Course title	Mathematical Formulation and Approximation				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	Numerical Methods Accuracy and precision; error analysis. Numerical solutions of linear and non-linear algebraic equations; Least square approximation, Newton's and Lagrange's polynomials, numerical differentiation, Integration by trapezoidal and Simpson's rule, single and multi-step methods for first order differential equations. Fourier Series and its role in numerical approximation.	20L
2.	Ordinary Differential Equation First order (linear and non-linear) equations; higher order linear equations with constant coefficients; Euler-Cauchy equations; Laplace transform and its application in solving linear ODEs; initial and boundary value problems.	12L
3.	Partial Differential Equation Separation of variables; solutions of one-dimensional diffusion equation; first and second order one-dimensional wave equation and two-dimensional Laplace equation.	10L
	Total	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

Text/Reference Books:

1. An Introduction to Numerical Analysis (2nd Edn.)-Atkinson, John Wiley and sons
2. Numerical Analysis-James Blaine Scarborough, Oxford University Press
3. Numerical Methods-S.A. Mollah, Books and Allied Publishers
4. Numerical Analysis- R.Burden and Faires, Cengage Learning, 9thEdn. 2010
5. Numerical Methods for Engineers and Scientists- J.D. Hoffman, CRC Press, 2001
6. Differential equations with special functions- J N Sharma and R K Gupta,. 20th Edition, Krishna Prakashan Mandir, 1991.
7. Ordinary Differential equations- Garrett Birkhoff, John Wiley & Sons; 4 editions (1989)

Course Outcomes: After completing the course the students will be able to

- Apply various numerical techniques like numerical interpolation, numerical differentiation, numerical integration etc. in solving different engineering problems and also analyze the error occurred in such computation.
- Use the techniques of Regula-Falsi, Newton-Raphson, Bisection method etc. to solve algebraic and transcendental equations and Gauss-Jacobi, Gauss-Seidel iteration process for solving a system of linear equations.
- Use the numerical methods like Euler's method, Runge-Kutta, Milne's method etc for solving ODE which are otherwise impossible to solve analytically.
- The effective mathematical tools for the solutions of differential equations that model physical processes.

Course Code	OEC-HU 721(d)				
Category	Open Elective Course (OEC)				
Course title	Soft Skills and Interpersonal Communications				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	Introduction: A new approach to learning, planning and goal setting Human perceptions: Understanding people Types of soft skills: Self-management skills Aiming for excellence: Developing potential and self-actualization, Need achievement and spiritual intelligence.	5L

2.	Conflict Resolution Skills: Seeking Win-Win Solution Inter-Personal Conflicts: Two Examples, Two Solutions Types of Conflicts: Becoming a conflict resolution expert Types of Stress: self-awareness about stress, regulating stress making the best out of stress.	5L
3.	Habits: Guiding principles, identifying good and bad habits, habit cycle, breaking bad habits, using the Zeigarnik effect for productivity and personal growth, forming habits of success.	6L
4.	Communication: Significance of listening, active listening, barriers to active listening Telephone Communication: Basic telephone skills, advanced telephone skills, essential telephone skills	5L
5.	Technology and Communication: Technological personality, mobile personality, E-Mail principles, Netiquette, E-Mail etiquette.	5L
6.	Communication Skills: Effective Communication. Barriers to Communication: Arising out of Sender/Receiver's Personality, Interpersonal Transactions, and Miscommunication.	5L
7.	Nonverbal Communication: Introduction and importance, issues and types, basics and universals, interpreting non-verbal cues, Body Language: For interviews, for Group Discussions.	5L
8.	Presentation Skills: Overcoming fear, becoming a professional, the role of body language, using visuals Reading Skills: Effective reading Human Relations: Developing trust and integrity	6L
	Total	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

Text Books:

1. The ACE of Soft Skills: Gopalaswamy Ramesh and Mahadevan Ramesh Pearson, Delhi: 2010.
2. Personality Development and Soft Skills: Barun K. Mitra Oxford University Press. New Delhi: 2016.
3. Soft Skill: Know Yourself and Know the World: Dr. K. Alex S. Chand, New Delhi: 2009.
4. Interpersonal Skills at Work: John Hayes, Taylor & Francis Ltd. 2002.

Reference Books:

1. What Are Soft Skills?: Dorch, Patricia Execute Dress Publisher, New York: 2013.
2. Soft Skills Revolution: Guide for Connecting with Compassion for Trainers, Teams, and Leaders Kamin, Maxine Pfeiffer & Company, Washington, DC: 2013.
3. The Hard Truth about Soft Skills: Klaus, Peggy, Jane Rahman & Molly Hamaker Harper Collins E-books, London: 2007.

4. Soft Skills and Professional Communication: PetesS.J., Francis Tata McGraw-Hill Education, New Delhi: 2011.
5. E.Book. The EQ Edge: Emotional Intelligence and Your Success & Howard Wiley & Sons, Canada: 2006.

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

- Analyze an exercise their skills of appropriate communication including verbal and non verbal behaviors in dynamic interactions across cultural differences nationally and internationally.
- Increase listening skills and understand communication barriers and be well-versed in using divergent mediums for technical communications including telephone and E-mail etiquette and netiquette.
- Transform more effective individual through planning and goal setting, understanding people's perceptions, self-management and actualization skills.
- Show mastery in group discussion and interview by identifying inter-personal conflicts, good and bad habits, trust and integrity and cues of body language.
- Develop various attributes such as leadership, interpersonal skills, decision making abilities and conflict management's techniques that will help in their personal and professional life.
- Exhibit effective presentation skills using audio visual aids in professional domain.

Course code	OEC-EI 721(e)				
Category	Open Elective Course (OEC)				
Course title	MEMS				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Sensors & Transducers, Industrial Instrumentation				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction: Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication – Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.	9L

2.	Sensors And Actuators-I: Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors – Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph – Applications – Magnetic Actuators – Micromagnetic components – Case studies of MEMS in magnetic actuators-Actuation using Shape Memory Alloys.	9L
3.	Sensors And Actuators-II: Piezoresistive sensors – Piezoresistive sensor materials – Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.	9L
4	Micromachining: Silicon Anisotropic Etching – Anisotropic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies –Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistricition methods – LIGA Process - Assembly of 3D MEMS – Foundry process. Polymer And Optical Mems: Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.	15L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.
2. Stephen D Senturia, 'Microsystem Design', Springer Publication, 2000.
3. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002.
4. Nadim Maluf, " An Introduction to Micro Electro Mechanical System Design", Artech House, 2000.
5. Mohamed Gad-el-Hak, editor, " The MEMS Handbook", CRC press Baco Raton, 2001.
6. Julian w. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, Micro Sensors MEMS and Smart Devices, John Wiley & Son LTD, 2002.
7. James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005.
8. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer, 2010.
9. M. Madou, Fundamentals of Microfabrication, CRC Press, 1997.
10. M.H. Bao, Micromechanical Transducers: Pressure sensors, accelerometers, and Gyroscopes, Elsevier, New York, 2000.
11. S. E.Lyshevski, Nano-and Micro-Electromechanical systems: Fundamentals of Nano-and Microengineering (Vol. 8). CRC press, (2005).
12. G. Kovacs, Micromachined Transducers Sourcebook, McGraw-Hill, Boston, 1998.

Course outcomes: After completion of the course, the students will be able to:

CO1: Understand the operation of micro devices, micro systems and their applications.

CO2: Have a good idea of using MEMS in different actuators.

CO3: Design the micro devices, micro systems using the MEMS fabrication process.

CO4: Learn about the optical MEMS

Course code	OEC-EC 721(f)				
Category	Open Elective Course (OEC)				
Course title	Nano Electronics				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	PCC-EC 301				

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	Introduction to Nanotechnology and Quantum Devices: Meson structures, Basics of Quantum Mechanics: Schrodinger equation, Density of States. Particle in a box Concepts, Degeneracy. Band Theory of Solids. Kronig-Penny Model. Brillouin Zones. Charge and spin in single quantum dots- Coulomb blockade– Electrons in mesoscopic structures - single electron transfer devices (SETs) – Electron spin transistor – resonant tunnel diodes, tunnel FETs - quantum interference transistors (QUITs) - quantum dot cellular automata (QCA) - quantum bits (qubits), Carbon Nanotube electronics, 2Dsemiconductors and electronic devices, Graphene.	7L
2	Nanoelectronic Devices: Electronic transport in 1,2 and 3 dimensions- Quantum confinement - energy subbands - Effective mass – Drude conduction - mean free path in 3D - ballistic conduction - phase coherence length - quantized conductance -Buttiker-Landauer formula- electron transport in pn junctions - short channel NanoTransistor – MOSFETs, Advanced MOSFETs - Trigate FETs, FinFETs - CMOS.	6L
3.	Molecular Nanoelectronics: Electronic and optoelectronic properties of molecular materials - Electrodes & contacts – functions – molecular electronic devices - elementary circuits using organic molecules- Organic materials based rectifying diode switches – TFTs- OLEDs- OTFTs – logic switches.	8L

4.	Spintronics: Spin tunneling devices - Magnetic tunnel junctions- Tunneling spin polarization - Giant tunneling using MgO tunnel barriers - Tunnel-based spin injectors - Spin injection and spin transport in hybrid nanostructures - spin filters –spin diodes - Magnetic tunnel transistor - Memory devices and sensors - ferroelectric random access memory- MRAMS -Field Sensors - Multiferro electric sensors- Spintronic Biosensors.	8L
5.	Nanoelectronic Architectures and Computations: Architecture Principles: Mono and Multi-processor systems – Parallel data processing – Power Dissipation and Parallelism – Classic systolic arrays - Molecular devices-properties - Self-organization – Size dependent limitations. Computation: Monte Carlo Simulations- Computational methods and Simulations from Ab initio to multi scale Modeling of Nanodevices.	8L
6.	Nanostructuring by Physical Techniques: Next-Generation Technologies: – State-Of-The-Art (including principles, capabilities, limits, applications) EUV lithography – Phase-shifting photolithography – X-ray lithography – Electron Beam Direct Writing System – Focused ion beam (FIB) lithography – Neutral atomic beam lithography – Plasma-Aided Nanofabrication – Soft Lithography – Nanosphere Lithography – Nanoimprint – Dip-pen nanolithography – key consequences of adopted techniques	5L
	Total :	42L
	Total Week Required:	14
	Total Week Reserved:	02

Text/ Reference Books:

1. G.W. Hanson, “Fundamentals of Nanoelectronics”, Pearson, 2009.
2. W. Ranier, “Nanoelectronics and Information Technology (Advanced Electronic Material and Novel Devices)”, Wiley-VCH, 2003.
3. K.E. Drexler, “Nanosystems”, Wiley, 1992.
4. J.H. Davies, “The Physics of Low-Dimensional Semiconductors”, Cambridge University Press, 1998.
5. C.P. Poole, F. J. Owens, “Introduction to Nanotechnology”, Wiley, 2003
6. Guozhong Cao, “Nanostructures & Nanomaterials Synthesis”, Properties G; Z: Applications, World Scientific Publishing Private, Ltd., Singapore (2004).
7. W.R. Fahrner, “Nanotechnology and Nanoelectronics – Materials, Devices, Measurement Techniques”, Springer Verlag Berlin, Germany (2006)
8. R. H. J. Hannink and A. J. Hill, “Nanostructure control of materials”, Woodhead Publishing Limited and CRC Press LLC, Cambridge, England (2006).
9. Zheng Cui, “Nanofabrication, Principles, Capabilities and Limits”, Springer Science business media, New York (2008).
10. Hari Singh Nalwa, “Handbook of Nanostructured Materials and Nanotechnology (Vol. 3)”, Electrical Properties, Academic Press, San Diego, USA (2000).
11. Huff, Howard, “Into the Nano Era: Moore's Law Beyond Planar Silicon CMOS (Vol. 106)”, Springer Series in Materials Science, Springer-Verlag Berlin (2009).
12. Marc J. Madou, “Fundamentals of Microfabrication: The Science of Miniaturization”, 2nd Edition, CRC Press, California, USA (2002).

13. Kostya (Ken) Ostrikov and Shuyan Xu, “Plasma-Aided Nanofabrication: From Plasma Sources to Nanoassembly”, WILEY-VCH Verlag GmbH & Co. KGaA (Weinheim) (2007).

Course Outcomes: At the end of the course, students will demonstrate the ability to

1. Characterize various parameters of Nano-technology and the processes involved in making Nano components and material.
2. Characterize the Nano-materials and its appropriate uses.
3. Analyze the Nano-materials and its appropriate uses
4. Solve the Nano-material component design problems
5. Model Nano architecture and do computations
6. Apply Nano structuring by physical techniques.

Course code	OEC-EE 722(a)				
Category	Open Elective Course (OEC)				
Course title	Renewable Energy				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)	Engineering Physics courses				

Theory Syllabus:-

Module	Detailed Description	Lecture/ Tutorial
1.	Introduction to Energy sources: Renewable and non-renewable energy sources, energy consumption as a measure of Nation’s development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. Impact of renewable energy generation on environment, Kyoto Protocol.	3L
2.	Physics of Wind Power: History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions. Wind generator topologies: Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.	10L

3.	<p>The Solar Resource: Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.</p> <p>Solar photovoltaic: Technologies-Amorphous, mono-crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.</p> <p>Solar thermal power generation: Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.</p>	10L
4.	<p>Bio-mass energy: Biomass: Generation and utilization, Properties of biomass, Agriculture Crop & Forestry residues used as fuels. Biochemical and Thermo-chemical Conversion, Combustion, Gasification, Biomass gasifiers and types etc. Concept of Bio-energy: Photosynthesis process, Biomass resources Bio based chemicals and materials Thermo-chemical Conversion: Pyrolysis, Combustion, Gasification, Liquification. Bio-Chemical Conversion: Aerobic and Anaerobic conversion, Fermentation etc.</p> <p>Bio-fuels: Types of Bio-fuels, Bio fuel applications, Ethanol as a fuel for I.C. engines, Importance of biogas technology, Different Types of Biogas Plants. Aerobic and anaerobic bioconversion processes, various substrates used to produce Biogas. Removal of CO₂ and H₂O, Bio-hydrogen production.</p>	9L
5.	<p>Geothermal, tide and wave energy: Availability of Geothermal Energy-size and Distribution, Recovery of Geothermal Energy, Various Types of Systems to use Geothermal Energy, Direct heat applications, Power Generation using Geothermal Heat, Sustainability of Geothermal Source, Status of Geothermal Technology, Economics of Geothermal Energy.</p>	7L
6.	<p>Network Integration Issues:</p> <p>Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.</p>	3L
	Total:	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

Text/References Books:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.
3. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.

4. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.
5. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
6. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.

Course Outcomes: At the end of this course, students will demonstrate the ability to:

- Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.
- Understand the basic physics of wind and solar power generation.
- Understand the Bio-mass and Geothermal energy generation.
- Understand the issues related to the grid-integration of solar and wind energy systems.

Course code	OEC-ME 722(b)				
Category	Open Elective Course (OEC)				
Course title	Modern Manufacturing Practice				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	Introduction to Manufacturing Process: Engineering materials, Properties of engineering materials. Manufacturing technology, Types of shops and shop layouts. Introduction to the traditional manufacturing processes Metal cutting and joining process, Machine shop. Idea of CNC	3L
2.	Mechanical Advanced Machining Processes: Need and classification of nontraditional machining processes – Material removal in traditional and nontraditional machining processes considerations in process selection. Ultrasonic machining – Working principle, mechanism of metal removal – Theory of Shaw, elements of the processes, tool feed mechanism, effect of parameters, applications and numerical. Abrasive jet machining, Water jet machining and abrasive water jet machine - Basic principles, equipments, process variables, mechanics of metal removal, MRR, application and limitations.	6L

3.	Electro–Chemical Processes: Principle of ECM process, chemistry of the ECM processes, Parameters of the process, determination of the metal removal rate, dynamics of ECM process, polarization, tool design, advantages and disadvantages, application, electrochemical grinding, electrochemical honing, electrochemical deburring, Application of ECM for deep hole drilling electro stream drilling and shaped tube electrolytic machining. Chemical machining - Fundamental principle, types of chemical machining, mask ants, etchants, advantages, disadvantages, applications	6L
4	Electric Discharge Machining: Working principle of EDM, Power circuits for EDM - RC pulse generator and controlled pulse generator– Analysis of R-C Circuits – Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface and recent development in EDM. Wire EDM – Working principle, process variables, process characteristics and applications. Electric discharge grinding and electric discharge diamond grinding - working principle, process capabilities and applications.	6L
5.	Laser, Electron Beam, Ion Beam and Plasma Arc Machining: General working principle of laser beam machining – Generation of Laser, types of Lasers, process characteristics and applications. Electron Beam Machining - Equipment for production of Electron Beam, theory of EBM, thermal and non-thermal type, process characteristics and applications. Ion Beam Machining - Mechanism of metal removal and associated equipment's, process characteristics and applications. Plasma Arc Machining - Metal removal mechanism, process parameters, process characteristics, types of torches, applications.	6L
6.	Advanced Finishing Processes: Abrasive flow Machining (AFM)- working principle, AFM system, process variables, process performance and applications. Magnetic abrasive finishing (MAF)- working principle, MAF system, material removal and surface finish, process variables and applications. Chemo-mechanical polishing, working principle, material removal and surface finish and applications.	6L
7.	Micro-Machining: Need- evolution- fundamentals and trends in micro technologies Consequences Of the technology and society- challenges to manufacturing technology- evolution of precision in manufacturing, tooling and current scenario, requirements and applications. Theory of micromachining- Chip formation- Size effect in micromachining- micro-turning, micro-drilling.	6L

8.	Layered manufacturing: Solid freedom fabrication, Rapid prototyping, selective laser sintering, stereo lithography. Advantages, disadvantages, current scope, future trends of layered manufacturing.	3L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

- 1., Manufacturing Science, A. Ghosh and A.K. Mallik, Affiliated East west Press Ltd, 2001.
2. Advanced Machining Processes, V.K. Jain Allied Publishers Pvt. Ltd. 2002
3. Advanced Machining Processes, H. El-Hofy, McGraw-Hill, New York, 2005.
4. Nontraditional Machining Processes, G.F. Benedict, Marcel Dekker Inc., New York, 1987.
5. Advanced Machining Methods, J.A. McGeough, Chapman and Hakk, London, 1988.
6. Modern Machining Methods, M. Aditya, Khanna Publishers, New Delhi, 2008.
7. Nonconventional Machining, P.K. Mishra, The Institution of Engineers (India) Text Book Series, Narosa Publishing House, New Delhi, 1997.
8. Modern Machining Processes, P.C. Pandey and H.S. Shan, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1980.
9. Introduction to Micromachining, V. K. Jain, Alpha Science International Limited, 2010.
10. Micromachining of Engineering Materials, J. A. McGeough, Taylor & Francis, 2001.

Course Outcomes: Student will be able to,

- Be familiar with traditional manufacturing process and production technology
- Gain the knowledge of different engineering materials and their properties
- Understand non- traditional machining processes and the effect of process parameters
- Differentiate the various non-traditional machining processes
- Demonstrate micromachining technology

Course Code	OEC ME 722(c)				
Category	Open Elective Course (OEC)				
Course title	Thermal Engineering & Fluid Machinery				
Scheme and Credits	L	T	P	Credits	Semester –VII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction: Basic thermodynamics, Heat, work ,system ,process ,path, cycle, P-V and T-S diagram, Properties of Ideal gas, Real gas, equation of state, heat value, Specific heats of gas ,Gas constants ,Heat balance sheet, Properties of Steam. Laws of Thermodynamics, Non flow and flow Process, Heat Reservoir, Source, Sink, Heat Engine, Refrigerator, Heat Pump , Enthalpy, Entropy. Modes of heat transfer, coefficient. Calculations of heat transfer for various modes, Heat Exchangers.	5L
2.	Thermodynamic Cycles: Carnot Cycle, Rankine cycle, Modified Rankine cycle, Otto cycle, Diesel Cycle, Brayton Cycle, Jule Cycle etc. Applications, Efficiency, Simple problems.	3L
3.	Boiler: Important terms used in boilers, Essentials of good boilers, Classification of steam boilers. Boiler mountings and accessories ,Heat value of fuels, Performance of steam boilers, Equivalent evaporation ,Boilers efficiency Boiler draught–Classification, Height of chimney, Chimney efficiency. Instruments used in modern boilers. Digital gauges.	6L
4	Internal Combustion Engine: Principle of operation, Classification, Engine components, Sequence of operations in a cycle, Scavenging, Air-Fuel ratio, Carburettor, Fuel pump, Injector, Sparkplug, Combustion procedure(Basicsonly), Detonation in ICEngine, Rating of SI and CI Engine fuel– Octane & Cetane Number, Fuel injection and ignition,Cooling of IC Engine,Supercharging,Enginefriction & Lubrication, Governing of ICEngines.Electrical parts used (concept only), performance of IC Engines, Electronic sensors used for sfe operation.	8L
5.	Steam Nozzles: Types, Flow of steam through convergent- divergent nozzle, Nozzle Efficiency, Applications.	2L
6.	Turbines: Principle of operation, Components,Classification.Impulse Turbine,– Pressure compounded,Velocitiescompounded, Pressure velocity compounded, Pressure and velocity of steam in an impulse turbine, Velocity triangle, Reaction turbine Velocity triangle, Power produced, Comparison between Impulse and Reaction turbine, Gland, Bleed steam, Feed water heaters, Heat loss, electronic and software control for modern turbines. Trip relay. Governor (Mechanical & Electro mechanical) Concept of gas turbine.	5L

7.	Fluid Mechanics/Machines: Basic of Fluid Mechanics, Kinematics and Dynamics, Fluid properties, dynamics, Discharge, Head, Continuity equation, Bernoulli's Equation, Venturimeter, Pitot tube, Units, Pascal Law, and Pressure measurement. Simple problems. Principal of fluid machines, Classification, hydraulic system.	3L
8.	Hydraulic Machines I–Turbines: Head & Efficiency of a turbine, Components, Classification of Hydraulic Turbines, Impulse Turbine- Pelton Wheel, Reaction Turbine, Radial flow reaction turbine–Francis Turbine, Axial flow reaction turbine– Kaplan Turbine, Draft tube, Specific speed, Unit quantities, Characteristic curves of hydraulics turbines, Governing of hydraulic turbines	4L
9.	Hydraulic Machines II – Pumps: Centrifugal pumps(CP): Main parts and working principle, Work done, Head & Efficiency of CP, Multistage CP, Priming of a CP, Characteristic curves of CP, Cavitations, NPSH Reciprocating Pumps (RP): Main parts and working principle, Classification of RP, Comparison between CP & RP .Maintenance.	3L
10.	Miscellaneous Fluid Machines: Compressors, Fans-Blowers, Fluid couplings, Special type of pumps. Hydraulic Press.	3L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. P K Nag – Engineering Thermodynamics– TMH Pub.
2. P K Nag– Power Plant Engineering.– TMH Pub.
3. P S Ballaney– Thermal Engineering –Khanna Pub.
4. Domkundwar & Arora– Power Plant Engineering– Dhanpat Rai & Co.
5. RS Khurmi & J K Gupta–Thermal Engineering– S Chand Pub.
6. Kothandaraman, Domkundwar-A Course in Thermodynamics (Thermal Engg.)-Dhanpat Rai & Co
7. R K Bansal– Fluid Mechanics & Hydraulics Machines-Laxmi Pub.
8. A R Basu – Fluid Mechanics & Hydraulics Machines– Dhanpat Rai & Co
9. R K Rajput- Fluid Mechanics & Hydraulics Machines – S Chand Pub
10. Som, Biswas -Fluid Mechanics & Hydraulic Machines–TMH Pub

Course outcomes: After completion of the course, the student will be able to:

- Get knowledge about characteristics basic thermal engineering and their applications in various engineering fields.
- Analyze the performance of different heat engines and calculate the heat loss.
- Learn boilers, Turbines, Nozzles and IC Engines

- Develop knowledge Different types of fluid machines used in industry and their control systems
- Know the functions and maintenance of hydraulic machines.

Course code	OEC- M 821(a)				
Category	Open Elective Course (OEC)				
Course title	Advanced Operations Research				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	Linear programming problem (LPP) -introduction and practical formulation, Graphical solution of LPP, Simplex method, Revised simplex method, Dual of a LPP, Dual simplex method, Sensitivity analysis	20L
2.	Nonlinear programming, Karush-Kuhn-Tucker necessary and sufficient conditions of optimality, Quadratic programming, Wolfe's method, Beale's method. Dynamic programming, Bellman's principle of optimality, Recursive relations, System with more than one constraint, Solution of LPP using dynamic Programming. Integer programming, Gomory's cutting plane method, Branch and bound technique. Inventory control, Concept of EOQ, Problem of EOQ with finite rate of replenishment, Problem of EOQ with shortages, Multi-item deterministic problem, Probabilistic inventory models Elements of Fuzzy set theory and its relevance in representing uncertainties, Fuzzy linear programming Introduction to Game Theory, Combinatorial games, Zero-sum games, General-sum games, Nash equilibria, Correlated equilibria, Price of anarchy. Cooperative games, Applications in Voting, Auctions, Elicitation, Scoring rules. Adaptive decision making.	22L
	Total	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

References:

1. Integer Programming and Network Flows: I.C. Hu Addison-Wesley
2. Nonlinear and Dynamic Programming: G. Hadley Addison-Wesley
3. Operations Research: H.A. Taha MacMillan Publ.
4. Mathematical Programming for Economics and Business: R.C. Pfaffenberger and D.A. Walker, The Iowa State University Press.
5. Nonlinear Programming: M.S. Bazaraa, H.D. Sherali, C.M. Shetty J. Wiley& Sons
6. Fuzzy Programming and Linear Programming with Several Objective Functions, Fuzzy Sets & Systems H.J. Zimmerman I, pp. 45-55, 1978.
7. Introduction to Optimization: J.C. Pant, New Delhi, Jain Brothers.

Course Outcomes: After completing the course the students will be able to

- Explain the theoretical foundations of various issues related to linear and non-linear programming modeling.
- Formulate real-world problems as linear or non-linear programming model and design their optimal solutions
- Comprehend the relationship between a linear program and its dual and perform sensitivity analysis to identify the orientation and extent of change of its optimal solution with the change in the input data
- Apply the knowledge of game theory concepts to enunciate real-world decision situations and to make strategic decisions to respond to the consequences.

Course code	OEC-EE 821(b)				
Category	Open Elective Course (OEC)				
Course title	Advanced Topics in Power Systems				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	Basic courses on Electrical Power Systems				

Theory Syllabus:

Module	Detailed Description	Lecturer/ Tutorial Period
01	Network matrix: Physical interpretation of bus admittance and impedance matrices, introduction to admittance matrix formulation, formation of admittance matrix due to inclusion of regulating transformer, development of admittance matrix using singular transformation, modification of admittance matrix for branch addition/ deletion.	7L

02	Complex power flow: Analytical formulation of complex power flow solution, Gauss-Seidal method of power flow, Newton-Raphson method of power flow, algorithm for solving power flow problem using N-R method in rectangular form, algorithm for solving power flow problem using N-R method in polar form, fast decoupled load flow method.	6L
03	Power System Stability: Definitions, classification of stability-rotor angle and voltage stability, synchronous machine representation for stability study. Transient stability: Assumptions for transient stability, derivation of swing equation, swing equation for synchronous machine connected to infinite bus, swing equation for a two machine system, solution of swing equation by Euler and Runge-Kutta method, equal area criterion, critical clearing angle, application of critical clearing angle to transient stability of synchronous machine. Methods of improving transient stability: reducing fault clearance time, automatic reclosing, single phase reclosing, electric braking, voltage regulators, fast governor action, high speed excitation system.	10L
04	Voltage stability: Definition and classification of voltage stability, mechanism of voltage collapse, analytical concept of voltage stability for a two bus system, expression for critical receiving end voltage and critical power angle at voltage stability limit for a two bus power system, PV and QV curves, L index for the assessment of voltage stability.	6L
05	Load Forecasting: Load Forecasting Categories-Long term, Medium term, short term, very short-term Applications of Load Forecasting, Factors Affecting Load Patterns Medium and long term load forecasting methods- end use models, econometric models, statistical model based learning. Short Term Load Forecasting (STLF): Applications of Load Forecasting, methods- similar day approach, regression methods, time series, ANN, Expert systems, Fuzzy logic-based method, support vector machines ANN architecture for STLF, Seasonal ANN, Adaptive Weight, Multiple-Day Forecast.	6L
06	Monitoring and Control: Overview of Energy Control Centre Functions: SCADA systems. Phasor Measurement Units and Wide-Area Measurement Systems. State-estimation. System Security Assessment. Normal, Alert, Emergency, Extremis states of a Power System. Contingency Analysis. Preventive Control and Emergency Control.	7L
	Total	42L
	Total week required	14
	Total week reserved	02

Course Outcomes: At the end of this course, students will demonstrate the ability to

- Understand the speed governing system and load frequency control.
- Analyze methods for reactive power and voltage control.
- Explain the working of the FACTS devices and HVDC.
- Analyze methods for economic operation of power plants.

Course code	OEC-HU 821(c)				
Category	Open Elective Course (OEC)				
Course title	Quality Control and Management				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	<p>Introduction: Quality concepts, Evolution of quality concept, Need for quality, Dimensions of product and service quality, Quality control, Benefits of Quality Control, steps and tools followed in quality control, Inspection: objectives, types, methods of inspection.</p> <p>Total Quality Management: Basic concept and philosophy of TQM, benefits of TQM, TQM Principles, TQM Program, Barriers to TQM, Quality concept in design, Control of purchased product, evaluation of supplies, capacity verification, development of sources, procurement procedure, Manufacturing Quality Methods and Techniques for manufacture, Inspection and control of product, Quality in sales and services, Guarantee, Analysis of claims</p>	9L
2.	<p>Contributions of Deming, Juran and Crosby - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer Complaints, Customer retention - Costs of quality.</p> <p>Leadership - Strategic quality planning, Characteristics and roles of a successful quality leader, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.</p>	6L

3.	Quality Management System: QM Organization structure and design, Quality function deployment, Economics of quality value and contribution, Quality cost, optimizing quality cost, ISO- 9000 and its concept and benefits of Quality Management: ISO 9000 series, Taguchi Method, JIT. TQM Implementation in manufacturing and service sectors.	8L
4	Statistical Process Control and Other Tools: Theory of control charts, measurement range, construction of \bar{x} and R charts, process capability study and use of control charts, Attribute control charts, Defects, construction and analysis of using p-chart, effect of variable sample size, construction and use of C-chart, The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing and service sector including IT, Bench marking: Reason to bench mark, Bench marking process - FMEA - Stages, Types.	13L
5.	Plant Management: Production planning, Plant capacity, Committed Capacity, Available capacity, Potential capacity, Required capacity, Individual operation capacity, Excess capacity, Productivity of Direct labour, Selection of Raw materials ,Principles of purchasing system based on contracts, Purchasing system based on Sales plan, Economic order quantity, Scheduling of machines, Balancing of work force, Principles of Manufacturing Resource Planning.	6L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Fundamentals of Quality Control and Improvement, Amitava Mitra, Wiley, Latest Edition, 2008.
2. Total Quality Management, Lt. Gen, H, Lal, Wiley Eastern Limited,
3. Introduction to Quality Management and Engineering - Sower, Savoie&Renick, Pearson Education Asia.
4. TQM in New Product Manufacturing - Menon, H.G, McGraw Hill.
5. Quality Planning and Analysis, Frank Gryna, TMH, 2001.
6. Total Quality Management, J.R. Evans – South-Western; 3rd revised edition, 2002.
7. Total Quality Management, L. Suganthi, PHI, 1st Edition, 2004.
8. Statistical Quality Control, M Mahajan, Dhanpat Rai& Co,2010
9. Total quality Management, Dale H. Besterfield, ET at., Third Edition, Pearson Education Asia, Indian Reprint, 2006.
10. Total Quality Management - Text and Cases, Janaki Raman. B and Gopal .R.K., Prentice Hall (India) Pvt. Ltd., 2006.

Course outcomes:

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

- Understand the concept of Quality, approaches in TQM, Quality in sales and services, analysis of claims.
- Know modern quality management techniques and leadership quality.
- Develop knowledge of Organization structure and design, quality function, quality cost, ISO- 9000, Taguchi method and JIT etc. in details.
- Get knowledge about different tools and techniques of quality control and management and their construction and application in manufacturing and services processes.
- Get acquainted with plant management

Course Code	OEC-HU 821(d)				
Category	Open Elective Course (OEC)				
Course title	Cyber Law & Computer Ethics				
Scheme and Credits	L	T	P	Credits	Semester :VIII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Cyber laws and Cybercrimes, Internet and need for cyber laws, modes of regulations of internet, Cybercrimes and Information Technology Act 2020, types of cyber terror capability, net neutrality, types of cybercrime, India and Cyber law, Internet censorship, Basics of Indian Evidence Act, Legal policies, Legislative background	10L
2.	Computer Ethics, Privacy and Legislation, Scopes and aims of Engineering and Professional Ethics, Business Ethics, Positive and Negative faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India): Profession, Professionalism and Professional responsibility, Clash of Ethics, Conflict of interests	10L

3.	Intellectual Property Rights Issues: Copyrights, Jurisdiction Issues and Copyright Infringement, Multimedia and Copyright issues, WIPO, Intellectual Property Rights, Understanding Patents, Understanding Trademarks, Trademarks in Internet, Domain name registration, Software Piracy, Legal Issues in Cyber Contracts, Authorship, Document Forgery.	8L
4	Value Sensitive design, Hacktivism, Kill Switch, Green Computing, Ethical decision making process, work place issues in the IT field: contracts, leadership, Intellectual property dispute in Cyber space, RA (Risk Analysis/Assessment), Data recovery.	8L
5.	International Laws governing Cyber Space: Introduction to International Cyber Law, Cyber Laws: Legal Issues and Challenges in India, Role of INTERPOL	6L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Cyber Laws: Intellectual property and E commerce, Security, Kumar, K, Dominant Publisher.
2. Information Security Policy and Implementation Issues, NIIT, PHI
3. Cyber Crime Notorious Aspects of the Human and Net Criminal Activity in Cyber World, Barna Y and Dayal D P, Dominant Publishers.
4. Cyber Crime Impact in the new millennium, Marine R C, Author Press.
5. Spam attack and cyber stalking and abuse, Barna Y and Dayal D P, Dominant Publishers
6. Frauds and financial circuses in Cyber Space, Barna Y and Dayal D P, Dominant Publishers
7. Cyber security, Nina Gobble & Sunit Belapune, Wiley India.
8. Information Security & Cyber laws, Gupta & Gupta, Khanna Publishing House.

Course Outcomes:

On completion of this course, the students will be able to,

- Recognize and apply constitutional standards for extra territorial application and enforcement of internet law.
- Conversant with the social and intellectual property issues emerging out of Cyber space
- Frame work of right to privacy and data security and protection.
- Develop resolutions and policy with ethical practices and models.
- Deal in an ethical manner with computer use and waste.

Course code	OEC-EC 821(e)				
Category	Open Elective Course (OEC)				
Course Title	Satellite Communication				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	Signal System, Analog and Digital Communication				

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	Introduction to Satellite Communication and Orbital Mechanics: Principles and architecture of satellite Communication, Brief history of Satellite systems, advantages, disadvantages, applications and frequency bands used for satellite communication. Orbital equations, Kepler's laws, Apogee and Perigee for an elliptical orbit, evaluation of velocity, orbital period, angular velocity etc. of a satellite, concepts of Solar day and Sidereal day. Satellite sub-systems: Study of Architecture and Roles of various sub-systems of a satellite	10L
2.	Satellite sub-systems: Study of Architecture and Roles of various sub-systems of a satellite system such as Telemetry, tracking, command and monitoring (TTC & M), Attitude and orbit control system (AOCS), Communication sub-system, power sub-systems etc. Satellite launching, Launch vehicles etc. Typical Phenomena in Satellite Communication: Solar Eclipse on satellite, its effects, remedies for Eclipse, Sun Transit Outage phenomena, its effects and remedies, Doppler frequency shift phenomena and expression for Doppler shift. Modeling, reliability, redundancy etc.	8L
3.	Link Estimation: Satellite link budget Flux density and received signal power equations, Calculation of System noise temperature for satellite receiver, noise power calculation, Drafting of satellite link budget and C/N ratio calculations in clear air and rainy conditions.	8L
4.	Modulation and Multiple Access Schemes: Various modulation schemes used in satellite communication, Meaning of Multiple Access, Multiple access schemes based on time, frequency, and code sharing namely TDMA, FDMA and CDMA.	8L

5.	Earth station and Special types of satellite networks: Brief overview of GLOBALSTAR, IRIDIUM, GPS, GLONASS etc. inter—satellite Concept of Earth station, classifications, schematic block diagram, discussions about the components of earth station. Special types of earth stations- VSAT Technology, networks configuration, multi access and networking. MSAT, operating environment, MSAT network concepts, CDMA, MSAT networks, statistics of mobile propagation link (ISL) and Maritime satellite.	8L
	Total	42L
	Total Week Required:	14
	Total Week Reserved:	2

Text /Reference Books:

1. Timothy Pratt Charles W. Bostian, Jeremy E. Allnutt, “Satellite Communications”, Wiley India, 2nd edition 2002.
2. Tri T. Ha, “Digital Satellite Communications”, Tata McGraw Hill, 2009
3. Dennis Roddy, “Satellite Communication”, 4th Edition, McGraw Hill, 2009
4. Wilbur L. Pritchard, Robert A Nelson and Henri G Suyderhoud, “Satellite Communications Engineering”, 2nd Edition, Pearson Publications, 5th Edition.
5. M. Richharia, BS Publications, “Satellite Communications: Design Principles”, 2nd Edition 2003.
6. D.C Agarwal, “Satellite Communication” Khanna Publications, 5th Ed.
7. K N Raja Rao, “Fundamentals of Satellite Communications”, PHI, 2004

Course Outcomes: At the end of this course students will demonstrate the ability to

1. Visualize the architecture of satellite systems as a means of high speed, high range communication system.
2. Comprehend various aspects related to satellite systems such as orbital equations, sub-systems
3. Estimate link budget and carrier power
4. Characterize modulation and multiple access schemes.
5. Develop to solve numerical problems related to orbital motion and design of link budget for the given parameters and conditions.

Course code	OEC-EE 821(f)				
Category	Open Elective Course (OEC)				
Course title	Energy Audit & Management				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	Basic understanding of Electrical Systems				

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	Energy Management & Audit: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments and intervals of EA regulation.	8L
2.	Energy Scenario: Commercial and Non-Commercial Energy, Primary Energy Resources, Commercial Energy Production, Final Energy Consumption, Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Concept of smart grid, Tariff.	8L
3.	Energy Conservation Act-2001 and related policies: Energy Conservation Act-2001 and its features, Notification Under the act, Designated agencies, Schemes of Bureau of Energy Efficiency (BEE)-ECBC, S & L, DSM, BLY, SME's, Designated Consumers, Electricity Act 2003, Integrated Energy Policy.	6L
4.	Energy Efficiency and Climate changes: Energy and environment, Air pollution, Climate change, United Nations Framework Convention on climate change (UNFCCC), Kyoto Protocol, Clean Development Mechanism (CDM), CDM methodology and Procedures, Sustainable development.	8L
5	Energy Efficient Technologies in Electrical Systems: Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls, Energy saving potential of each technology	6L
6	Non-Conventional Energy Sources: Concept of renewable Energy and importance, Different types of renewable Energy, Solar energy, Wind energy, Biomass energy, Hydro-energy, Fuel cells, Energy from wastes, Wave, Tidal and geothermal. Concept of energy storing device.	6L
	Total	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

Text / References:

1. Energy Management Supply and Conservation, Dr. Clive Beggs, Butterworth Heinemann, 2002.
2. Handbook of Energy Engineering, Albert Thumann & Paul Mehta, The Fairmont Press, INC.
3. Plant Engineers & Manager Guide to Energy Conservation, Albert.
4. Energy Management Handbook, Wayne C, John Willey and Sons
5. Guide to Energy Management, Cape Hart, Turner and Kennedy

Course outcomes: After completing the course, the students will be able to

- Understand the basics of energy auditing systems and role of energy management.
- Acquire the knowledge of present energy scenario as well as some of the energy conservation acts.
- Comprehend the concepts of environmental aspects assistances with energy management and little knowledge of energy efficient electrical systems.
- Develop knowledge and skill to analyse different non-conventional forms of energy sources.

Course Code	OEC-HU 822 (a)				
Category	Open Elective Course (OEC)				
Course title	Digital Marketing				
Scheme and Credits	L	T	P	Credits	Semester –VIII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Introduction to concept and meaning of digital marketing Digital marketing planning, SWOT analysis, definition of a target group, introducing various digital channels with their advantages and ways of integration; An introduction to create marketing content by integrating different digital media; Understanding of Search Engines Work, optimization of a web site and Search optimization; Understanding Google Page Rank; Social media planning along with development of an Accessible Site; Keyword Research and Optimization, Link Building Strategies, Useful Tools for Search Engine Optimization; Past, Present and Future of SEO.	10L

2.	Search Engine Marketing (SEM) Internet and Search Engine Marketing, Creation of Google AdWords campaigns; Social media planning for Google analytics, measuring effects of digital marketing through Google analytics, AdWords Account Structure, Navigating in Google AdWords, Working with Keywords Creating Ads in Google AdWords, Creating and Managing your First Ad Campaign, AdWords Reporting and Account Performance Reports.	10L
3.	Social Media Marketing (SMM) Use of Social Media for developing different marketing strategies; Social Media Marketing and Budgeting, Making a Facebook page, Building Relationships via Twitter, Building Relationships via LinkedIn, Instagram, Marketing through YouTube, Handling Positive and Negative Comments, Social Media Content Base Creation, Define a target group.	07L
4	Analytics Web Analytics and Intelligence Tools, Basic Metrics Demystified, Introduction to Google Analytics, Goals and Actionable Insights, Data Management, Social Media Analytics, Social Media Goals and KPI's, Tools for Social Media Analytics, Digital marketing performance efficiency.	10L
5.	Online Reputation Management What is ORM? CRM platform and benefits of ORM, Case study, students individual and group work along with Presentation.	05L
	Total	42
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Understanding Digital Marketing Rayan D
2. Marketing Strategies for Engaging for Digital Generation. Kogan Page. 2014.
3. Fundamentals of Digital Marketing, Bhatia, P.S. 2e. Pearson Education India.2016.
4. The Digital Marketing Hand Book. Entrepreneur, Bly, R.W. Press.2018.
5. Social Media Marketing, Tuten, T.L. and M.R. Solomon, Sage. 2016.
6. Digital Marketing Insights. Kumar, S. And M. Bansal, Sia Publishing House. 2018.

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

- Learn the objectives and importance of digital marketing.
- Understand how to use basic elements of digital marketing to increase sales and business growth.
- Understand the impact of technology on traditional marketing.

- Develop digital marketing techniques by using Google AdWords and integrate with strategic marketing plan.
- Build customer relationship and lay out a particular pattern of customer choice based marketing channel.
- Demonstrate advanced practical skills in common digital marketing tools such as SEO, SEM, Social media and Blogs.

Course Code	OEC-HU 822(b)				
Category	Open Elective Course (OEC)				
Course title	Human Resource Development and Organizational Behavior				
Scheme and Credits	L	T	P	Credits	Semester –VIII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Organizational Behavior(OB): Definition, Concept, Fundamental key features of OB, Need and Importance of OB, Nature and Scope of OB. Organizational Behavior Frame work, OB Model	4L
2.	Individual Behavior: Personality: Definition, Types, Factors influencing personality Perception: Definition, Nature and Importance, Factors influencing Perception, Perceptual Selectivity, Link between Perception and Decision Making. Attitude: Characteristics, components, Formation, Measurement, Barriers to change attitude. Motivation: Definition, Importance, types, Effects of motivation on work from individual and organizational perspective. Theories of Motivation-Maslow's Hierarchy of Needs Theory, McGregor's Theory X &Y, Herzberg's Motivation-Hygiene Theory, Aldermen's ERG Theory, McClelland's Theory of Needs, Vroom's Expectancy Theory. Learning: The learning process and Theories Values , Emotions; Emotional Labor, Emotional Intelligence	14L

3.	Group Behavior: Organization structure formation, Definition, Characteristics of Group, Types of Groups, Stages of group of Group Development, Group Dynamics, Group Decision making techniques, Team building, Communication and its barriers. Johari Window.	5L
4	Leadership and Power: Meaning and Importance, Leadership Styles, Behavioral Theories, Fiedler model, LMX theory and Path Goal theory, Leader vs manager, Sources of power, power centers, Power and Politics. Conflict Management, Stress Management, Job Satisfaction, Balancing work and life. Kurt Lewin's Three step model.	5L
5.	Human Resource Development (HRD): Definition, concept, features and importance of HRD, Critical HRD roles, Challenges for HRD. HRD Process, Methods of Implementation, Evaluation of HRD programs. HRD Interventions; Mentoring for Employee Development : Role of mentoring in development, Employee coaching and Performance management, Competency framework of HRD, Steps in competency mapping, Understanding the competency mapping framework, Carrier Planning, Management and Development, Career development stages and activities, role of individual and organization in career planning, Issues in career management. Intellectual Capital, its management and measurement. The future of HRD and HRD Ethics: Research, practice and Education of HRD for innovation and talent development and management. Role of HRD in developing ethical attitude and behavior and development, Ethical problems with HRD roles. HRD subsystems and HRD Audit.	14L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Organizational Behavior: Robbins, S. P. & Judge, T.A., Pearson Education, 15thEdn.
2. Organizational Behavior: Luthans, Fred, McGraw-Hill, 12thEdn.
3. Understanding Organizations – Organizational Theory Practice in India, Shukla, Madhukar PHI
4. Principles of Organizational Behavior Fincham, R. & Rhodes, P. OUP, 4thEdn.
5. Management of Organizational Behavior Leading Human Resources: Hersey, P. Blanchard, K.H., Johnson: D.E.
6. Human Resource Development: Werner and DeSimone (2006): Thomson Press, New York.
7. Human Resource Development: David Mankin (2009). Oxford University Press. Delhi.
8. Human Resource Management: .P.Subba Rao, Himalaya Publishing House, 2012.
9. HumanResourceManagement.K.Aswathappa.McGrawhillEducation, 2013.

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

- Analyze individual and group behavior, and understand the implications of organizational behavior on the process of management.
- Demonstrate the applicability of analyzing the complexities associated with management of individual behavior and group behavior within and outside the organization.
- Identify different motivational theories and evaluate motivational strategies used in a variety of organizational settings.
- Evaluate the appropriateness of various leadership styles and conflict management strategies used in organizations to integrate motivation and leadership of people.
- Deal actively the issues related to employees' essential identification, training & development, talent management, succession planning, performance management, coaching and mentoring for their overall development.
- Act confidently in changing attitude of the people in decision making process and encouraging within the organizational culture that can enhance innovation and creativity.
- Create a positive workplace culture by developing ethical attitude of the employees, increasing the sense of togetherness within the organization, enhancing performance of each individual within the group and his career development for future projects for ensuring maximum organizational success.

Course code	OEC-EC 822(c)				
Category	Open Elective Course (OEC)				
Course Title	Machine Learning				
Scheme and Credits	L	T	P	Credits	Semester –VIII
	3	0	0	3	
Pre-requisites (if any)	BSC-M 401, PCC-EC 502				

Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
1.	Introduction: Overview of machine learning, applications, types of machine learning, Linear models of regression, linear basis function models, The Bias-Variance decomposition, Bayesian linear regression, Bayesian model comparison.	6L
2	Supervised Learning: Linear models of classification- Discriminant functions, probabilistic generative models, probabilistic discriminative models, Bayesian logistic regression, decision trees, classification trees, regression trees, and pruning.	9L

	Neural networks- feed forward network functions, error, back propagation, regularization. Mixture density and Bayesian Neural network, kernel methods, dual representations, Radial basis function networks, ensemble methods, bagging, boosting.	
3.	Unsupervised Learning: Clustering, K-means, EM mixtures of Gaussians, the EM algorithm in general, model selection for latent variables models, high dimensional spaces, the curse of dimensionality, dimensionality reduction, factor analysis, principal component analysis, probabilistic PCA, independent component analysis.	9L
4.	Probabilistic graphical models: Directed graphical models, Bayesian networks, exploiting independence properties, form distribution to graphs and examples, Markov random fields. Inference in graphical models, learning, Naïve Bayes classifiers, Markov models, Hidden Markov models, inference, learning generalization, undirected graphical models, Markov random fields, conditional independence properties. Parameterization of MRFs, examples, learning, conditional random fields(CRFs), structural SVMs.	9L
5.	Advanced learning: Sampling methods, Monte Carlo, Reinforcement learning, K Armed Bandit elements, Model based learning, value iteration, policy iteration, Temporal difference learning, exploration strategies, deterministic and non-deterministic rewards and actions, eligibility traces generalization, partially observable states, the setting example, semi supervised learning, computational learning theory, mistake bound analysis, sample complexity analysis, VC dimension, Occam learning, accuracy and confidence boosting.	9L
	Total:	42L
	Total Week Required:	14
	Total Week Reserved:	02

Test/Reference Books:

1. Tom M Mitchell -Machine learning, McGraw Hill Education (India) Pvt Ltd 2013
2. Ethen Alpaydin—Introduction to machine learning (Adaptive computation and machine learning) , The MIT Press 2004
3. Stephen Marsland—Machine learning, an algorithm perspective, CRC Press, 2009.

Course Outcomes: At the end of this course students will demonstrate the ability to

- Comprehend the basics of machine learning
- Characterize the parameters of supervised and unsupervised learning algorithm
- Analyze the concepts of reinforcement
- Implement aspects of computational learning

Course code	OEC-EI 822(d)				
Category	Open Elective Course (OEC)				
Course title	Sensor Technology				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	Sensors and Transducers				

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial Period
1.	Sensors Fundamentals and Characteristics Sensors, Signals and Systems; Sensor Classification; Units of Measurements; Sensor Characteristics	5L
2.	Physical Principles of Sensing Electric Charges, Fields, and Potentials; Capacitance; Magnetism; Induction; Resistance; Piezoelectric Effect; Hall Effect; Temperature and Thermal Properties of Material; Heat Transfer; Light; Dynamic Models of Sensor Elements	10L
3.	Interface Electronic Circuits Input Characteristics of Interface Circuits, Amplifiers, Excitation Circuits, Analog to Digital Converters, Direct Digitization and Processing, Bridge Circuits, Data Transmission, Batteries for Low Power Sensors	10L
4	Sensors in Different Application Area Occupancy and Motion Detectors; Position, Displacement, and Level; Velocity and Acceleration; Force, Strain, and Tactile Sensors; Pressure Sensors, Temperature Sensors	10L
5.	Sensor Materials and Technologies Materials, Surface Processing, Nano-Technology	7L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text and/or Reference Books:

1. J. Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, AIP Press, Springer
2. D. Patranabis, Sensors and Transducers, PHI Publication, New Delhi
3. Mechatronics- Ganesh S. Hegde, Published by University Science Press (An imprint of Laxmi Publication Private Limited).

Course outcomes:

After completion of the course, the student will able to:

CO1: Understand the concept of sensors and its characteristics.

CO2: Familiar about practical approach in design of technology based on different sensors

CO3: Get fundamental knowledge of various sensor materials

CO4: Gain knowledge different technology used in designing sensors.

Course code	OEC-EE 822(e)				
Category	Open Elective Course (OEC)				
Course title	Automotive Control & Robotics				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)	Control Systems Engineering				

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

- Explain the fundamentals of robotics and its components.
- Illustrate the Kinematics and Dynamics of robotics.
- Elucidate the need and implementation of related Instrumentation & control in robotics.
- Illustrate the movement of robotic joints with computers/microcontrollers.
- Explain sensors and instrumentation in robotics.

Theory Syllabus:-

Module	Detailed Description	Lecture / Tutorial Period
1	Basic Concepts in Robotics Automation and robotics, Robot anatomy, Basic structure of robots, Resolution, Accuracy and repeatability, and Classification and Structure of robots, Point to point and continuous path systems.	6L
2.	Robotic System and Control Systems Components of robotic system, Hydraulic systems, d.c. servo motors, Basic control systems concepts and models, Control system analysis, Robot activation and feedback components. Positional and velocity sensors, actuators. Power transmission systems.	8L

3.	Robot arm Kinematics and Dynamics Robot joints, direct kinematics problem, inverse kinematics solution, Lagrange-Euler formation, Generalized D'Alembert equations of motion, Denavit-Hartenberg convention and its applications.	6L
4.	Sensors and Instrumentation in robotics Tactile sensors, proximity and range sensors, Force and torque sensors, Uses of sensors in robotics. Vision equipment, Image processing, Concept of low level and high-level vision.	6L
5.	Robot Control Fundamental principles, Classification, Position, path and speed control systems, adaptive control, and application of adaptive control in robotics.	8L
6.	Computer based Robotics Method of robots programming, GUI based robotic arm control, Interfacing with computer, communication and data processing, Introduction to Artificial Intelligence.	9L
	Total:	42L
	Total Week Required:	14
	No. Of Week Reserved:	02

Text/Reference Book:

1. Nikku, S.B., "Introduction to Robotics", Prentice-Hall of India Private Limited (2002).
2. Schilling. R. J., Fundamentals of Robotics: Analysis and Control, Prentice-Hall of India Private Limited (2006).
3. Criag, J., "Fundamentals of Robotics: Analysis and Control", Prentice-Hall of India Private Limited (2006).
4. Gonzalex, R. C. and Fu, K. S., "Robotics Control Sensing, Vision and Intelligence", McGraw-Hill (2004).
5. Phillipe Collet, "Robotic Technology (Vol. I-V)", Prentice Hall.
6. Coiffet and Chirooza, "An Introduction to Robot Technology", Kogan Page.
7. YKoren, "Robotics for Engineers", McGraw Hill.
8. K.S. Fu, R.C. Gonzalez & CSG Lee, "Robotics", McGraw Hill.
9. J.J. Craig, "Robotics", Addison-Wesley.
10. Groover, Mitchell Weiss, Nagel Octrey, "Industrial Robots", McGraw Hill.
11. Asfahl, "Robots & Manufacturing Automation", Wiley Eastern.

Course Code	OEC- ME 822(f)				
Category	Open Elective Course (OEC)				
Course title	Power Plant Engineering (Theory)				
Scheme and Credits	L	T	P	Credits	Semester – VIII
	3	0	0	3	
Pre-requisites (if any)					

Theory Syllabus:

Module	Detailed Description	Lecture/ Tutorial
1	Introduction: Introduction to the course, Power and energy, sources of energy, fuels and combustion, various terms and factors involved in power plant calculations, Selection of power plant. Thermodynamics and thermodynamic cycles related to power plants, Power plant layout. Concept of computerized controls and instrumentations at power plants.	5L
2	Steam power plant: General layout of steam power plant, Essential feature of Rankine cycle, Reheating and regeneration, Problems on Rankine Cycle, Combined cycle power generation, Binary vapour cycles. Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories, Different systems such as coal handling system, pulverizers and coal burners, combustion system, draft, ash handling system, Feed water treatment and condenser and cooling towers and cooling ponds, Steam turbines, Turbine auxiliary systems such as governing, feed heating, reheating, flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant.	10L
3	Diesel power plant: General layout, Components of Diesel power plant, Performance of diesel power plant, fuel system, lubrication system, air intake and admission system, supercharging system, exhaust system, diesel plant operation and efficiency, heat balance, Site selection of diesel power plant, Comparative study of diesel power plant with steam power plant.	5L

4	Gas turbine power plant: Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, Combined cycle power plants, Site selection of gas turbine power plants	4L
5	Hydro-Electric power plant: Hydro electric station, Hydrology, Principles of working, applications, site selection, classification and arrangements, hydro-electric plants, Turbines, Dam, Run off river plant, operation and maintenance, hydro systems, interconnected systems	5L
6	Nuclear power plant: Principles of nuclear energy, Layout of nuclear power plant, Basic components of nuclear reactions, nuclear power station, Nuclear waste disposal, Site selection of nuclear power plants..	4L
7	Non Conventional Power Plants : Introduction to non-conventional power plants (Solar, wind, geothermal, tidal)etc.	2L
8	Electrical system: Generators and their cooling, transformers and their cooling. Instrumentation Purpose, classification, selection and application, recorders and their use, listing of various control rooms. Modern software based system in control room, maintenance.	4L
9	Power plant economics and other issues: Power plant economics, Load duration curves, Load estimation, estimation of tariff, Pollution due to power generation and its control, Greenhouse effect and control, Peak load.	3L
	Total	42L
	Total Week Required	14
	No. of Week Reserved	02

Text/Reference Books:

1. Engineering Thermodynamics, P K Nag, TMH Pub.
2. Power Plant Engineering, P K Nag TMH Pub.
3. Thermal Engineering P S Ballaney, Khanna Pub.
4. Power Plant Engineering, Domkundwar & Arora Dhanpat Rai & Co.
5. Thermal Engineering, RS Khurmi & J K Gupta S Chand Pub.
6. A Course in Thermodynamics (Thermal Engg.)- Kothandaraman, Domkundwar Dhanpat Rai
7. Fluid Mechanics & Hydraulics Machines, R K Bansal Laxmi Pub.
8. Fluid Mechanics & Hydraulics Machines, A R Basu Dhanpat Rai & Co.
9. Fluid Mechanics & Hydraulic Machines, Som, Biswas TMH Pub
10. Power Plant Technology, M.M. El-Wakil McGraw Hill Com., 1985
11. Power Plant Engineering, P.C. Sharma S.K. Kataria & Sons, New Delhi, 2010

Course outcomes:

At the end of this course,

- Students will be able to understand the functions of the various components of power plant.
- Students will acquire the knowledge of the working of nuclear, thermal, hydro ,diesel and gas based power plants
- Students can evaluate the design layout and working of power plants ,their efficiency and load calculations
- Students will gain the knowledge of electrical system used in various types of power plants
- Students will be familiar with the controlling of modern type software based system used in the control room of power plants.
- Students will be able to analyze the economics and management in power generating stations
- Students will learn the instrumentation used in various equipment at power plants