



APJ ABDUL KALAM
TECHNOLOGICAL
UNIVERSITY

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Curriculum

for

B.Tech Degree

Semesters III to VIII

2016

Electronics and Communication Engineering

Estd.



2014

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

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BRANCH: Electronics & Communication Engineering

SEMESTER - 8

Course Code	Course Name	L-T-P	Credits	Exam Slot
EC402	Nano electronics	3-0-0	3	A
EC404	Advanced Communication Systems	3-0-0	3	B
	Elective 4	3-0-0	3	C
	Elective 5 (Non Departmental)	3-0-0	3	D
EC492	Project		6	s

Total Credits = 18

Hours: 29

Cumulative Credits= 180

Elective 4:-

1. EC462 Mixed Signal Circuit Design
2. EC464 Low Power VLSI Design
3. EC466 Cyber Security
4. EC468 Secure Communication
5. EC472 Integrated Optics & Photonic Systems
6. EC474 Computer Vision



ELECTIVE 5 (NON DEPARTMENTAL ELECTIVE COURSES)

(Note:- If the student has studied or is studying the elective course given in the bracket then the corresponding ND elective cannot be chosen)

1. AO482 FLIGHT AGAINST GRAVITY
2. AE482 INDUSTRIAL INSTRUMENTATION
3. AE484 INSTRUMENTATION SYSTEM DESIGN
4. AU486 NOISE, VIBRATION AND HARSHNESS
5. BM482 BIOMEDICAL INSTRUMENTATION
6. BM484 MEDICAL IMAGING & IMAGE PROCESSING TECHNIQUES
7. BT461 DESIGN OF BIOLOGICAL WASTEWATER SYSTEMS
8. BT362 SUSTAINABLE ENERGY PROCESSES
9. CH482 PROCESS UTILITIES AND PIPE LINE DESIGN
10. CH484 FUEL CELL TECHNOLOGY
11. CE482 ENVIRONMENTAL IMPACT ASSESSMENT
12. CE484 APPLIED EARTH SYSTEMS
13. CE486 GEO INFORMATICS FOR INFRASTRUCTURE MANAGEMENT
14. CE488 DISASTER MANAGEMENT
15. CE494 ENVIRONMENT HEALTH AND SAFETY
16. CS482 DATA STRUCTURES
17. CS484 COMPUTER GRAPHICS
18. CS488 C # AND .NET PROGRAMMING
19. EE482 ENERGY MANAGEMENT AND AUDITING
20. EE486 SOFT COMPUTING (EC 360 SOFT COMPUTING)
21. EE488 INDUSTRIAL AUTOMATION
22. EE494 INSTRUMENTATION SYSTEMS
23. FT482 FOOD PROCESS ENGINEERING

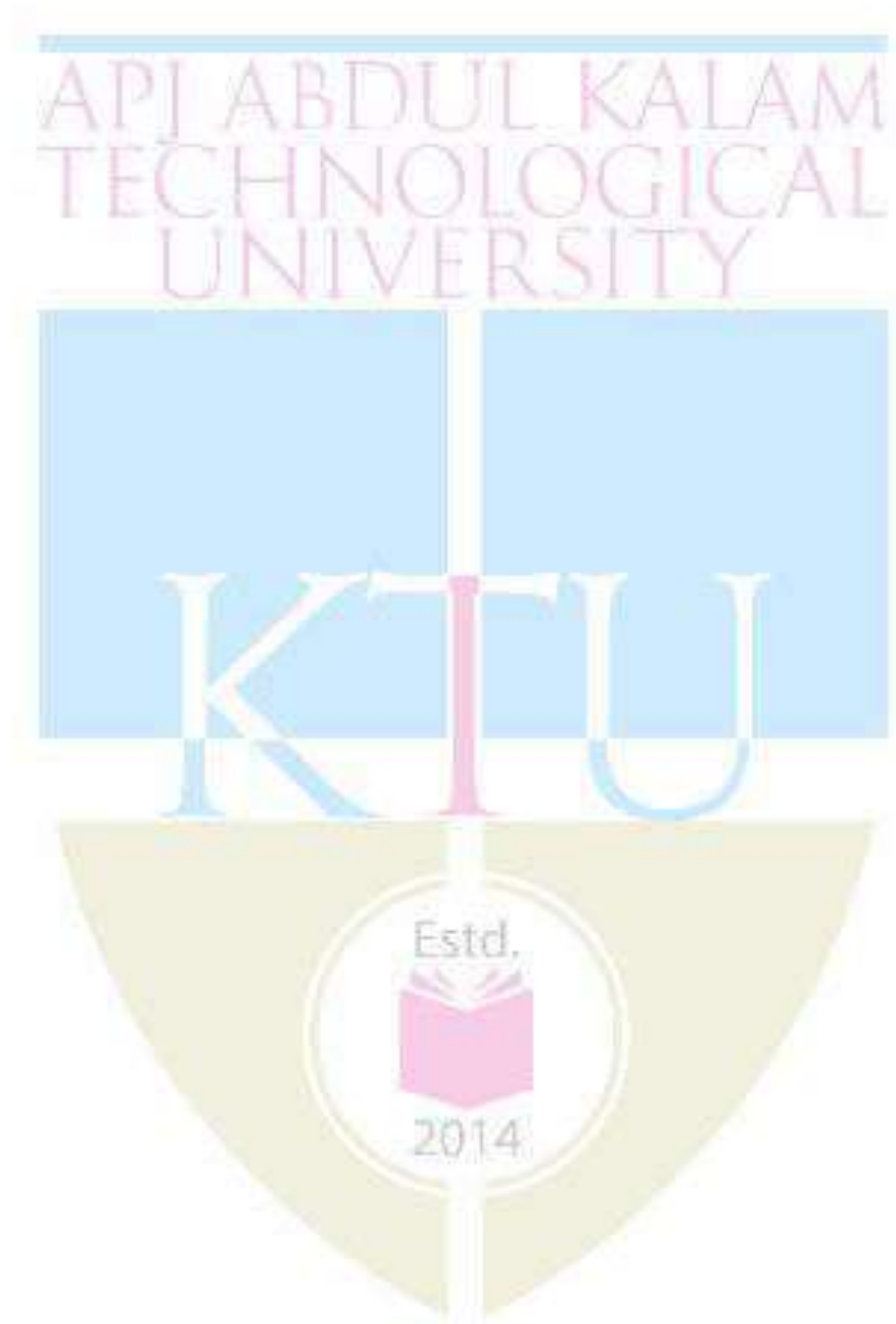
24. FT484	FOOD STORAGE ENGINEERING
25. FT486	FOOD ADDITIVES AND FLAVOURING
26. IE482	FINANCIAL MANAGEMENT
27. IE484	INTRODUCTION TO BUSINESS ANALYTICS
28. IE486	DESIGN AND ANALYSIS OF EXPERIMENTS
29. IE488	TOTAL QUALITY MANAGEMENT
30. IC482	BIOMEDICAL SIGNAL PROCESSING
31. IT482	INFORMATION STORAGE MANAGEMENT
32. MA482	APPLIED LINEAR ALGEBRA
33. MA484	OPERATIONS RESEARCH (EC 363 OPTIMISATION TECHNIQUES)
34. MA486	ADVANCED NUMERICAL COMPUTATIONS
35. MA488	CRYPTOGRAPHY
36. ME484	FINITE ELEMENT ANALYSIS
37. ME482	ENERGY CONSERVATION AND MANAGEMENT
38. ME471	OPTIMIZATION TECHNIQUES (EC 363 OPTIMISATION TECHNIQUES)
39. MP482	PRODUCT DEVELOPMENT AND DESIGN
40. MP469	INDUSTRIAL PSYCHOLOGY & ORGANIZATIONAL BEHAVIOUR
41. MP484	PROJECT MANAGEMENT
42. MT482	INDUSTRIAL SAFETY
43. MR482	MECHATRONICS
44. FS482	RESPONSIBLE ENGINEERING
45. SB482	DREDGERS AND HARBOUR CRAFTS
46. HS482	PROFESSIONAL ETHICS

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC402	NANOELECTRONICS	3-0-0 -3	2016
Prerequisite: EC203 Solid State Devices, EC304 VLSI			
Course objectives:			
<ul style="list-style-type: none"> To introduce the concepts of nanoelectronics. 			
Syllabus:			
Introduction to nanotechnology, Mesoscopic physics, trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence, Schrodinger's Equation, wave function, Low dimensional structures Quantum wells, Basic properties of two dimensional semiconductor nanostructures, Quantum wires and quantum dots, carbon nano tube, grapheme, Introduction to methods of fabrication of nano-layers, Introduction to characterization of nanostructures, Principle of operation of Scanning Tunnelling Microscope, X-Ray Diffraction analysis, MOSFET structures, Quantum wells, modulation doped quantum wells, multiple quantum wells, The concept of super lattices, Transport of charge in Nanostructures under Electric field, Transport of charge in magnetic field, Nanoelectronic devices, principle of NEMS			
Expected outcome:			
<ul style="list-style-type: none"> The students will be able to understand basic concepts of nanoelectronic devices and nano technology. 			
Text Books:			
<ol style="list-style-type: none"> J.M. Martinez-Duart, R.J. Martin Palma, F. Agulle Rueda Nanotechnology for Microelectronics and optoelectronics, Elsevier, 2006 W.R. Fahrner, Nanotechnology and Nanoelctronics, Springer, 2005 			
References:			
<ol style="list-style-type: none"> Chattopadhyay, Banerjee, Introduction to Nanoscience & Technology, PHI, 2012 George W. Hanson, Fundamentals of Nanoelectronics, Pearson Education, 2009. K. Gosser, P. Glosekotter, J. Dienstuhl, Nanoelectronics and nanosystems, Springer 2004. Murty, Shankar, Text book of Nanoscience and Nanotechnology, Universities Press, 2012. Poole, Introduction to Nanotechnology, John Wiley, 2006. Supriyo Dutta, Quantum Transport- Atom to transistor, Cambridge, 2013. 			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Introduction to nanotechnology, Impacts, Limitations of conventional microelectronics, Trends in microelectronics and optoelectronics	1	15%
	Mesoscopic physics, trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, Quantum mechanical coherence	2	
	Classification of Nano structures, Low dimensional structures Quantum wells, wires and dots, Density of states and dimensionality	1	

	Basic properties of two dimensional semiconductor nanostructures, square quantum wells of finite depth, parabolic and triangular quantum wells,	2	
	Quantum wires and quantum dots, carbon nano tube, graphene	1	
II	Introduction to methods of fabrication of nano-layers, different approaches, physical vapour deposition, chemical vapour deposition	2	15%
	Molecular Beam Epitaxy, Ion Implantation, Formation of Silicon Dioxide- dry and wet oxidation methods.	2	
	Fabrication of nano particle- grinding with iron balls, laser ablation, reduction methods, sol gel, self assembly, precipitation of quantum dots.	2	
FIRST INTERNAL EXAM			
III	Introduction to characterization of nanostructures, tools used for of nano materials characterization, microscope-optical, electron, and electron microscope.	2	15%
	Principle of operation of Scanning Tunnelling Microscope, Atomic Force Microscope, Scanning Electron microscope, Specimen interaction. Transmission Electron Microscope	2	
	X-Ray Diffraction analysis, PL & UV Spectroscopy, Particle size analyser.	2	
IV	Two dimensional electronic system, two dimensional behaviour, MOSFET structures, Heterojunctions	2	15%
	Quantum wells, modulation doped quantum wells, multiple quantum wells	2	
	The concept of super lattices Kronig - Penney model of super lattice.	2	
FIRST INTERNAL EXAM			
V	Transport of charge in Nanostructures under Electric field - parallel transport, hot electrons, perpendicular transport.	2	20%
	Quantum transport in nanostructures, Coulomb blockade	2	
	Transport of charge in magnetic field - Effect of magnetic field on a crystal. Aharonov-Bohm effect, the Shubnikov-de Hass effect, the quantum Hall effect.	3	
VI	Nanoelectronic devices- MODFETS, heterojunction bipolar transistors	1	20%
	Resonant tunnel effect, RTD, RTT, Hot electron transistors	2	
	Coulomb blockade effect and single electron transistor, CNT transistors	2	
	Heterostructure semiconductor laser	1	
	Quantum well laser, quantum dot LED, quantum dot laser	2	
	Quantum well optical modulator, quantum well sub band photo detectors, principle of NEMS.	2	
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 70% for theory and 30% for logical/numerical problems, derivation and proof.



COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC404	ADVANCED COMMUNICATION SYSTEMS	3-0-0-3	2016
Prerequisite: EC302 Digital Communication, EC403 Microwave & Radar Engineering			
Course objectives:			
<ul style="list-style-type: none"> To impart the basic concepts of various communication system. 			
Syllabus:			
Microwave Radio Communications, Diversity, protection switching arrangements, Digital TV, Satellite communication systems, Satellite sub systems, Evolution of mobile radio communications, Introduction to Modern Wireless Communication Systems, wireless networks, Over view of WIMAX technologies, Cellular concept, Wireless propagation mechanism, Introduction to Multiple Access GSM system architecture, Introduction to new data services			
Expected outcome:			
<ul style="list-style-type: none"> The students will be able to understand the basics and technology of advanced communication system 			
Text Books:			
<ol style="list-style-type: none"> Dennis Roody, Satellite communication, 4/e, McGraw Hill, 2006. Herve Benoit, Digital Television Satellite, Cable, Terrestrial, IPTV, Mobile TV in the DVB Framework, 3/e, Focal Press, Elsevier, 2008 Simon Haykin, Michael Mohar, Modern wireless communication, Pearson Education, 2008 Theodore S. Rappaport: Wireless communication principles and practice, 2/e, Pearson Education, 1990 			
References:			
<ol style="list-style-type: none"> Jochen Schiller, Mobile Communications, Pearson, 2008. Mishra, Wireless communications and Networks, McGraw Hill, 2/e, 2013. Nathan, Wirelesscommunications, PHI, 2012. Singal, Wireless communications, Mc Graw Hill, 2010. Tomasi, Advanced Electronic Communication Systems, 6/e, Pearson, 2015. W.C.Y.Lee, Mobile Cellular Telecommunication, McGraw Hill, 2010. 			
Course Plan			
Module	Course content (42hrs)	Hours	End Sem. Exam Marks
I	Microwave Radio Communications : Introduction, Advantages and Disadvantages, Analog vs digital microwave, frequency vs amplitude modulation	1	15%
	Frequency modulated microwave radio system, FM microwave radio repeaters	1	
	Diversity, protection switching arrangements, FM microwave radio stations, microwave repeater station, line of sight path characteristics	2	
II	Digital TV: Digitized Video, Source coding of Digitized Video, Compression of Frames, DCT based (JPED), Compression of Moving Pictures (MPEG). Basic blocks of MPEG2 and MPE4, Digital Video Broadcasting (DVB)	4	15%
	Modulation: QAM (DVB-S, DVB-C), OFDM for Terrestrial Digital TV (DVB -T). Reception of Digital TV Signals (Cable, Satellite and	4	

	terrestrial). Digital TV over IP, Digital terrestrial TV for mobile		
	Display Technologies: basic working of Plasma, LCD and LED Displays	2	
FIRST INTERNAL EXAM			
III	Satellite Communication systems, introduction, Kepler's laws, orbits, orbital effects, orbital perturbations	2	15%
	Satellite sub systems, Antennas, Transponders, earth station technology, Link calculation,	2	
	Satellite systems- GEO systems, non-GEO communication systems, Satellite Applications- Global Positioning System, Very Small Aperture Terminal system, Direct to Home Satellite Systems	3	
IV	Evolution of mobile radio communications, paging systems, Cordless telephone systems, comparison of various wireless systems	2	15%
	Introduction to Modern Wireless Communication Systems, Second generation cellular networks, third generation wireless networks, fourth generation wireless technologies	1	
	Wireless in local loop, wireless local area networks, Blue tooth and Personal Area networks, Over view of WIMAX Technologies, architecture, spectrum allocation	2	
SECOND INTERNAL EXAM			
V	Cellular concept, hand off strategies, Interference and system capacity: Cell splitting, Sectoring, Repeaters, and Microcells. Cellular System Design Fundamentals: Frequency Reuse, channel assignment strategies, handoff Strategies, Interference and system capacity, tracking and grade off service, improving coverage and capacity	3	20%
	Wireless propagation mechanism, free space propagation model, ground reflection model, knife edge diffraction model, path loss prediction in hilly terrain, introduction to fading and diversity techniques, Introduction to MIMO system	3	
VI	Introduction to Multiple Access, FDMA, TDMA, Spread Spectrum multiple Access, space division multiple access, CDMA, OFDM	2	20%
	Wireless Networking, Difference between wireless and fixed telephone networks, development of wireless networks, fixed network transmission hierarchy, traffic routing in wireless networks, wireless data services, Wireless standards,	2	
	GSM system architecture, radio link aspects, network aspects	1	
	Introduction to new data services like High Speed Circuit Switched Data (HSCSD), General Packet Radio Service (GPRS), Digital Enhanced Cordless Telecommunications (DECT) , Enhanced Data Rate for Global Evolution (EDGE), Ultra wideband systems (UWB), Push To Talk (PTT) technology, Mobile IP	5	
END SEMESTER EXAM			

Question Paper Pattern

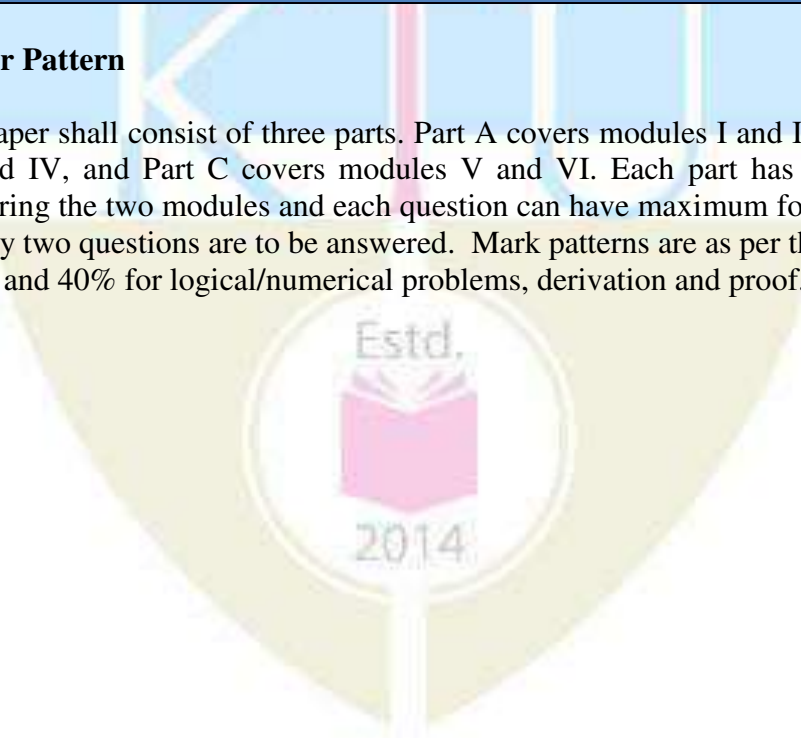
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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC462	MIXED SIGNAL CIRCUIT DESIGN	3-0-0 -3	2016
Prerequisite: EC 304 VLSI, EC308 Embedded Systems			
Course objectives: <ul style="list-style-type: none"> To give the knowledge about various analog and digital CMOS circuits To impart the skill in analysis and design of analog and digital CMOS circuits. 			
Syllabus: CMOS Amplifiers: CS,CG,CD stages, Cascoded stages, Folded cascode Amplifier, MOS Current Mirror, MOSFET cascode current mirror, Differential Amplifiers, MOS telescopic cascode amplifier,CMOS OP AMPS, Design of classical Two Stage OP AMP, Comparator, Band gap References, Phase Locked Loop, Dynamic analog circuits, Data Converters, Switched Capacitor Circuits, Data Converters- Specifications, DAC, ADC Architecture			
Expected outcome: The students will be able to design and analyse various analog and digital CMOS circuits.			
Text Books: <ol style="list-style-type: none"> Phillip E. Allen, Douglas R. Holbery, CMOS Analog Circuit Design, Oxford, 2004. Razavi B., Fundamentals of Microelectronics, Wiley student Edition 2014. 			
References: <ol style="list-style-type: none"> Baker, Li, Boyce, CMOS: Circuits Design, Layout and Simulation, Prentice Hall India, 2000 Razavi B., Design of Analog CMOS Integrated Circuits, Mc Graw Hill, 2001. 			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	CMOS Amplifiers- Common Source with diode connected loads and current source load, CS stage with source degeneration, CG stage and Source Follower (Only Voltage Gain and Output impedance of circuits)	4	15%
	Cascoded stages - Cascoded amplifier, Cascoded amplifier with cascoded loads , Folded cascode Amplifier	4	
II	MOS Current Mirror- Basic circuit, PMOS and NMOS current mirrors Current mirror copying circuits, MOSFET cascode current mirror circuits	3	15%
	Differential Amplifiers- Differential Amplifier with MOS current source Load, with cascaded load and with current mirror load, MOS telescopic cascode amplifier. (Only Voltage Gain and Output impedance of circuits)	4	
FIRST INTERNAL EXAM			
III	CMOS OP AMPS- Two Stage Operational Amplifiers - Frequency compensation of OPAMPS - miller compensation,	3	15%

	Design of classical Two Stage OP AMP		
	Comparator- Characterization of a comparator-static and dynamic, A Two stage open loop comparator (analysis not required)	3	
IV	Band gap References- Supply Independent Biasing, Temperature independent references –band gap reference	5	15%
	Phase Locked Loop – Simple PLL ,Basic PLL Topology, Charge Pump PLL, Basic Charge Pump PLL	3	
SECOND INTERNAL EXAM			
V	Dynamic analog circuits – charge injection and capacitive feed through in MOS switch, Reduction technique	3	20%
	Switched Capacitor Circuits- sample and hold circuits, Switched Capacitor Integrator, Ladder filters	3	
VI	Data Converters- DAC Specifications-DNL, INL, latency, SNR, Dynamic Range ADC Specifications-Quantization error, Aliasing, SNR, Aperture error	4	20%
	DAC Architecture - Resistor String, Charge Scaling and Pipeline types. ADC Architecture- Flash and Pipe line types	3	
END SEMESTER EXAM			

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC464	LOW POWER VLSI	3-0-0 -3	2016
Prerequisite: EC 304 VLSI, EC308 Embedded Systems			
Course objectives: <ul style="list-style-type: none"> To identify the power dissipation mechanisms in various MOS logic styles To familiarize suitable techniques to reduce power dissipation 			
Syllabus: Physics of Power dissipation in MOSFET devices, Sources of power dissipation in CMOS, Circuit techniques for leakage power reduction, Design and test of low voltage CMOS, Non clocked circuit design style, Adiabatic switching.			
Expected outcome: The students will be able to: <ol style="list-style-type: none"> Identify the sources of power dissipation in digital IC systems. Understand the impact of power on system performance and reliability Understand leakage sources and reduction techniques Recognise advanced issues in VLSI systems, specific to the deep-submicron silicon technologies Identify the mechanisms of power dissipation in CMOS integrated circuits 			
Text Books: <ol style="list-style-type: none"> Gray Yeap, Practical low power digital VLSI design, Springer, 1998 Kaushik Roy, Sharat C Prasad, Low power CMOS VLSI circuit design, Wiley India, 2000 			
References: <ol style="list-style-type: none"> Abdellatif Bellaouar, Mohamed I Elmasry, Low power digital VLSI design, Kluwer Academic, 1995 Anatha P Chandrakasan, Robert W Brodersen, Low power digital CMOS Design, Kluwer Academic, 1995 Christian Pignet, Low power CMOS circuits, Taylor & Francis, 2006 Kiat Seng Yeo, Kaushik Roy, Low voltage, low power VLSI sub systems, Tata McGraw Hill, 2004 			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Physics of Power dissipation in MOSFET devices MIS structure, Need for low power circuit design	2	15%
	Threshold voltage, body effects,	1	
	Short channel effects-surface scattering, punch through, velocity saturation, impact ionization	2	
	Hot electron effects, drain induced barrier lowering, narrow width effects	2	
II	Sources of power dissipation in CMOS-Switching power dissipation,	2	15%
	Short circuit power dissipation, glitching power dissipation	2	
	Leakage power dissipation, Transistor leakage mechanisms of	3	

	deep submicron transistors		
FIRST INTERNAL EXAM			
III	Circuit techniques for leakage power reduction – standby leakage control using transistor stacks	2	15%
	multiple V_{th} techniques, Dynamic V_{th} techniques	2	
	supply voltage scaling techniques, Deep submicron devices design issues	2	
	Minimizing short channel effect	2	
IV	Design and test of low voltage CMOS – Circuit design style- clocked design style- Basic concept	2	15%
	Domino logic (domino NAND gate)	1	
	Differential Current Switch Logic.	2	
SECOND INTERNAL EXAM			
V	Non clocked circuit design style -fully complementary logic	2	20%
	NMOS and pseudo –NMOS logic	2	
	differential cascade voltage switch logic(DCVS),	2	
	pass transistor logic	2	
VI	Adiabatic switching – Adiabatic charging, adiabatic amplification	2	20%
	One stage and two stage adiabatic buffer	2	
	fully adiabatic system	1	
	Adiabatic logic gates, pulsed power supplies	2	
END SEMESTER EXAM			

Question Paper Pattern

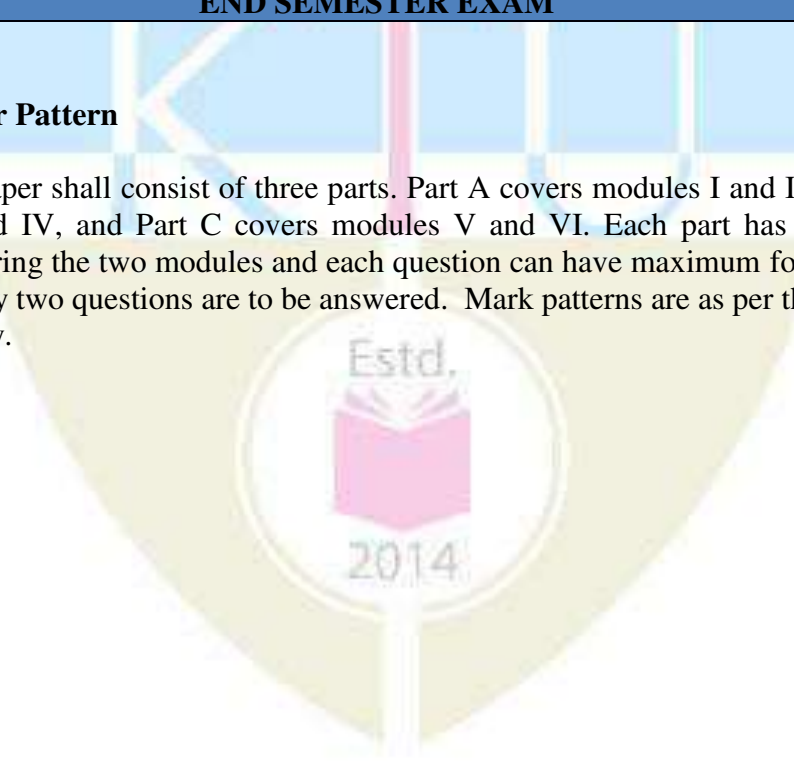
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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC466	CYBER SECURITY	3-0-0 -3	2016
Prerequisite: EC407 Computer Communication			
Course objectives:			
<ul style="list-style-type: none"> • To familiarize various types of cyber-attacks and cyber-crimes. • To give an overview of the cyber laws • To study the defensive techniques against these attacks 			
Syllabus:			
Vulnerability scanning, tools for scanning, Network defense tools, Firewalls and Intrusion Detection Systems, Virtual Private Networks, Scanning for web vulnerabilities tools, Cyber crimes and law, cyber crime investigation			
Expected outcome:			
The students will be able to understand cyber-attacks, types of cybercrimes, cyber laws and also how to protect them self and ultimately the entire Internet community from such attacks			
Text Books:			
<ol style="list-style-type: none"> 1. Mike Shema , Anti-Hacker Tool Kit, Mc Graw Hill 2. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley 			
References:			
<ol style="list-style-type: none"> 1. Achyut S.Godbole Data Communication and Networking,2e, McGraw –Hill Education New Delhi,2011 2. Forouzan, Data Communication and Networking (Global Edition) 5/e, McGraw Hill Education India, 2013. 3. Forouzan,TCP/IP Protocol Suite 4e, McGraw Hill Education India, 2010 			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Introduction to Vulnerability Scanning Overview of vulnerability scanning, Open Port / Service Identification, Banner / Version Check, Traffic Probe, Vulnerability Probe, Vulnerability Examples, OpenVAS, Metasploit.	7	15%
II	Network Vulnerability Scanning Networks Vulnerability Scanning - Netcat, Socat, understanding Port and Services tools - Datapipe, Fpipe, WinRelay, Network Reconnaissance – Nmap, THC-Amap and System tools, Network Sniffers and Injection tools – Tcpdump and Windump, Wireshark, Ettercap, Hping, Kismet	7	15%
FIRST INTERNAL EXAM			
III	Network Defense tools Firewalls and Packet Filters: Firewall Basics, Packet Filter Vs Firewall, How a Firewall Protects a Network, Packet Characteristic to Filter, Stateless Vs Stateful Firewalls, Network Address Translation (NAT) and Port Forwarding, the basic of Virtual Private Networks, Linux Firewall, Windows Firewall, Snort: Introduction Detection	8	15%

IV	Web Application Tools Scanning for web vulnerabilities tools: Nikto, W3af, HTTP utilities - Curl, OpenSSL and Stunnel, Application Inspection tools – Zed Attack Proxy, Sqlmap. DVWA, Webgoat, Password Cracking and Brute-Force Tools – John the Ripper, L0htcrack, Pwdump, HTC-Hydra	6	15%
SECOND INTERNAL EXAM			
V	Introduction to Cyber Crime and law Cyber Crimes, Types of Cybercrime, Hacking, Attack vectors, Cyberspace and Criminal Behavior, Clarification of Terms, Traditional Problems Associated with Computer Crime, Introduction to Incident Response, Digital Forensics, Computer Language, Network Language, Realms of the Cyber world, A Brief History of the Internet, Recognizing and Defining Computer Crime, Contemporary Crimes, Computers as Targets, Contaminants and Destruction of Data, Indian IT ACT 2000.	8	20%
VI	Introduction to Cyber Crime Investigation Firewalls and Packet Filters, password Cracking, Keyloggers and Spyware, Virus and Worms, Trojan and backdoors, Steganography, DOS and DDOS attack, SQL injection, Buffer Overflow, Attack on wireless Networks	6	20%
END SEMESTER EXAM			

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC468	SECURE COMMUNICATION	3-0-0 -3	2016
Prerequisite: EC407 COMPUTER COMMUNICATION			
Course objectives: •To impart the students about the theory and technology behind the secure communication.			
Syllabus: Introduction on Security, Security Goals, Types of Attacks, Modular arithmetic: Groups, Ring, Fields. The Euclidean algorithm, Finite fields of the form GF(p), Polynomial arithmetic, Symmetric Ciphers, Symmetric Cipher Model, Substitution Techniques, Transposition techniques, Block Ciphers, Data encryption Standards, Differential and Linear Crypt analysis Advanced Encryption standard, The AES Cipher, Public key cryptosystem, RSA algorithm, Intruders, Password management			
Expected outcome: The student will be <ul style="list-style-type: none"> i. Exposed to the different approaches that handle security and the algorithms in use for maintaining data integrity and authenticity. ii. Enabled student to appreciate the practical aspects of security features design and their implementation 			
Text Books: <ol style="list-style-type: none"> 1. Behrouz A. Forouzan , Cryptography and Network security Tata McGraw-Hill, 2008 2. William Stallings, Cryptography and Network security: principles and practice", 2nd Edition, Prentice Hall of India, New Delhi, 2002 			
References: <ol style="list-style-type: none"> 1. David S. Dummit & Richard M Foote, Abstract Algebra, 2nd Edition, Wiley India Pvt. Ltd., 2008. 2. Douglas A. Stinson, Cryptography, Theory and Practice, 2/e, Chapman & Hall, CRC Press Company, Washington, 2005. 3. Lawrence C. Washington, Elliptic Curves: Theory and Cryptography, Chapman & Hall, CRC Press Company, Washington, 2008. 4. N. Koblitz: A course in Number theory and Cryptography, 2008 5. Thomas Koshy: Elementary Number Theory with Applications, 2/e, Academic Press, 2007 6. Tyagi and Yadav , Cryptography and network security, Dhanpatrai, 2012 			
Course Plan			
Module	Course contents	Hours	End Sem. Exam Marks
I	Introduction on security, security goals and types of attacks: Passive attack, active attack, attacks on confidentiality, attacks on integrity and availability, Security services and mechanisms.	5	15%
II	Modular arithmetic: Groups, Ring, Fields. The Euclidean algorithm, Finite fields of the form GF(p)	4	15%
	Polynomial arithmetic: Finite fields of the form GF (2n).	4	
FIRST INTERNAL EXAM			
III	Symmetric Ciphers, Symmetric Cipher Model	3	15%

	Substitution Techniques, Caesar Cipher, Mono alphabetic Cipher, Play fair cipher, Hill cipher, Poly alphabetic Cipher, one time pad	4	
IV	Transposition techniques ,Block Ciphers, Data encryption Standards, DES Encryption, DES decryption	3	15%
	Differential and Linear Crypt analysis Advanced Encryption standard	2	
	The AES Cipher, substitute bytes transformation, Shift row transformation, Mix Column transformation.	2	
SECOND INTERNAL EXAM			
V	Public key cryptosystem, Application for Public key cryptosystem requirements	2	20%
	RSA algorithm, Key management, Distribution of public key, public key certificates, Distribution of secret keys.	5	
VI	Intruders: Intrusion techniques, Intrusion detection, Statistical anomaly detection, Rule based intrusion detection, Distributed intrusion detection, Honey pot, Intrusion detection exchange format.	5	20%
	Password management: Password protection, password selection strategies.	2	
END SEMESTER EXAM			

Question Paper Pattern

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COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC472	INTEGRATED OPTICS & PHOTONIC SYSTEMS	3-0-0 -3	2016

Prerequisite: EC303 Applied Electromagnetic Theory, EC405 Optical Communication

Course objectives:

- To discuss basic goals, principles and techniques of integrated optical devices and photonic systems
- To explain operation and integration of various optoelectronic devices in an integrated optical system
- To study about various components like optical waveguides, optical couplers, design tools, fabrication techniques, and the applications of optical integrated circuits.
- To introduce some of the current state-of-the-art devices and systems.

Syllabus: Review of Electromagnetics: Maxwell's equations, optical waveguides and devices, Waveguide Fabrication Techniques, Electro-Optic Waveguides, Polymer Waveguide Device, Losses in optical wave guide, Wave guide input and output couplers, coupled mode theory, Light Propagation in Waveguides, FFT-BPM, FD-BPM, Electro-Optic Modulators: Types, Integrated semiconductor laser, integrated semiconductor optical amplifier, integrated optical detectors, applications of optical integrated circuits, devices and systems for telecommunications, microwave carrier generation by optical techniques, photonic crystals, nanophotonic device.

Expected outcome:

The student will have an in depth knowledge of

- Devices that are basic components of integrated optics and photonic systems including Optical wave guides, optical couplers, Lasers, Detectors and modulators
- Light propagation in waveguides
- The fabrication process of Optical Integrated devices
- Applications of Optical Integrated devices
- Nano photonic devices

Text Books:

1. Lifante, Integrated Photonics: Fundamentals, John Wiley 2003
2. Robert Hunsperger, Integrated optics :Theory and technology 6/e Springer, 2009

References:

1. H. Nishihara, M. Haruna, and T. Suhara, Optical Integrated Circuits, McGraw-Hill Professional, 1989.
2. KeicoIizuka, Elements of photonics, John Wiley, 2002 .
3. Pappannareddy, Introduction to light wave systems,Artech House,1995

RELATED LINKS

Website of IEEE photonics society: www.ieee.org/photonics.

Course Plan

Module	Course content (42hrs)	Hours	End Sem. Exam Marks
I	Review of Electromagnetics , Maxwell's equations - Wave equation	3	15%
	Analysis of optical waveguides and devices- Planar waveguides, chanel waveguides, graded index waveguides.	4	

II	Waveguide Fabrication Techniques -substrate materials for optical IC , Epitaxially Grown Waveguides- Electro-Optic Waveguides	4	15%
	Types of Polymers-Polymer Waveguide Devices, Optical Fiber Waveguide Devices	3	
FIRST INTERNAL EXAM			
III	Losses in optical wave guide, measurement of losses. Wave guide input and output couplers, types of couplers, coupling between wave guides,	4	15%
	Optical Fiber Couplers and Splitters, coupled mode theory	3	
IV	Light Propagation in Waveguides: The Beam Propagation Method-Fresnel Equation - Fast Fourier Transform Method (FFT-BPM) - Solution based on discrete fourier transform - Method Based on Finite Differences (FD-BPM), Boundary Conditions	7	15%
SECOND INTERNAL EXAM			
V	Electro-Optic Modulators - Basic Operating Characteristics- The Electro-Optic Effect,Mach-Zehnder Modulator, acousto-optic modulator,	4	20%
	Integrated semiconductor laser, integrated semiconductor optical amplifier, integrated optical detectors, structures.	3	
VI	Applications of Optical Integrated Circuits-Spectrum Analyser-Temperature and High Voltage Sensors,	3	20%
	Devices and Systems for Telecommunications- Microwave Carrier Generation by Optical Techniques, - Photonic Crystals-Nanophotonic Device.	4	
END SEMESTER EXAM			

Question Paper Pattern

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 50% for theory and 50% for logical/numerical problems, derivation and proof.

COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC474	COMPUTER VISION	3-0-0-3	2016

Prerequisite: EC301 Digital Signal Processing

Course objectives:

- To review image processing techniques for computer vision
- To understand shape and region analysis
- To understand three-dimensional image analysis techniques and motion analysis
- To study some applications of computer vision algorithms
- To introduce methods and concepts which will enable the student to implement computer vision systems with emphasis on applications and problem solving

Syllabus:

Review of Image processing operations, Image formation models, Image processing and feature extraction, Motion Estimation, Shape representation and Object recognition.

Expected outcome:

The students will be able to:

- Implement fundamental image processing techniques required for computer vision
- Perform shape analysis and boundary tracking techniques
- Implement motion related techniques
- To develop applications using computer vision techniques

Text Books:

1. B K P Horn , Robot Vision, McGraw-Hill,1986
2. D Forsyth and J Ponce, Computer Vision - A modern approach, Prentice Hall of India, 2002

References:

1. E R Davies, Computer & Machine Vision, Fourth Edition, Academic Press, 2012.
2. R. Szeliski, Computer Vision: Algorithms and Applications, Springer 2011
3. Simon J D Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012.

Course Plan

Module	Course content	Hours	End Sem. Exam Marks
I	Review of image processing techniques : filtering, thresholding	1	15
	Mathematical morphology, Texture	1	
	Binary shape analysis, connectedness, object labelling and counting	2	
	Boundary descriptors	1	
II	Monocular and binocular imaging system	2	15
	Orthographic & Perspective Projection	2	
	Camera models	2	

	Camera Calibration, Stereo vision: introduction; concept of disparity and its relationship with depth	3	
FIRST INTERNAL EXAM			
III	Image Processing for Feature Detection and Image Synthesis, Edge detection	1	15
	Corner detection, Harris corner detection algorithm, Line and curve detection, Hough transform	3	
	SIFT operator, Mosaics, snakes	2	
IV	Shape from X - Shape from shading, Photometric stereo, Texture, Occluding contour detection.	3	15
	Motion Analysis- Regularization theory, Optical Flow: brightness constancy equation, aperture problem, Horn-Shunck method, Lucas-Kanade method	4	
	Structure from motion.	2	
SECOND INTERNAL EXAM			
V	Object recognition: Hough transforms and other simple object recognition methods	3	20
	Shape correspondence and shape matching, Principal Component Analysis	3	
	Shape priors for recognition	1	
VI	Application: Photo album, Face detection, Face recognition, Eigen faces, Active appearance and 3D shape models of faces	3	20
	Application: In-vehicle vision system: locating roadway, road markings, identifying road signs, locating pedestrians	3	
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 70% for theory and 30% for logical/numerical problems, derivation and proof.

Course code	Course Name	Credits	Year of Introduction
**492	PROJECT	6	2016
Prerequisite : Nil			
Course Objectives			
<ul style="list-style-type: none"> • To apply engineering knowledge in practical problem solving • To foster innovation in design of products, processes or systems • To develop creative thinking in finding viable solutions to engineering problems 			
Course Plan			
<p>In depth study of the topic assigned in the light of the preliminary report prepared in the seventh semester</p> <p>Review and finalization of the approach to the problem relating to the assigned topic</p> <p>Preparing a detailed action plan for conducting the investigation, including team work</p> <p>Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed</p> <p>Final development of product/process, testing, results, conclusions and future directions</p> <p>Preparing a paper for Conference presentation/Publication in Journals, if possible</p> <p>Preparing a report in the standard format for being evaluated by the dept. assessment board</p> <p>Final project presentation and viva voce by the assessment board including external expert</p>			
Expected outcome			
<p>The students will be able to</p> <ul style="list-style-type: none"> iii. Think innovatively on the development of components, products, processes or technologies in the engineering field iv. Apply knowledge gained in solving real life engineering problems 			
Evaluation			
Maximum Marks : 100			
(i) Two progress assessments		20% by the faculty supervisor(s)	
(ii) Final project report		30% by the assessment board	
(iii) Project presentation and viva voce		50% by the assessment board	
<p><i>Note:</i> All the three evaluations are mandatory for course completion and for awarding the final grade.</p>			

Course code	Course name	L-T-P-Credits	Year Of Introduction
AE482	INDUSTRIAL INSTRUMENTATION	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives			
<ul style="list-style-type: none"> To equip the students with the basic knowledge of pressure, temperature, flow, level, density and viscosity measurements. To understand the construction and working of measuring instruments 			
Syllabus			
Temperature measurement- Pressure measurement- Measurement of viscosity- Flow measurement- Anemometers- Target flow meters- Level measurement			
Expected outcome			
<ul style="list-style-type: none"> The student will be able to understand the various instruments used for industrial measurement. 			
Text Books			
<ol style="list-style-type: none"> Doebelin E.O, “<i>Measurement Systems: Application and Design</i>”, 4th Edition, McGraw Hill, New York, 2003. Patranabis D, “<i>Principles of Industrial Instrumentation</i>”, 2nd Edition, Tata McGraw Hill, New Delhi, 1997. Spitzer D. W., <i>Flow measurement</i>, ISA press, New York, 1998 			
Reference Books			
<ol style="list-style-type: none"> Andrew W.G, “<i>Applied Instrumentation in Process Industries – A survey</i>”, Vol I & Vol II, Gulf Publishing Company, Houston, 2001. Douglas M. Considine, “<i>Process / Industrial Instruments & Controls Handbook</i>”, 5th Edition, McGraw Hill, Singapore, 1999. Liptak B.G, “<i>Process Measurement and Analysis</i>”, 4th Edition, Chilton Book Company, Radnor, Pennsylvania, 2003. Noltingk B.E., “<i>Instrumentation Reference Book</i>”, 2nd Edition, Butterworth Heinemann, 1995. 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Temperature measurement: Resistance temperature detector (RTD), principle and types, construction requirements for industry, measuring circuits. Thermistors, principle and sensor types, manufacturing techniques, measuring circuits, linearization methods and applications. Pneumatic and suction pyrometers, integrated circuit sensors, diode type sensors, ultrasonic thermometers, Johnson noise thermometer, fluidic sensors, spectroscopic temperature measurements, thermograph, temperature switches and thermostats.	7	15%
II	Pressure measurement basics, mechanical type instruments, electromechanical type, low pressure measurement, related accessories, pressure measuring standards, selection and application. Transmitter definition, classification, pneumatic transmitter-force balance type, torque balance type, two wire and four wire transmitters, I/P and P/I converters.	7	15%

FIRST INTERNAL EXAMINATION			
III	Measurement of viscosity: definitions, units, Newtonian and Newtonian behaviour, measurement of viscosity using laboratory viscometers, industrial viscometers. Viscometer selection and application. Measurement of density, definitions, units, liquid density measurement, gas densitometers, its application and selection.	7	15%
IV	Flow measurement: Introduction, definitions and units, classification of flow meters, pitot tubes, positive displacement liquid meters and provers, positive displacement gas flow meters, variable area flow meters.	6	15%
SECOND INTERNAL EXAMINATION			
V	Anemometers: Hot wire/hot film anemometer, laser Doppler anemometer (LDA), electromagnetic flow meter, turbine and other rotary element flow meters, ultrasonic flow meters, doppler flow meters, cross correlation flow meters, vortex flow meters. Measurement of mass flow rate: radiation, angular momentum, impeller, turbine, constant torque hysteresis clutch, twin turbine Coriolis, gyroscopic and heat transfer type mass flow meters. Target flow meters: V-cone flow meters purge flow regulators, flow switches, flow meter calibration concepts, flow meter selection and application.	8	20%
VI	Level measurement: introduction, float level devices, displacer level devices, rotating paddle switches, diaphragm and differential pressure detectors, resistance, capacitance and RF probes, radiation, conductivity, field effect, thermal, ultrasonic, microwave level switches, radar and vibrating type level sensors. Level sensor selection and application.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks: 100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions from Module 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions. (15 x 2 = 30 marks)

Part B

Answer any two out of three questions from Module 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions. (15 x 2 = 30 marks)

Part C

Answer any two out of three questions from Module 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions. (20 x 2 = 40 marks)

Course code	Course name	L-T-P-Credits	Year of Introduction
AE484	INSTRUMENTATION SYSTEM DESIGN	3-0-0-3	2016
Prerequisite : NIL			
Course Objective			
<ul style="list-style-type: none"> • To equip the students with the basic Concept of Instrumentation system design • To understand the construction and working of different instrumentation system 			
Syllabus			
Temperature measurement- Pressure measurement- Measurement of viscosity- Flow measurement- Anemometers- Target flow meters- Level measurement			
Expected outcome			
The students will be able to understand the concepts behind instrumentation system design and its working			
Text Books			
<ol style="list-style-type: none"> 1. E.O. Doblin, Measurement Systems Application and Design, McGraw Hill, New York, 2003 2. Harry N Norton, Hand Book of transducers, PHI, 1989 			
Reference Books			
<ol style="list-style-type: none"> 1. Gregory K McMillan, Douglas M Conside, Process and Industrial Instrumentation Control, McGraw Hill, 5ed, 1999 2. John P Bentley, Principles of Measurement Systems, Pearson Education, 2004 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction: Concept of generalized measurement system, functional elements, generalized input-output configuration, static sensitivity, drifts, linearity, hysteresis, threshold, resolution, static stiffness and input-output impedance	7	15%
II	Transducers: Operating principle, construction and design of variable resistive transducers, variable inductive transducers, variable capacitive transducers, piezoelectric transducers, magnetostrictive transducers	7	15%
FIRST INTERNAL EXAMINATION			
III	Hall effect, eddy current, ionization, optical transducers, digital transducers, single shaft encoders, photo voltaic cell, photo conductive, photo emissive, fiber optic sensors, concept of smart and intelligent sensor, bio-sensors	7	15%
IV	Construction and performance of industrially important transducer for measuring displacement, speed, vibrations, temperature, electrical power, strain, torque Force, Design of intelligent instrumentation system.	6	15%
SECOND INTERNAL EXAMINATION			
V	Signal Conditioning & Recording (Part1): Quarter, half and full bridge circuit, active filters, differential instrumentation amplifiers, carrier amplifiers	8	20%
VI	Signal Conditioning & Recording (Part2): design of display elements, LED, bar graph displays, LCDs , nixie tube and their interfacing	7	20%

END SEMESTER EXAMINATION

QUESTION PAPER PATTERN:

Maximum Marks: 100

Exam Duration: 3 Hours

Part A

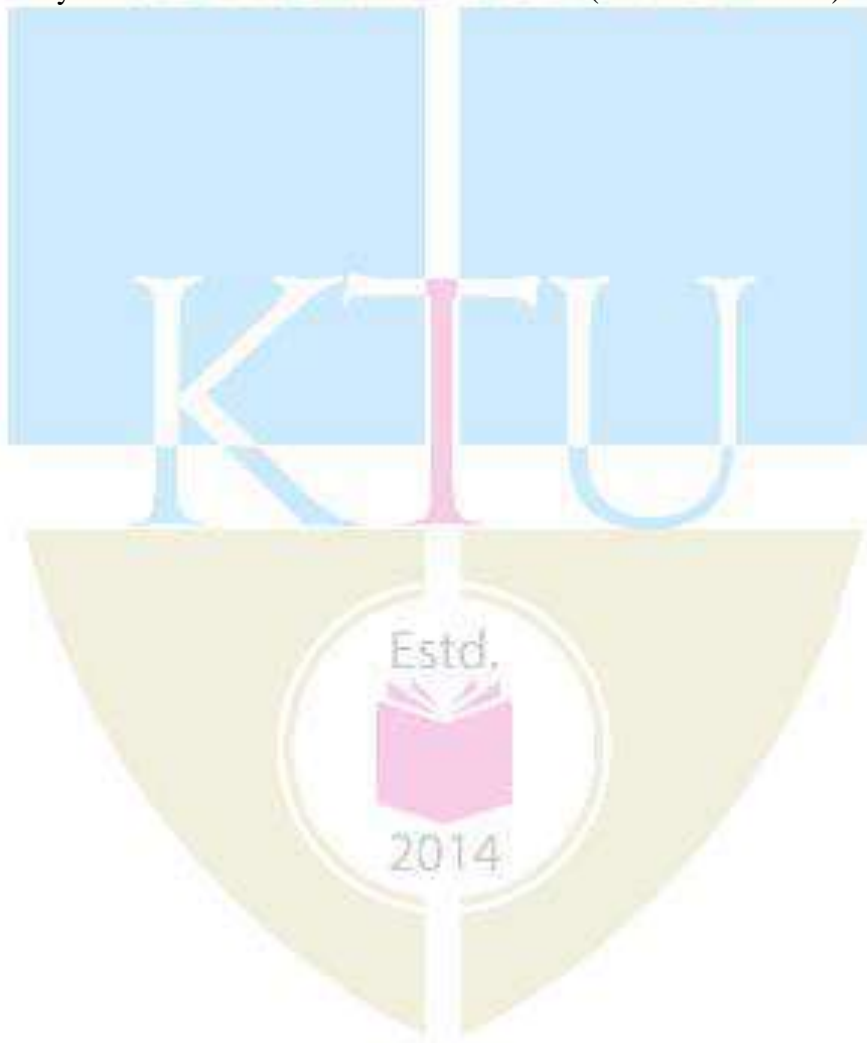
Answer any two out of three questions from Module 1 and 2 together. Each question carries 15 marks and may have not more than four sub divisions. (15 x 2 = 30 marks)

Part B

Answer any two out of three questions from Module 3 and 4 together. Each question carries 15 marks and may have not more than four sub divisions. (15 x 2 = 30 marks)

Part C

Answer any two out of three questions from Module 5 and 6 together. Each question carries 15 marks and may have not more than four sub divisions. (20 x 2 = 40 marks)



Course code	Course Name	L-T-P - Credits	Year of Introduction
AO482	FLIGHT AGAINST GRAVITY	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives			
<ul style="list-style-type: none"> To introduce the basic concepts of aerospace engineering and the current developments in the field. 			
Syllabus:			
History of aeronautics – helicopters – aircraft propulsion – aircraft configurations – Atmosphere and atmospheric flight – space flight – aircraft structures and materials – rockets.			
Text Book:			
Anderson, J.D., “Introduction to Flight”, McGraw-Hill, 1995.			
Reference:			
Kermode, A.C., “Flight without Formulae”, McGraw-Hill, 1997.			
Syllabus & Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Historical Developments in Aeronautical Activities: Early air vehicles: Balloons, Biplanes and Monoplanes	3	15%
	Helicopters; Developments in aerodynamics, aircraft materials, aircraft structures & aircraft propulsion.	3	
II	Aircraft Configurations: Different types of flight vehicles and their classifications;	2	15%
	Components of fixed wing airplane and their functions;	2	
	Airfoils, wings and other shapes.	2	
FIRST INTERNAL EXAMINATION			
III	Principles of Atmospheric Flight: Physical properties and structure of the atmosphere:	3	15%
	The Standard Atmosphere, Temperature, Pressure and Altitude relationships, Mach number	2	
	Evolution of theory of lift and drag, Maneuvers, Concepts of stability and control.	3	
IV	Introduction to Space Flight: Introduction to basic concepts, the upper atmosphere	3	15%
	Space vehicle trajectories-some basic concepts, Kepler’s Laws of planetary motion.	3	
SECOND INTERNAL EXAMINATION			
V	Introduction to airplane structures and materials : General types of construction, Monocoque, semi-monocoque.	3	20%
	Typical wing and fuselage structure. Metallic and non-metallic materials	2	
	Use of aluminium alloy, titanium, stainless steel and composite materials.	2	
VI	Power plants used in airplanes : Basic ideas about piston, turboprop and jet engines.	3	20%

Comparative merits, Principles of operation of rocket, types of rockets and typical applications,	3	
Exploration into space.	2	
END SEMESTER EXAM		

Question Paper Pattern

Maximum marks: 100 Exam duration: 3 hours

The question paper shall consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

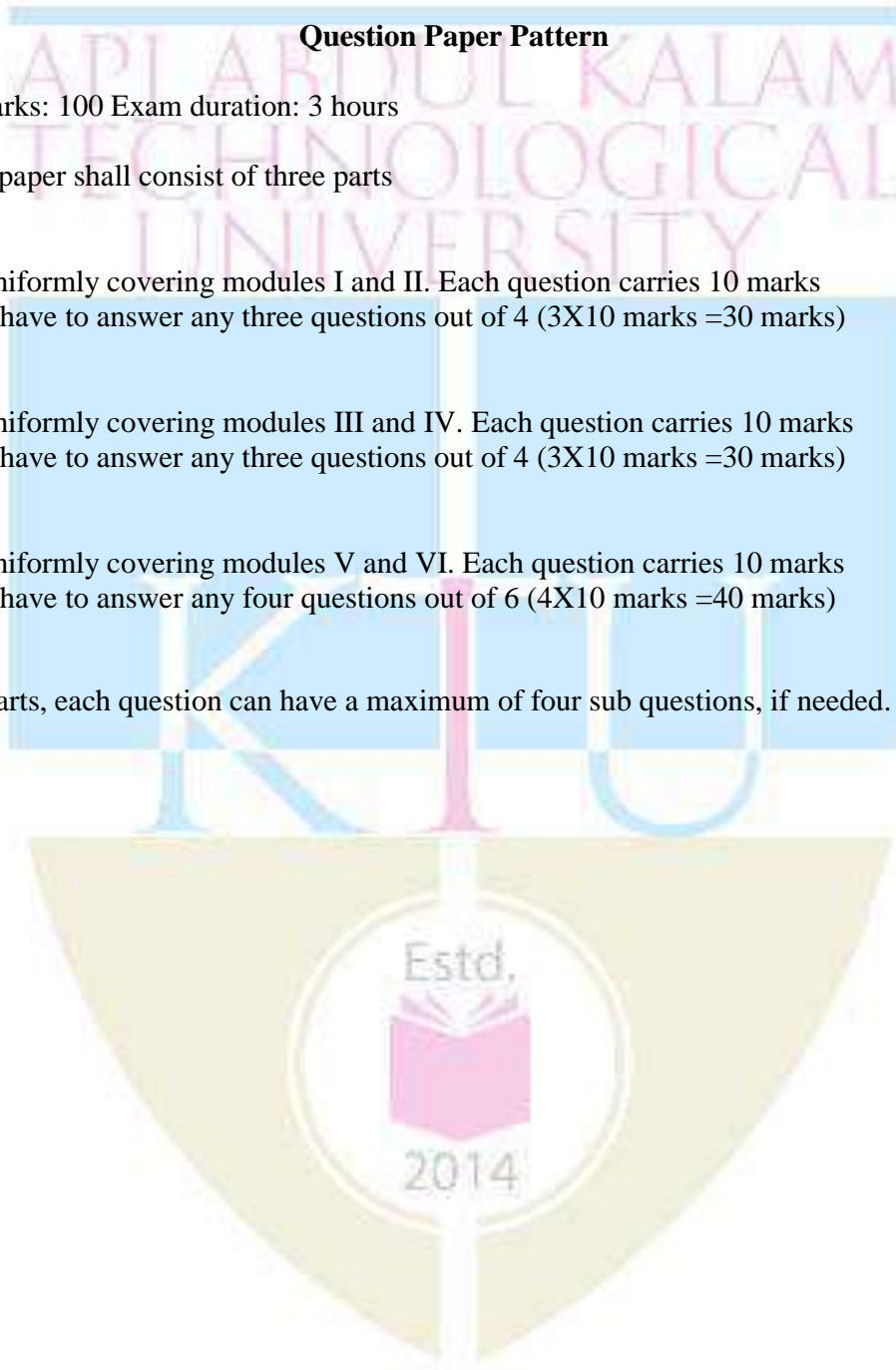
Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.



Course code.	Course Name	L-T-P -C	Year of Introduction
AU484	MICROPROCESSOR AND EMBEDDED SYSTEMS	3-0-0-3	2016
Prerequisite: NIL			
Course Objectives			
<ul style="list-style-type: none"> • To impart the basic concepts of microprocessors • To impart the basic concepts of embedded systems 			
Syllabus			
Introduction to microprocessors, Intel 8085 microprocessor, Instruction Set of 8085, Assembly language programming, Interfacing I/O devices, Overview of embedded system, Intel 8051 microcontroller, 8051 interfacing, Other microcontroller architectures: PIC-Atmel AVR-ARM			
Expected outcome.			
The students will			
<ol style="list-style-type: none"> i. Get idea about Intel 8085 Microprocessor ii. Be able to do assembly language programming iii. Gain an overview of embedded systems iv. Know about Intel 8051 microcontroller and its interfacing 			
Text Books:			
<ol style="list-style-type: none"> 1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Fifth edition, Prentice hall, 2002. 2. Shibu K.V, Introduction to Embedded Systems, Tata McGraw Hill, 2009 			
References:			
<ol style="list-style-type: none"> 1. Aditya P. Mathur, "Introduction to Microprocessors", Third Edition, Tata McGraw-Hill Publishing Co Ltd., New Delhi, 1989. 2. Ahson.S.I., "Microprocessors with Applications in Process Control", Tata McGraw-Hill Publishing Co Ltd.,New Delhi, 1986. 3. K Uma Rao, "The 8051 Microcontrollers: Architecture, Programming & Applications", Pearson, 2010. 4. Steve Heath, "Embedded system design second edition", Elsevier, 2002 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to microprocessors: Microcomputers and microprocessors, 8/16/32/ 64-bit microprocessor families. Internal architecture of Intel 8085 microprocessor: Block diagrams, Registers, Functional details of pins, Control signals.	7	15%
II	Instruction Set of 8085: Instruction set, Instruction format, Addressing modes. Machine cycle and instruction cycles, Timing diagrams, Fetch and execute operations. Assembly Language Programming: Data copy operations, Arithmetic operations, Branching operations, Logic and bit manipulation instructions	7	15%
FIRST INTERNAL EXAMINATION			
III	Interfacing I/O devices: Interrupts, Programmable interface	7	15%

	devices, Interfacing keyboard and seven segment display, Serial I/O and data communication.		
IV	Overview of Embedded System: Embedded System, Categories of Embedded System, Requirements of Embedded Systems, Challenges and Issues in Embedded Software Development, Major application areas of embedded system.	7	15%
SECOND INTERNAL EXAMINATION			
V	Intel 8051 microcontroller: Architecture, Memory organization, Registers and I/O ports, Addressing modes, Instruction sets, Assembly language programming.	7	20%
VI	8051 interfacing: Keyboard, Stepper motor, ADC, DAC, and LCD module interface. Frequency counter and temperature measurement. Other microcontroller architectures: Microchip technology PIC, Atmel AVR, ARM core processors.	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Duration: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a **maximum** of four sub questions, if needed.

Course code	Course Name	L-T-P - C	Year of Introduction
AU486	Noise, Vibration and Harshness	3-0-0-3	2016
Prerequisite : NIL			
Course Objectives			
<ul style="list-style-type: none"> • To impart the basics of noise, vibration, sources of vibration and noise in automobiles • To study the effect of noise and vibration on human beings and nature. • To introduce the methods of measurement of noise and vibration. • To provide knowhow on various methods to reduce the vibration and noise 			
Syllabus			
Fundamentals of Acoustics and Noise, Vibration - Effects of Noise, Blast, Vibration, and Shock on People- Introduction to Transportation Noise and Vibration Sources – Engine noise - Reduction of noise and vibrations - Noise and Vibration Transducers - Noise and Vibration Measurements - Vibration Data Analysis			
Expected outcome.			
The students will			
<ol style="list-style-type: none"> i. understand the sources, effects, prediction, control techniques, measurement techniques of noise, vibration pertain to an automobile ii. know about reduction of noise and vibration from an automobile. 			
Text Books:			
<ol style="list-style-type: none"> 1. Clarence W. de Silva , “Vibration Monitoring, Testing, and Instrumentation “,CRC Press, 2007 2. Colin H Hansen “Understanding Active Noise Cancellation“ , Spon Press , London 2003 3. Kewal Pujara “Vibrations and Noise for Engineers, Dhanpat Rai & Sons, 1992. 4. Singiresu S.Rao,“Mechanical Vibrations” - Pearson Education, ISBM –81-297-0179-2004. 			
References:			
<ol style="list-style-type: none"> 1. Allan G. Piersol ,Thomas L. Paez “Harris’ Shock and Vibration Handbook” , McGraw-Hill , New Delhi, 2010 2. Bernard Challen and Rodica Baranescu - “Diesel Engine Refrence Book” - Second edition - SAE International - ISBN 0-7680-0403-9 – 1999. 3. David A.Bies and Colin H.Hansen “Engineering Noise Control: Theory and Practice “Spon Press, London, 2009 4. Julian Happian-Smith - “An Introduction to Modern Vehicle Design”- Butterworth-Heinemann, ISBN 0750-5044-3 – 2004 5. Matthew Harrison “Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles “, Elsevier Butterworth-Heinemann, Burlington, 2004 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Fundamentals of Acoustics and Noise, Vibration: Introduction, classification of vibration and noises: Theory of Sound—Predictions and Measurement, Sound Sources, Sound Propagation in the Atmosphere, Sound Radiation from Structures and Their Response to	7	15%

	Sound, General Introduction to Vibration, free and forced vibration, undamped and damped vibration, linear and non linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems		
II	Effects of Noise, Blast, Vibration, and Shock on People: General Introduction to Noise and Vibration Effects on People and Hearing Conservation, Noise Exposure, Noise-Induced Annoyance, Effects of Infrasound, Low-Frequency Noise, and Ultrasound on People, Effects of Intense Noise on People and Hearing Loss, Effects of Vibration on People, Effects of Mechanical Shock on People, Rating Measures, Descriptors, Criteria, and Procedures for Determining Human Response to Noise.	7	15%
FIRST INTERNAL EXAMINATION			
III	Introduction to Transportation Noise and Vibration Sources, Noise Characteristics of engines, engine overall noise levels, assessment of combustion noise, assessment of mechanical noise, engine radiated noise, intake and exhaust noise, engine accessory contributed noise, transmission noise, aerodynamic noise, tyre noise, brake noise	7	15%
IV	Reduction of noise and vibrations I: Vibration isolation, tuned absorbers, untuned viscous dampers, damping treatments, application dynamic forces generated by IC engines, engine isolation, crank shaft damping, modal analysis of the mass elastic model shock absorbers.	7	15%
SECOND INTERNAL EXAMINATION			
V	Reduction of noise and vibrations: noise dose level, legislation, measurement and analysis of noise, measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis. Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers	8	20%
VI	Noise and Vibration Transducers, Analysis Equipment, Signal Processing, and Measuring Techniques: General Introduction to Noise and Vibration Transducers, Measuring Equipment, Measurements, Signal Acquisition and Processing, Acoustical Transducer Principles and Types of Microphones, Vibration Transducer Principles and Types of Vibration Transducers, Sound Level Meters, Noise Dosimeters, Analyzers and Signal Generators, Equipment for Data Acquisition, Noise and Vibration Measurements, Determination of Sound Power Level and Emission Sound Pressure Level, Sound Intensity Measurements, Noise and Vibration Data Analysis, Calibration of Measurement Microphones, Calibration of Shock and Vibration Transducers.	8	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Duration: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

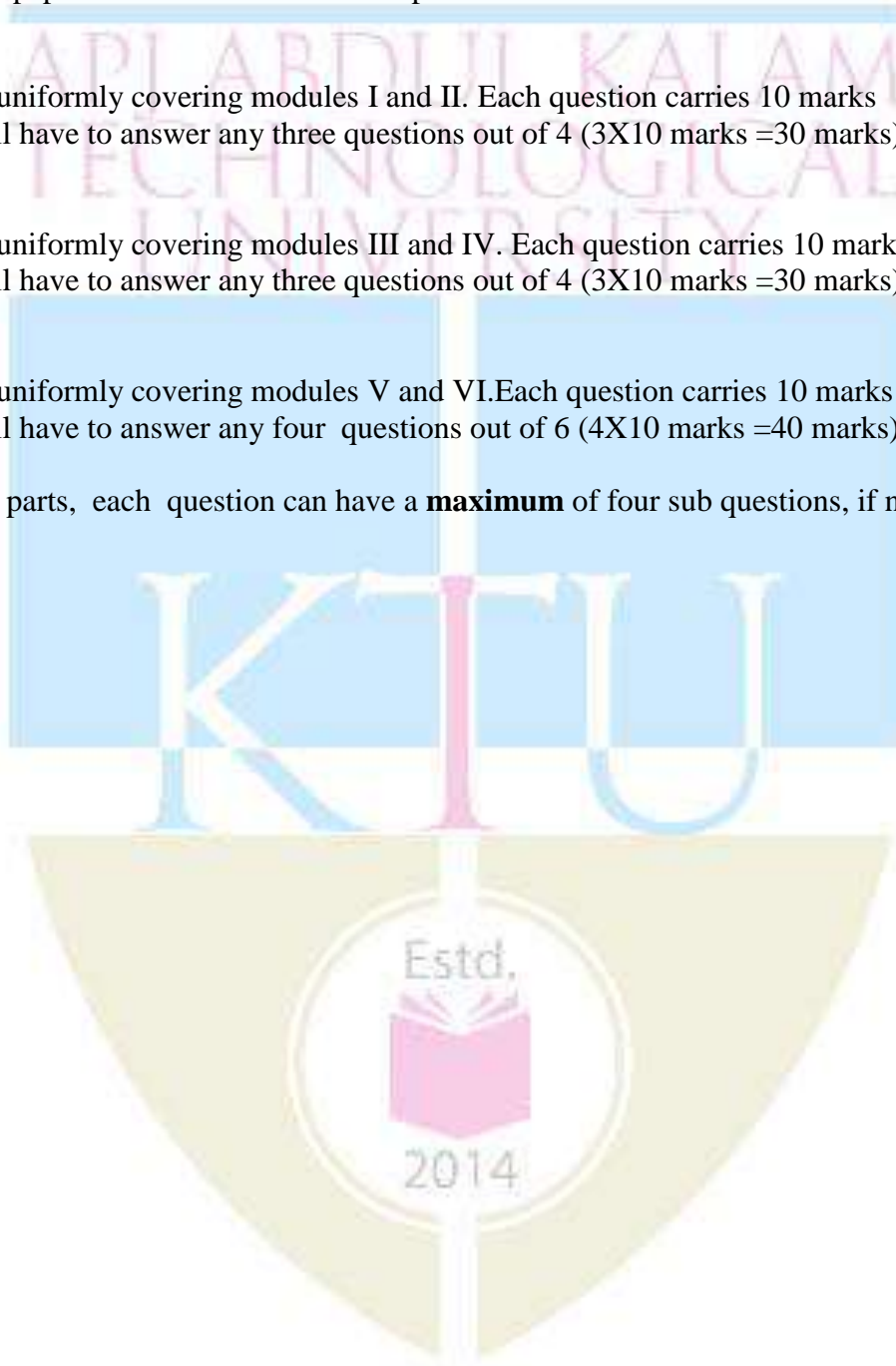
Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a **maximum** of four sub questions, if needed.



Course code	Course Name	L-T-P-Credits	Year of Introduction
CH484	FUEL CELL TECHNOLOGY	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives			
<ul style="list-style-type: none"> To expose the students to the fundamental knowledge required in the development of fuel cell technology. 			
Syllabus			
Introduction to Fuel Cells and Fuel Cell Technology, General Thermodynamics, Reaction Kinetics, Charge and Mass Transport, Overview of Fuel Cell Types, Stack Design, Fuel Cell Characterization, Hydrogen Economy.			
Expected Outcome			
At the end of the course the students will be able to:			
<ol style="list-style-type: none"> Know the fundamentals of electrochemistry, thermodynamics, fluid mechanics, and heat and mass transfer, appropriate for the design or review of components of fuel cells and fuel cell systems. Analyze the fuel cell technology and compare different types of fuel cell systems. Calculate the various losses in fuel cells and analyze the fuel cell power plant subsystems. Defend the significance of fuel cell technology in the new global energy scenario. Distinguish the expectancies of hydrogen as a fuel and energy vector in the context of renewable energy. 			
References Books:			
<ol style="list-style-type: none"> Andreas Zuttel; Andreas Borgschulte; Louis Schdaptach, Hydrogen as a future energy carrier, Wiley-VCH Verlag GmbH & Co., KGaA, Weinheim, 2008. Costamagna, P.; Srinivasan, S, J Power Sources 2001, 102, 242-269.. Frano Barbir. PEM Fuel Cells: Theory and Practice. Elsevier, 2005 Fuel Cell Handbook, 7th Edn., EG & G Technical Services, Nov 2004 Hordeski, M. F. Alternative Fuels: The Future of Hydrogen, The Fairmont Press: Lilburn, GA, 2007. Kordesch, K.; Simader, G. Fuel Cells and Their Applications. VCH: 1996 Larminie, J.; Dicks, A. Fuel Cell Systems Explained. John Wiley & Sons Ltd: Chichester, 1999. Ryan P. O'Hayre, Suk-Won Cha, Whitney Colella & Fritz B. Prinz, Fuel Cell Fundamentals, John Wiley & Sons, Inc., New Jersey, 2006 Vielstich, W, Gasteiger, H. A. Lamm, A. (Eds): Handbook of Fuel Cells- Fundamentals, Technology and Applications. John Wiley & Sons Ltd: NY, 2003; Vols1-4 			
Course Plan			
Module	Contents	Hours	Sem. exam marks
I	Introduction: Fuel Cell, Brief History of fuel cells, Types of Fuel Cells, Working of a PEM fuel Cell, Fuel Cell and conventional processes – comparison, Energy & power relations, units, Application scenarios, Advantages and disadvantages.	7	15%

	General Thermodynamics: Enthalpy-Heat potential of fuel, Gibb's free energy-Work potential of fuel, Reversible voltage - NERNST Equation, Voltage and P, T and concentration dependence – examples, Faraday's Laws, Efficiency: thermodynamic, voltage and fuel.		
II	Reaction Kinetics: Electrochemical reaction fundamentals, electrode kinetics, Charge transfer and activations energy, Exchange current density - slow and fast reactions, Potential and equilibrium - galvanic potential, Reaction rate and potential - Butler Volmer equation & Tafel equation, Electrocatalysts and reaction kinetics – typical exchange current densities, Electrode design basics	7	15%
FIRST INTERNAL EXAMINATION			
III	Charge and Mass Transport: Charge transport resistances, voltage losses, Ionic and electronic conductivities, Ionic conduction in different FC electrolytes: Aqueous, polymeric and ceramic, Diffusive transport & voltage loss: Limiting current density, Nerstian and kinetic effect, Convective transport: flow channels, gas diffusion / porous layer, gas velocity, pressure, Flow channel configurations	7	20%
IV	Overview of Fuel Cell Types: PAFC, PEMFC, AFC, MCFC, SOFC. Major Cell Components, Material Properties, Processes and Operating Conditions of PEMFC.	7	20%
SECOND INTERNAL EXAMINATION			
V	Stack Design: Sizing of a Fuel Cell Stack, Stack Configuration, Uniform distribution of Reactants, Heat removal, Stack Clamping Fuel Cell Diagnostics: Polarization Curve, Current Interrupt, AC Impedance Spectroscopy, Pressure drop as a diagnostic tool.	7	15%
VI	Fuel Cell System Design: Hydrogen-Oxygen Systems, Hydrogen-Air Systems, Fuel Cell Systems with Fuel Processor, System Efficiency Fuel Cells and Hydrogen Economy: Hydrogen Energy Systems, Hydrogen Energy Technologies, Transition to Hydrogen Economy	7	15%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum Marks: 100

Exam Duration: 3 Hours

Part A: There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.

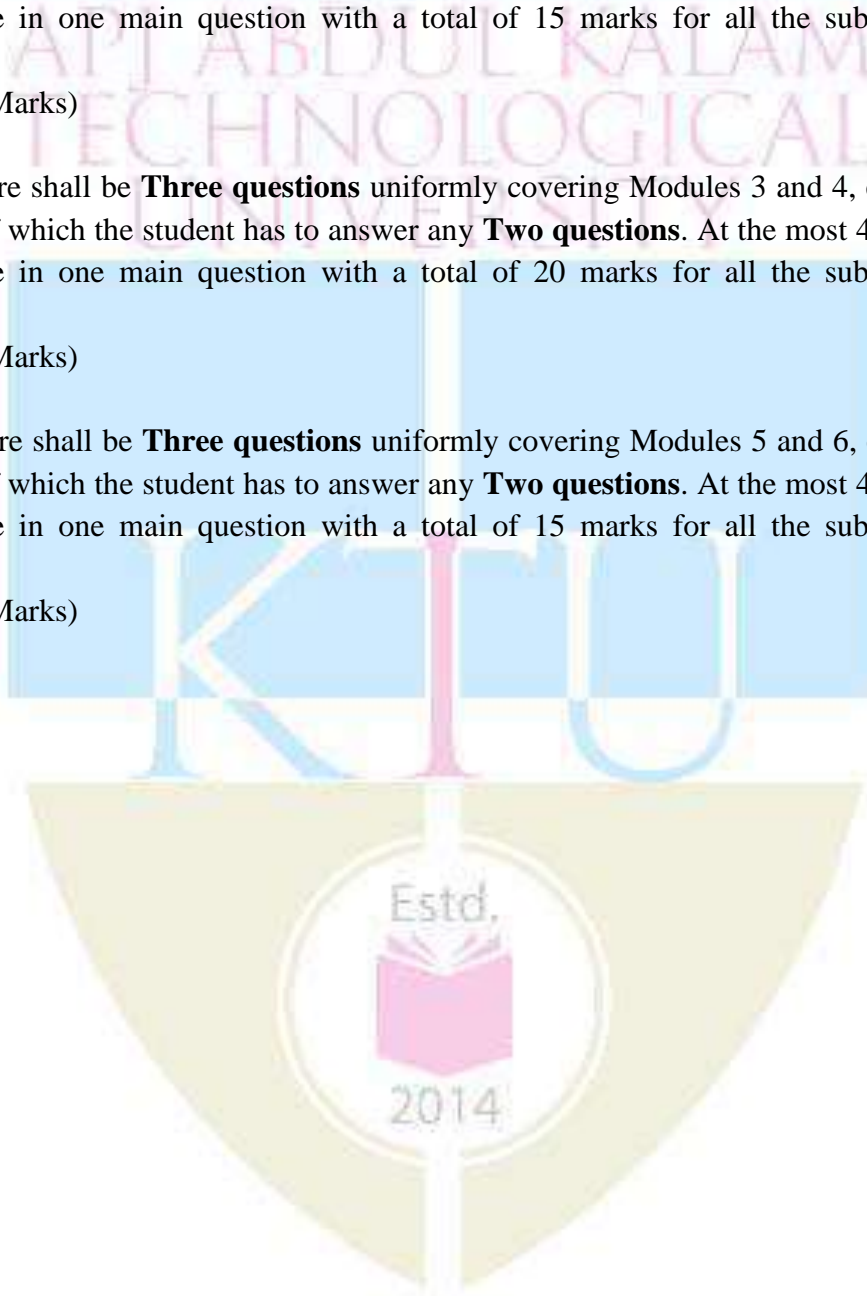
(2 x15= 30 Marks)

Part B: There shall be **Three questions** uniformly covering Modules 3 and 4, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 20 marks for all the subdivisions put together.

(2 x20= 40 Marks)

Part C: There shall be **Three questions** uniformly covering Modules 5 and 6, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.

(2 x15= 30 Marks)



Course code	Course Name	L-T-P-Credits	Year of Introduction
BM482	BIOMEDICAL INSTRUMENTATION	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives			
<ul style="list-style-type: none"> To impart knowledge about the principle and working of different types of biomedical electronic equipment/ devices. 			
Syllabus			
Bioelectric potentials, Electrodes, Transducers, ECG, Pacemakers, Defibrillators, PCG, Blood pressure, PPG, Pulse oximeters, Holter ECG, Stress testing, Patient monitoring systems, EEG, EP, EMG, Spirometers, Heart lung machine, Infant incubators, Infusion pumps, Artificial heart valves, lithotripsy, Surgical diathermy, X-ray radiography, CT, US and MR imaging systems.			
Expected Outcome			
At the end of the course the students will be			
<ol style="list-style-type: none"> Familiar with the principle and applications various analytical, diagnostic and therapeutic instruments Knowing the different methods and modalities used for medical imaging. 			
Text Books:			
Joseph J. Carr, John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education (Singapore) Pvt. Ltd., 2001.			
Reference Books:			
<ol style="list-style-type: none"> Bronzino, Hand book of Biomedical Engineering, IEEE press book. Geddes & Baker, 'Principles of Applied Biomedical Instrumentation', Wiley John G Webster (Ed), Encyclopedia of Medical Devices and Instrumentation, Wiley R.S Khandpur – Handbook of Biomedical Instrumentation – Tata McGraw Webster J, 'Medical Instrumentation-Application and Design', John Wiley 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Origin of bioelectric potentials – resting and action potentials - propagation of action potentials – Examples of bioelectric potentials - ECG, EEG, EMG, ERG, EOG, EGG – Electrodes for measurement of biopotentials.	3	15%
	Transducers for measurement of temperature, pressure & displacement - Basic principles only	3	
II	Electrical activity of heart, electrocardiogram - lead systems - ECG machine – block diagram	2	15%
	Cardiac pacemakers – internal and external pacemakers, defibrillators – basic principles. Measurement of heart sounds – phonocardiography	3	

	Measurement of blood pressure – sphygmomanometer & oscillometric methods. Photo plethysmography - for pulse rate measurement - Pulse oximeters	2	
	Holter recorders. Cardiac stress testing – methods & protocols Patient monitoring systems-Bed side & central station	2	
FIRST INTERNAL EXAM			
IV	Electrical activity of brain - Electro encephalogram – EEG measurement & waveforms - block diagram. Evoked potential - types & applications	3	15%
	Electrical activity of Muscle – Electromyogram (EMG) – Types of electrodes.	1	
	Spiro meter - measurement of respiratory parameters.	2	
III	Heart lung machine, Infant incubators, Infusion pumps, Artificial heart valves - Basic principles & block diagram only.	4	15%
	Lithotripsy – principles, types & applications. Surgical diathermy - Basic principles & block diagram only.	3	
SECOND INTERNAL EXAM			
V	X-ray radiography - Principles of x-ray generation – Block diagram of x-ray machine - Description. Angiography - Basic principles	3	20%
	X-ray computed tomography - Principle of operation, sectional imaging, scanner configurations. Reconstruction of images - Iterative & Fourier methods	5	
VI	Ultrasonic imaging – Basic principles - Ultrasonic transducers & Types - modes of image display-Principles & applications. Doppler & colour flow imaging	3	20%
	MRI – Basic Principles - FID signal-excitation & emission – Basic pulse sequences - Block diagram	3	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100 Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course code	Course Name	L-T-P-Credits	Year of Introduction
BM484	MEDICAL IMAGING & IMAGE PROCESSING TECHNIQUES	3-0-0-3	2016

Course Objectives

- To introduce the underlying principles of biomedical imaging modalities such as US, X-ray, CT, SPECT, PET and MRI
- To provide an overview of the image processing techniques used in these images

Syllabus

Imaging Techniques – X-ray - CT, Nuclear medicine imaging modalities - SPECT and PET, Ultrasound Imaging - Doppler ultrasound, Magnetic resonance imaging –T1, T2 and Proton density weighted, Thermography and Microwave imaging, Image sampling and quantization, Image enhancement-spatial and frequency domain methods, Image segmentation-edge based and region based.

Expected Outcome

The students will be able to

- Identify major processes involved in formation of medical images
- Recognize the imaging modality from their visualizations
- Classify the various medical image processing algorithms
- Describe fundamental methods for image enhancement and segmentation

Reference Books:

- A C Kak, Principle of Computed Tomography, IEEE Press New York
- Atam P Dhawan , Medical Imaging Analysis, Wiley Interscience publication, 2003
- D L Hykes, W R Hedrick &D E Starchman: Ultrasound Physics &Instrumentation, Churchill Livingstone, Melbourne, 1985.
- Douglas A Christensen: Ultrasonic Bioinstrumentation, John Wiley, New York, 1988.
- Gonzalez Rafel C, Wintz Paul: Digital Image Processing, Addison Wesley.1993
- Issac N Bankman, Handbook of Medical Imaging, Processing and Analysis, Academic Press, 2008
- M N Rehani: Physics of Medical Imaging, Macmillian India Ltd., 1991.
- Peter Fish, The Physics of Diagnostic Ultrasound, John Wiley &sons, Eng land,1990.
- S Webb, The Physics of Medical Imaging, IOP Publishing Ltd., 1988.
- Thomas M. Deserno : Biomedical Image Processing Springer-Verlag Berlin Heidelberg 2011

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	X-ray imaging – basic principles of image formation – block diagram of an x-ray machine. Digital radiography - basic principles.	3	15%
	X-ray Computed Tomography - basic principles, contrast scale, different generations of CT scanners, basic principles of image reconstruction.	4	
II	Ultrasonic imaging – Physical principles, Transducer parameters, Different modes - A-mode, M-mode (echocardiograph), B-mode. Principles of Doppler ultrasonic imaging.	4	15%

	Magnetic Resonance Imaging – Principles of MRI, T1 weighted , T2 weighted and proton density weighted images, applications of MRI	3	
FIRST INTERNAL EXAM			
III	Nuclear medicine imaging modalities - Emission Computed Tomography – SPECT & PET	4	15%
	Thermography- Physics of thermography, applications of thermography	3	
IV	Image sampling and quantization, Image enhancement in spatial domain-gray level transformations, histogram processing	4	15%
	Smoothing and sharpening, spatial filters	3	
SECOND INTERNAL EXAM			
V	Image enhancement in frequency domain- filtering- low pass high pass , band pass and band stop filters	4	20%
	Homomorphic filter, Zooming operation	3	
VI	Image segmentation - detection of discontinuities- point, line, edge, edge-based image segmentation- edge linking and boundary detection	4	20%
	Region based segmentation- region growing, region splitting and merging	3	
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100

Exam Duration: 3 Hours

There shall be three parts for the question paper.

Part A includes Modules 1 & 2 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part B includes Modules 3 & 4 and shall have three questions of fifteen marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Part C includes Modules 5 & 6 and shall have three questions of twenty marks out of which two are to be answered. There can be subdivisions, limited to a maximum of 4, in each question.

Note: Each part shall have questions uniformly covering both the modules in it.

Course Code	Course Name	L-T-P	Credits	Year of Introduction
BT362	Sustainable Energy Processes	3-0-0	3	2016
Prerequisite: Nil				
Course Objectives				
<ul style="list-style-type: none"> To introduce the current and potential future energy systems, covering resources, extraction, conversion, and applications, with emphasis on meeting regional and global energy needs in a sustainable manner. 				
Syllabus				
Classification of energy, extraction, conversion, and applications of solar energy, wind energy, ocean energy, biomass energy, fuel cells and hydro-dynamic systems, merits and demerits of various energy systems, energy storage.				
Expected outcome				
Students who successfully complete this course should be able to				
<ol style="list-style-type: none"> Identify global and Indian energy sources. Explain capture, conversion and application of solar and wind energy. Explain conversion of biomass to energy. Explain the capture of energy from oceans. Explain fuel cells and energy storage routes. 				
Reference Books				
<ol style="list-style-type: none"> Bansal N K, Kleemann M, Michael Meliss, <i>Renewable Energy Sources & Conversion Technology</i>, Tata McGraw Hill publishing Company, New Delhi, 1990. Boyle, Godfrey, <i>Renewable Energy</i>, 3/e, Oxford University Press, 2012. S P Sukhatme, <i>Solar Energy - Principles of Thermal Collection and Storage</i>, 2/e, Tata McGraw- Hill Publishing company, New Delhi, 1996. Pramod Jain, <i>Wind Energy Engineering</i>, McGraw Hill, 2011. Donald L Klass, <i>Biomass for Renewable Energy, Fuels and Chemicals</i>, Academic Press, 1998. 				
Course Plan				
Module	Contents	Hours	Sem. Exam Marks	
I	General classification of energy. Conventional and non-conventional. Renewable and non-renewable. Global and Indian energy sources. Global and Indian energy consumption. Problems of fossil fuels. Environmental aspects of energy utilization. Energy and sustainable development. Energy planning. Renewable energy sources, potentials, achievements and applications.	7	15%	
II	Solar energy. Solar radiation. Solar thermal systems. Flat plate and concentrating collectors. Solar desalination. Solar pond. Solar cookers. Solar dryers. Solar thermal electric power plant. Solar photovoltaic conversion. Semiconductor and thin film technology. Solar cells. Solar photovoltaic power generation. Hybrid systems. Merits and limitations of solar energy.	7	15%	
FIRST INTERNAL EXAM				

III	Wind energy. Availability of wind energy, Site characteristics, Wind turbine types-horizontal axis and vertical axis-design principles of wind turbine. Wind power plants, Wind energy storage. Safety and environmental aspects. Merits and limitations of wind energy.	7	15%
IV	Biomass energy. Biomass resources, Biomass conversion technologies-direct combustion, pyrolysis, biomass gasification. Biogas production. Biomethanation as an aid to environment improvement. Bioethanol, biodiesel and biobutanol production. Hydrogen as fuel. Biohydrogen production. Storage of hydrogen.	7	15%
SECOND INTERNAL EXAM			
V	Energy from the oceans. Ocean thermal electric conversion. Tidal energy conversion. Geothermal energy conversion. Hydro power-global and Indian scenario. Positive and negative attributes of hydropower. Electricity from hydropower. Small hydropower.	7	20%
VI	Fuel cells. Alkaline fuel cells. Phosphoric acid fuel cell. Molten carbonate fuel cell. Solid oxide fuel cell, Solid polymer electrolyte fuel cell. Magneto-hydrodynamic systems. Electric vehicles. Energy storage routes like thermal, chemical, mechanical, electrical storage. Batteries.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks: 100

Exam Duration: 3 hours

The question paper consists of Part A, Part B and Part C.

Part A consists of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer two questions (15×2=30 marks).

Part B consists of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer two questions (15×2=30 marks).

Part C consists of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer two questions (20×2=40 marks).

For each question there can be a maximum of 4 subparts.

Course Code	Course Name	L-T-P	Credits	Year of Introduction
BT461	Design of Biological Wastewater Treatment Systems	3-0-0	3	2016
Prerequisite : Nil				
Course Objectives				
<ul style="list-style-type: none"> To provide the necessary theoretical background for the design of most common biological waste treatment systems. 				
Syllabus				
Characteristics and <i>impacts of wastewater on</i> the environment, basic design considerations, types of biological treatment processes and reactors, aerobic suspended growth systems, anaerobic digesters, design consideration for upflow anaerobic sludge blanket reactors, biogas production.				
Expected outcome				
A student who successfully completes this course will be able to <ol style="list-style-type: none"> Explain the characteristics of wastewater. Identify different types of reactors for wastewater treatment. Design a completely mixed activated sludge system. Explain the design features of an upflow anaerobic sludge blanket reactor. Explain the factors affecting biogas production. 				
Reference Books				
<ol style="list-style-type: none"> G Karia, R A Christian, <i>Wastewater Treatment: Concepts and Design Approach</i>, 2/e, PHI Learning Pvt., Ltd., 2013. P Venugopala Rao, <i>Textbook of Environmental Engineering</i>, Prentice-Hall of India Pvt. Ltd., 2002. Metcalf & Eddy, <i>Wastewater Engineering: Treatment and Reuse</i>, 4/e, Tata McGraw-Hill Education, 2003. M Narayana Rao, Amal K Datta, <i>Waste Water Treatment: Rational Methods of Design and Industrial Practices</i>, 3/e, Oxford & IBH Publishing Company Pvt. Ltd., New Delhi, R S Khoiyangbam, Navindu Gupta, Sushil Kumar, <i>Biogas Technology: Towards Sustainable Development</i>, The Energy and Resources Institute (TERI), 2011. 				
Course Plan				
Module	Contents	Hours	Sem. Exam Marks	
I	Wastewater-origin, characteristics, <i>impacts of wastewater on</i> the environment, basic design considerations-estimation of wastewater quantities, variation in wastewater flow rates-average daily flow, maximum daily flow, peak hourly flow, minimum daily flow, minimum hourly flow, process flow sheet, reactor considerations.	5	15%	
II	Objectives and fundamentals of biological treatment, types of biological treatment processes, types of reactors used for wastewater treatment process, kinetics of biological treatment systems-batch and continuous systems, biological nitrogen removal, biological phosphorous removal.	5	15%	
FIRST INTERNAL EXAM				

III	Aerobic suspended growth systems-Conventional activated sludge processes and its modifications-theoretical principles, design of completely mixed activated sludge system, F/M ratio, hydraulic loading, MLSS, MLVSS, sludge age, sludge return, calculation of the reactor volume, production and removal of excess sludge, sludge volume index, Solids Retention Time (SRT) or Mean Cell Residence Time, oxygen requirements.	8	15%
IV	Aerobic attached growth system-Trickling filters-theoretical principles, classification, design principles, process design considerations, Oxidation ponds-construction and design considerations, aerobic sludge digestion, waste stabilization ponds, oxidation ditches-theory and design, factors affecting the design, theory and design of rotating biological contactors	8	15%
SECOND INTERNAL EXAM			
V	Fundamentals of anaerobic treatment, types of anaerobic digesters-conventional systems, high-rate systems and combined treatment systems, design of upflow anaerobic sludge blanket reactors, anaerobic sequencing batch reactor, anaerobic filters-upflow and downflow anaerobic filters, sludge treatment and disposal, sludge digestion, sludge drying, sludge conditioning, sludge drying characteristics.	8	20%
VI	Biogas technology-microbiology of biogas production, process parameters for a biogas plant, biogas yield from different substrates, methods to enhance biogas production-effect of heating, insulation and stirring on gas production, basic components of a biogas plant, biogas plant designs-continuous type plants, semi-continuous plants, fixed dome type, floating gasholder digester (KVIC),kinetic models for predicting biogas production, design equations of biogas plants.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks: 100

Exam Duration: 3 hours

The question paper consists of Part A, Part B and Part C.

Part A consists of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer two questions ($15 \times 2 = 30$ marks).

Part B consists of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer two questions ($15 \times 2 = 30$ marks).

Part C consists of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer two questions ($20 \times 2 = 40$ marks).

For each question there can be a maximum of 4 subparts.

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE482	ENVIRONMENTAL IMPACT ASSESSMENT	3-0-0-3	2016

Prerequisites: Nil

Course objectives:

- To study the various types of environmental pollution
- To study the impact of various types of pollutants and their assessment techniques

Syllabus:

Pollution, Types. Air pollution-sources, effects, types of pollutants. Water pollution, characteristics of water pollutants, Solid wastes, sources, types, soil pollution, pesticide pollution. Noise pollution, Impacts, positive and negative Environmental impact assessment, steps of doing EIA, methodology adopted, EIA procedure in India, Case studies.

Course Outcomes:

- The students will have a basic knowledge of various pollution sources and their impacts

Text Books / References:

1. B.C Punmia , “Waste Water Engineering”, Laxmi Publications Pvt. Ltd,
2. Dr. PN Modi, “Sewage Treatment & Disposal and Waste water Engineering”, Standard Book House, New Delhi
3. John Glasson, Riki Therivel & S Andrew Chadwick “Introduction to EIA” University College London Press Limited
4. Larry W Canter, “Environmental Impact Assessment”, McGraw Hill Inc. , Newyork.
5. Mackenzie L Davis, Introduction to Environmental Engineering, McGraw hill Education (India)
6. Peavy H S, Rowe, D.R. Tchobanaglou “Environmental Engineering” Mc Graw Hill Education
7. Rau G J and Wooten C.D “EIA Analysis Hand Book” McGraw Hill
8. Robert A Corbett “Standard Handbook of Environmental Engineering” McGraw Hill

COURSE PLAN

Module	Contents	Hours	End Sem. Exam Marks %
I	INTRODUCTION: Classification of Pollution and Pollutants, AIR POLLUTION: Primary and Secondary Pollutants, air pollutants-sulfur dioxide- nitrogen dioxide, carbon monoxide, Impact of air pollutants on human, vegetation and environment, , Ambient Air Quality Standards	7	15
II	WATER POLLUTION: Point and Non-point Source of Pollution, Major Pollutants of Water, Physical, chemical and biological characteristics of water , Water borne diseases, Water Quality standards	7	15

FIRST INTERNAL EXAMINATION			
III	SOLID WASTE: Classification and sources of Solid Waste, Characteristics of Solid Waste, e waste, Radioactive wastes LAND/SOIL POLLUTION: Effects of urbanization on land degradation, Impact of Modern Agriculture on Soil, pesticide pollution, Effect on Environment	6	15
IV	NOISE POLLUTION: Sources of Noise, Effects of Noise, measurement of noise, Equivalent sound pressure level, Control measures	6	15,
SECOND INTERNAL EXAMINATION			
V	Impacts of pollutants, types, scale of impact-Global, local pollutants. Climate change, Ozone layer depletion, Deforestation, land degradation Environmental impact assessment, Need for EIA,	8	20
VI	EIA Procedure-Screening, Scoping, EIA procedure in India, Impact analysis- checklists, matrix methods, overlay analysis, Case studies of EIA	8	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (External Evaluation) :

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V &VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE484	APPLIED EARTH SYSTEMS	3-0-0-3	2016

Prerequisites: Nil

Course objectives:

- Appreciation of earth as a system of interrelated components
- Understanding mechanisms that give rise to oceanographic and atmospheric phenomena
- Comprehension of processes that result in characteristic land features in different climatic regimes

Syllabus :

Fundamental concepts of equilibrium - Geomorphic agents and processes -Earth systems -climate change - Weathering- Fluvial processes- Stages of stream development- Drainage patterns - Soil-Deserts- Wagner's ideas of continental drift, Plate Tectonics- Basics of oceanography-. Basic ideas about plankton and primary productivity -Basics of atmosphere and atmospheric processes - Heat budget- Fundamental concepts of precipitation, global wind patterns.

Expected Outcomes:

- i. The students would understand the roles of surface and sub surface phenomena in shaping surface features of earth
- ii. The course would appreciate the ramifications of any atmospheric, oceanographic or land process on other component subsystems including biosphere.

Text Books / References:

1. Critchfield H J ,*General Climatology* Prentice Hall, New Delhi, 1983
2. Fetter C W, *Applied Hydrogeology* CBS New Delhi, 1990
3. Carlson, D H, Plummer, CC and McGreary, D, *Physical geology: Earth Revealed* McGraw Hill, New York, 2006
4. Pinet P R, *Oceanography – An Introduction to the Planet Oceanus*, West Publishing Co., 1992
5. Valdiya K S, *Environmental Geology: Ecology, Resource and Hazard Management* McGraw-Hill Education (India) Private Limited, New Delhi, 2013

COURSE PLAN			
Module	Contents	Hours	End Sem. Exam Marks %
I	Fundamental concepts of equilibrium. Geomorphic agents and processes. Basic concept of Earth as a system and its component sub systems. Climate Change vis-a-vis the interrelationships of the subsystems- Green House Effect and Global warming, basic ideas about their causes and effects.	7	15
II	Weathering- relevance, influence of and on earth systems, types and controlling factors Fluvial processes-hydrological cycle, fluvial erosion, transportation and deposition, fluvial landforms. Stages of stream development; Drainage patterns.	7	15
FIRST INTERNAL EXAMINATION			
III	Soil- formation and controls, soil profile, soil erosion and conservation methods. Deserts-distribution and controls.	7	15
IV	Wagner's ideas of continental drift, Plate Tectonics- seafloor spreading. Plate boundaries and their features, mechanisms of plate movements.	7	15
SECOND INTERNAL EXAMINATION			
V	Basics of oceanography: coastal upwelling and downwelling. Outlines of ocean floor topography, Brief account of marine sediments, turbidity currents, basic outlines of origin and circulation of deep sea surface currents (Atlantic and Pacific Oceans), coral reefs- types and concepts about their formation. Basic ideas about plankton and primary productivity.	7	20
VI	Basics of atmosphere and atmospheric processes: Structure and composition of the atmosphere. Heat budget, factors affecting solar radiation. Fundamental concepts of precipitation, global wind patterns.	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End Semester Exam)

Maximum Marks : 100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V &VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-C	Year of Introduction
CE486	GEOINFORMATICS FOR INFRASTRUCTURE MANAGEMENT	3-0-0-3	2016

Prerequisites: Nil

Course objectives:

- To expose the concept of GIS and Remote sensing
- To introduce the applications of GIS and Remote sensing for infrastructure management

Syllabus:

Remote Sensing - Energy sources and radiation principles - Data acquisition - Multispectral, Thermal and Microwave remote sensing -; Elements of visual image interpretation- Introduction to Digital Image processing - Coordinate Systems – Map projections - GIS: Components of GIS - Data input and editing –GIS output- Data visualization -Digital Elevation Models and Digital Terrain Models – Mapping - Site suitability analysis - Network Analysis

Course Outcomes:

The students will

- Understand various satellite data products and their uses.
- Know about the Geospatial data and its importance in Spatialanalysis.
- Apply Geoinformatics techniques in various engineering applications and for infrastructure development.

Text Books / References:

1. Burrough P.P. &McDonnel, R.A. (1998) Principles of GIS, Oxford University Press
2. Chang, K (2008), Introduction to Geographic Information Systems, Tata McGraw-Hill
3. Davis, B. E. (2001), GIS: A visual approach, Onword Press
4. F.F Sabins(Jr.), Remote Sensing : Principals and Interpretation, Freeman & Co., San Francisco, 1978
5. Joseph, G., Fundamentals of Remote Sensing, Universities Press (2003)
6. Keith P.B., Thompson et. Al. (Ed.), Remote Sensing and Water Resources Management, American Water Resources Association, Urbana Illinois, 1973.
7. Kennie, T.J.M. and Matthews, M.C., Remote Sensing in Civil Engineering, Surrey University Press (1985)
8. Lo, C.P. and Albert Yeung , Concepts and Techniques of GIS , Prentice Hall, 2nd Ed. 2006
9. M Anji Reddy(2001), Remote Sensing and Geographic Information Systems, B S Publications, Hyderabad
10. Panigrahi,N (2008), Geographical Information Science, University Press
11. R.N. Colwel (Ed.), Manual of Remote Sensing, Vol. I & II, American Society of Photogrammetry and Remote Sensing, Falls Church, Va. (1983)
12. Schowengerdt, R. A.,Remote sensing, Models and Methods for image processing, Academic Press (2009)
13. T.M. Lillesand and R.W.Kiefer, Remote Sensing and Image Interpretation, John Wiley and Sons, 1979

COURSE PLAN

Module	Contents	Hours	End Sem Exam Marks %
I	Remote Sensing: Energy sources and radiation principles- Interaction of EM energy with atmosphere and surface features,	7	15

	spectral reflectance patterns, Data acquisition - Multistage and multispectral remote sensing concept		
II	Classification of Remote sensing systems - Optical, Thermal and Microwave remote sensing. Image Interpretation: Elements of visual image interpretation – Image interpretation keys - Introduction to Digital Image processing.	7	15
FIRST INTERNAL EXAMINATION			
III	Coordinate Systems: Geographic coordinate systems- approximations of earth, ellipsoid and geoid models, geodetic datum and vertical datum, coordinate transformation, Map projections-concepts, properties, and types.	7	15
IV	GIS: Geographical concepts and terminology, Components of GIS, Spatial and non-spatial data, Vector and raster data; Methods of data input, Spatial data editing; Vector data analysis-buffering, overlay, slivers; Raster data analysis- categories; GIS output: cartographic and non-cartographic output	7	15
SECOND INTERNAL EXAMINATION			
V	Digital Elevation Models and Digital Terrain Models; Land use/ Land cover mapping, Ground Water Potential Zonation Mapping, Hazard Zonation Mapping.	7	20
VI	Site suitability analysis for Residential area, Industrial area, Recreational Area, Solid Waste Disposal, Water treatment plant Network Analysis- Water supply line, Sewer line, Power line, Telecommunication, Road network	7	20
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester examination)

Maximum Marks : 100

Duration : 3 hours

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V &VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE488	DISASTER MANAGEMENT	3-0-0-3	2016

Course Objectives

- To provide an overview of the common hazards and their dynamics
- To inculcate the basic concepts of disaster management

Syllabus

Fundamental concepts of hazards and disasters - Basic concept of Earth as a system and its component sub systems - . Climate Change - Introduction to key concepts and terminology of hazard, vulnerability, exposure, risk, crisis, emergencies, Disasters, Resilience - Natural Disasters - Earth quakes, Landslides. Floods, Coastal disasters, Tidal waves, Tsunamis. Nature of Impacts - Anthropogenic Disasters - Soil degradation and desertification -water and atmospheric pollution -Hazard and disaster management plans for floods, tidal waves.

Expected Outcome

The students will

- get general ideas about the processes involved in natural and anthropogenic disasters
- understand the concepts of disaster management and measures to mitigate and contain common episodes of disasters

References:

1. Andrew, S., "Environmental Modeling with GIS and Remote Sensing", John Willey and sons, 2002
2. Ariyabandu, M. and Sahni P. (Eds), "Disaster Risk Reduction in South Asia", Prentice-Hall (India), 2003.
3. Bell, F.G., "Geological Hazards: Their assessment, avoidance and mitigation", E & FN SPON Routledge, London. 1999
4. Bossler, J.D., "Manual of Geospatial Science and Technology", Taylor and Francis, London, 2001
5. David Alexander, "Natural Disasters", Research Press, New Delhi, 1993
6. Matthews, J.A., "Natural hazards and Environmental Change", Bill McGuire, Ian Mason, 2002
7. Nick Carter. W., "Disaster Management - A Disaster Manager's Handbook". Asian Development Bank, Philippines. 1991
8. United Nations , Mitigating Natural Disasters, Phenomena, Effects and options, A Manual for policy makers and planners, New York, 1991

COURSE PLAN

Module	Contents	Hours	End Sem. Exam Marks
I	Fundamental concepts of hazards and disasters: Introduction to key concepts and terminology of hazard, vulnerability, exposure, risk, crisis, emergencies, Disasters, Resilience. Basic concept of Earth as a system and its component sub systems. Climate Change vis-a-vis the interrelationships of the subsystems- Green House Effect and Global warming, basic	7	15%

	ideas about their causes and effects.		
II	Types of Natural Disasters I- Earth quakes, Landslides. Nature of impacts.	7	15%
FIRST INTERNAL EXAMINATION			
III	Types of Natural Disasters II- Floods, Coastal disasters- Cyclones, Tsunamis. Nature of impacts.	7	15%
IV	Types of Anthropogenic Disasters I- soil and soil degradation, desertification.	7	15%
SECOND INTERNAL EXAMINATION			
V	Types of Anthropogenic Disasters II-Fundamental concepts of water and atmospheric pollution.	7	20%
VI	Hazard and disaster management plans for floods, tidal waves.	7	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End Semester Examination)

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V &VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course Code	Course Name	L-T-P-Credits	Year of Introduction
CE494	ENVIRONMENTAL HEALTH AND SAFETY	3-0-0-3	2016

Pre-requisites: Nil

Course objectives:

- To introduce the different types of hazards in industries and the management of hazards.
- To learn the various types of pollution.

Syllabus:

Occupational health and toxicology- Lead-nickel, chromium and manganese toxicity-gas poisoning- Industrial hygiene, Physical, chemical and biological hazards, Safety and Health Management, noise-effects, source, Electrical Hazards and Hazards in Construction Industry, Air pollution, Water pollution, Hazardous Waste Management, pollution control in different industries

Expected Outcomes:

The students will

- Be able to understand the various occupational hazards and the techniques that can be adopted for managing hazards and related problems
- Become aware regarding air pollution and water pollution problems and pollution control in industries

Text Books / References:

- Gerard Kiely, Environmental Engineering, McGraw hill Education
- Mackenzie L Davis, Introduction to Environmental Engineering, McGraw hill Education (India)
- National Safety Council , Hand book of Occupational Safety and Health, Chicago, 1982
- R.K.Jain and Sunil S.Rao , Industrial Safety , Health and Environment Management Systems, Khanna publishers , New Delhi (2006)
- S.P.Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 1993
- Slote.L, Handbook of Occupational Safety and Health, John Willey and Sons, New York

COURSE PLAN

Module	Contents	Hours	End Sem. Exam Marks
I	Occupational Health And Toxicology : occupational related diseases, silicosis, asbestosis, pneumoconiosis, etc. lead, nickel, chromium and manganese toxicity, effects and prevention –Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects. Industrial Hygiene.	7	15%

II	Noise, noise exposure regulation. Ionizing radiation, types, effects. Chemical hazards-dust, fumes, mist, vapour, fog, gases, Methods of Control. Biological hazards-Classification of Biohazardous agents – bacterial agents, viral agents, fungal, parasitic agents, infectious diseases.	7	15%
FIRST INTERNAL EXAMINATION			
III	Radiation and Industrial Hazards, Types and effects of radiation on human body, disposal of radioactive waste Air Pollution - air pollutants from industries, effecton human health, animals, Plants and Materials - concept of clean coal combustion technology - depletion of ozone	6	15%
IV	Electrical Hazards, Protection against voltage fluctuations, Effects of shock on human body. Introduction of Construction industry, Scaffolding and Working platform, Welding and Cutting, Excavation Work, Concreting and Cementing work, Transportation of men and material,	6	15%
SECOND INTERNAL EXAMINATION			
V	Water Pollution -water pollutants-health hazards - effluent quality standards,tannery, textile effluents Hazardous Waste Management -waste identification, characterization and classification, health hazards-toxic and radioactive wastes-recycling and reuse.	8	20%
VI	Pollution Control In Process Industries - Pollution control in process industries like cement, paper, petroleum products-textile, tanneries-thermal power plants – dyeing and pigment industries - eco-friendly energy.	8	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (External Evaluation) :

Maximum Marks :100

Exam Duration: 3 Hrs

Part A -Module I & II : 2 questions out of 3 questions carrying 15 marks each

Part B - Module III & IV: 2 questions out of 3 questions carrying 15 marks each

Part C - Module V &VI : 2 questions out of 3 questions carrying 20 marks each

Note : 1.Each part should have at least one question from each module

2.Each question can have a maximum of 4 subdivisions (a,b,c,d)

Course code	Course Name	L-T-P-Credits	Year of Introduction
CH482	PROCESS UTILITIES AND PIPE LINE DESIGN	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives			
<ol style="list-style-type: none"> 1. To impart the basic concepts of project engineering 2. To develop understanding about process auxiliaries and utilities in process industries 			
Syllabus			
<p>Process Auxiliaries. Piping design, Piping insulation, Piping fittings, Valves, Pumps, Process control and instrumentation diagram.</p> <p>Process Utilities: Process Water, Steam, Compressors and Vacuum Pumps, Methods of vacuum development and their limitations, materials handling under vacuum. Refrigeration and Chilling systems, Oil heating systems, Nitrogen systems</p>			
Expected Outcome			
<p>After successful completion of the course the students will be able to</p> <ol style="list-style-type: none"> i. Acquire the overall knowledge about the process plant. ii. Understand the importance of process auxiliaries and utilities in process industries. iii. Learn the conceptual design of chemical process plant. iv. Build a bridge between theoretical and practical concepts used for process auxiliaries and utilities in any process industry. 			
References:			
<ol style="list-style-type: none"> 1. F.C. Vibrandt and C.E. Dryden, "Chemical Engineering Plant Design", McGraw Hill, Fifth Edition. 2. Jack Broughton; Process utility systems; Institution of Chem. Engineers, U.K. 3. M.S. Peters and Timmerhaus, "Plant design and Economics for Chemical Engineers", Mc Graw Hill 3rd Edition. 4. Roger Hunt and Ed Bausbacher, "Process Plant layout and Piping Design" PTR Prentice-Hall Inc., 			
Course Plan			
Mod ule	Contents	Hours	Sem. Exam Marks
I	Process Auxiliaries: Basic considerations and flow diagrams in chemical engineering plant design. Piping design: Selection of material, pipe sizes, working pressure, Basic principles of piping design, piping drawings, pipe installations, overhead installations, Process steam piping, selection and determination of steam – pipe size, Piping insulation, application of piping insulation, weather proof and fire resisting pipe insulation jackets, piping fittings, pipe joints	7	15
II	Valves: Types of valves, selection criteria of valves for various systems. Pumps: Types of pumps, NPSH requirement, pump location, pump piping, pump piping support. Process control and instrumentation diagram, control system design for process auxiliaries.	7	15

FIRST INTERNAL EXAMINATION			
III	Process Utilities: Process Water: Sources of water, hard and soft water, Requisites of industrial water and its uses, Methods of water treatment, Chemical softening, Demineralization, Resins used for water softening, Water for boiler use, cooling purposes, cooling towers, drinking and process water treatment, reuse and conservation of water, 27 50% water resources management, waste water treatment and disposal.	7	15
IV	Steam: Steam generation and its application in chemical process plants, distribution and utilization, boilers, design of efficient steam heating systems, steam economy, condensate utilization, steam traps, their characteristics, selection and application, waste heat utilization	7	15
SECOND INTERNAL EXAMINATION			
V	Compressors and Vacuum Pumps: Types of compressors and vacuum pumps and their performance characteristics, Methods of vacuum development and their limitations, materials handling under vacuum, lubrication and oil removal in compressors and pumps, instrument air.	7	20
VI	Refrigeration and Chilling systems. Oil heating systems, Nitrogen systems.	7	20
END SEMESTER EXAMINATION			

Question Paper Pattern:

Maximum Marks: 100

Exam Duration: 3 Hours

Part A: There shall be **Three questions** uniformly covering Modules 1 and 2, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.

(2 x15= 30 Marks)

Part B: There shall be **Three questions** uniformly covering Modules 3 and 4, each carrying 15 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 15 marks for all the subdivisions put together.

(2 x15= 30 Marks)

Part C: There shall be **Three questions** uniformly covering Modules 5 and 6, each carrying 20 marks, of which the student has to answer any **Two questions**. At the most 4 subdivisions can be there in one main question with a total of 20 marks for all the subdivisions put together.

(2 x20= 40 Marks)

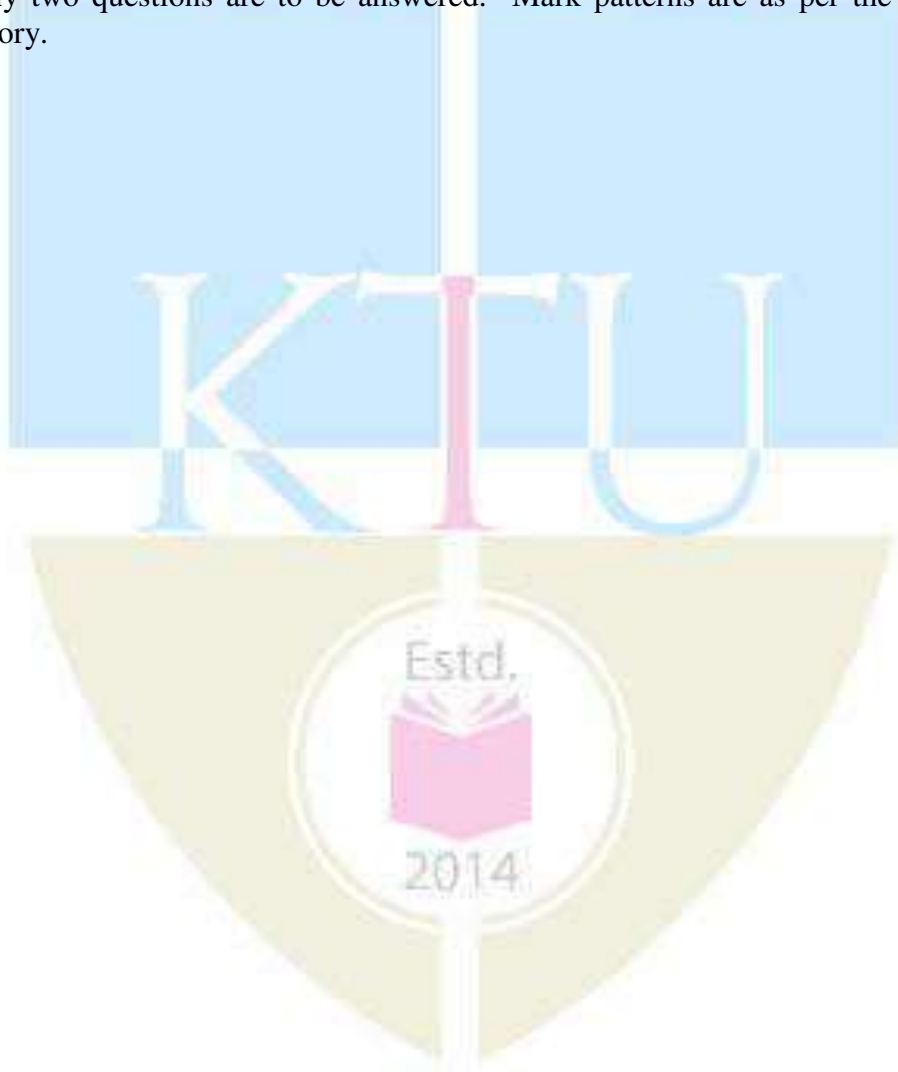
COURSE CODE	COURSE NAME	L-T-P-C	YEAR OF INTRODUCTION
EC482	Biomedical Engineering	3-0-0-3	2016
Prerequisite: Nil			
Course objectives:			
<ul style="list-style-type: none"> • To introduce basics of biomedical engineering technology • To understand the anatomy & physiology of major systems of the body in designing equipment for medical treatments. • To impart knowledge about the principle and working of different types of bio-medical electronic equipment/devices. 			
Syllabus:			
Human body-overview, Physiological systems of body, Measurement of physiological parameters, Assisting and therapeutic devices, Medical laboratory equipments, Telemetry in patient care, Patient safety, Medical imaging system			
Expected outcome:			
The students will be able:			
<ol style="list-style-type: none"> i. To understand diagnosis and therapy related equipments. ii. To understand the problem and identify the necessity of equipment for diagnosis and therapy. iii. To understand the importance of electronics engineering in medical field. iv. To understand the importance of telemetry in patient care 			
Text Books:			
<ol style="list-style-type: none"> 1. K S Kandpur, "Hand book of Biomedical instrumentation", Tata McGraw Hill 2nd e/d. 2. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, PHI, 2nd Edition, 2004 			
References:			
<ol style="list-style-type: none"> 1. Barbara Christe, Introduction to Biomedical Instrumentation, Cambridge University Press, 2008. 2. J J Carr, "Introduction to Biomedical Equipment Technology", 4ed, Pearson Education 3. John G Webster, "Medical Instrumentation application and design", 3ed, John Wiley 4. Richard Aston, "Principle of Biomedical Instrumentation and Measurement", Merrill Education/Prentice Hall. 			
Course Plan			
Module	Course content	Hours	End Sem. Exam Marks
I	Introduction to bio-medical instrumentation system, overview of anatomy and physiological systems of the body.	1	15%
	Sources of bio-electric potential: Resting and action potential, propagation of action potentials. Bioelectric potentials examples (ECG, EEG, EMG, ERG, EOG, EGG, etc introduction only.)	2	

	Electrode theory: Nernst relation Bio potential electrodes: Microelectrodes, skin surface electrodes, needle electrodes.	1	
	Instrumentation for clinical laboratory: Bio potential amplifiers-instrumentation amplifiers, carrier amplifiers, isolation amplifiers, chopper amplifiers	2	
II	Heart and cardiovascular system (brief discussion), electro conduction system of the heart. Electrocardiography, ECG machine block diagram, ECG lead configurations, ECG recording system, Einthoven triangle, analysis of ECG signals.	3	15%
	Measurement of blood pressure: Direct, indirect and relative methods of blood pressure measurement, auscultatory method, oscillometric and ultrasonic non-invasive pressure measurements.	2	
	Measurement of blood flow: Electromagnetic blood flow meters and ultrasonic blood flow meters.	2	
FIRST INTERNAL EXAM			
III	The human nervous system. Neuron, action potential of brain, brain waves, types of electrodes, placement of electrodes, evoked potential, EEG recording, analysis of EEG.	2	15%
	Electromyography: Nerve conduction velocity, instrumentation system for EMG.	1	
	Physiology of respiratory system (brief discussion), Respiratory parameters, spirometer, body plethysmographs, gas exchange and distribution.	2	
	Instruments for clinical laboratory: Oxymeters, pH meter, blood cell counter, flame photometer, spectrophotometer	3	
IV	Therapeutic Equipments: Principle, block schematic diagram, working and applications of: pacemakers, cardiac defibrillators, heart-lung machine, dialyzers, surgical diathermy equipment, ventilators	6	15%
SECOND INTERNAL EXAM			
V	Medical Imaging systems (Basic Principle only): X-ray imaging - Properties and production of X-rays, X-ray machine, applications of X-rays in medicine.	2	20%
	Computed Tomography: Principle, image reconstruction, scanning system and applications.	2	
	Ultrasonic imaging systems: Basic pulse echo system, propagation of ultrasonic through tissues and reflections, display types, A-Scan, B-Scan, M-Scan, applications, real-time ultrasonic imaging systems and probes.	3	
VI	Magnetic Resonance Imaging – Basic NMR components, Biological effects and advantages of NMR imaging	3	20%

	Biomedical Telemetry system: Components of biotelemetry system, application of telemetry in medicine, single channel telemetry system for ECG and temperature	2	
	Patient Safety: Electric shock hazards, leakage current, safety codes for electro medical equipments	1	
END SEMESTER EXAM			

Question Paper Pattern (End semester exam)

The question paper shall consist of three parts. Part A covers modules I and II, Part B covers modules III and IV, and Part C covers modules V and VI. Each part has three questions uniformly covering the two modules and each question can have maximum four subdivisions. In each part, any two questions are to be answered. Mark patterns are as per the syllabus with 100% for theory.



Course code.	Course Name	L-T-P - Credits	Year of Introduction
EE482	ENERGY MANAGEMENT AND AUDITING	3-0-0-3	2016
Prerequisite: NIL			
Course Objectives			
<ul style="list-style-type: none"> • To enable the students to understand the concept of energy management • To understand the different methods used to control peak demand • To understand the energy management opportunities in different systems • To understand how the use of energy audit. • To understand the different methods used for the economic analysis of energy projects 			
Syllabus			
General principles of Energy management and Energy management planning - Peak Demand controls - Energy management opportunities in electrical systems and HVAC systems – Reactive power management – Energy audit – cogeneration system – Economic analysis of energy projects			
Expected outcome.			
The students will be able to:			
<ol style="list-style-type: none"> i. Understand the different methods used to reduce energy consumption ii. Know energy audit iii. Do economic analysis of energy projects 			
Text Book/Refernces:			
<ol style="list-style-type: none"> 1. Albert Thumann, William J. Younger, Handbook of Energy Audits, CRC Press, 2003 2. Charles M. Gottschalk , Industrial energy conservation, John Wiley & Sons, 1996. 3. Craig B. Smith, Kelly E Parmenter Energy management principles, Elsevier, 2ed, 2015 . 4. D. Yogi Goswami, Frank Kreith, Energy Management and Conservation Handbook , CRC Press, 2007. 5. G.G. Rajan , Optimizing energy efficiencies in industry, Tata McGraw Hill, Pub. Co., 2001. 6. IEEE recommended practice for energy management in industrial and commercial facilities, IEEE std 739 - 1995 (Bronze book). 7. M Jayaraju and Premlet , Introduction to Energy Conservation And Management, Phasor Books, 2008. 8. Paul W O'Callaghan, Energy management, McGraw Hill Book Co., 1993 9. Wayne C. Turner, Energy management Hand Book, The Fairmount Press, Inc., 1997. 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	General principles of Energy management and Energy management planning. Peak Demand controls, Methodologies, Types of Industrial Loads, Optimal Load scheduling-Case studies	6	15%
II	Energy management opportunities in Lighting and Motors. Electrolytic Process and Electric heating, Case studies	8	15%
FIRST INTERNAL EXAMINATION			

III	Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler. Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings. Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control, Waste heat recovery.	8	15%
IV	HVAC system: Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Classification and Advantages of Waste Heat Recovery system, analysis of waste heat recovery for Energy saving opportunities	7	15%
SECOND INTERNAL EXAMINATION			
V	Energy audit -Definition, Need, Types of energy audit, Energy audit Instruments. Cogeneration-Types and Schemes, Optimal operation of cogeneration plants- Case study. Computer aided energy management.	7	20%
VI	Economic analysis methods-cash flow model, time value of money, evaluation of proposals, pay-back method, average rate of return method, internal rate of return method, present value method, life cycle costing approach, Case studies.	6	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100

Exam Duration: 3Hrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x 5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P -C	Year of Introduction
EE484	Control Systems	3-0-0-3	2016
Prerequisite : NIL			
Course Objectives			
<ul style="list-style-type: none"> • To give the knowledge of Mathematical model of physical systems. • To impart knowledge of different control equipment. • To provide knowhow of analysing systems with mathematical model. 			
Syllabus-			
Linear Time Invariant systems: Open loop-and closed loop control systems, Transfer function: Mechanical, Electromechanical systems. block diagram representation, signal flow graph. Control system components. Time domain analysis of control systems. PID controllers, Concept of stability, Frequency domain analysis, Introduction to Statespace.			
Expected outcome.			
The students will have the			
<ol style="list-style-type: none"> i. Concept of modelling in transfer function and state space domain ii. Ability to analyse stability of linear time invariant systems. 			
Text Books:			
<ol style="list-style-type: none"> 1. Katsuhiko Ogata, “Modern Control Engineering”, Fourth edition, Pearson Education, New Delhi, 2002. 2. Nagarath I.J. and Gopal M., “Control System Engineering”, Wiley Eastern, New Delhi. 3. Richard C. Dorf, Robert. H. Bishop, “Modern Control Systems”, Pearson Education, New Delhi – 11th Edition, 2007. 			
References:			
<ol style="list-style-type: none"> 1. Gibson & Tutter, “Control System Components”, Mc Graw Hill. 2. Kuo B.C., “Automatic Control Systems”, Prentice Hall of India, New Delhi, 6ed.,1991. 3. Norman S. Nise, “Control Systems Engineering”, 5th Edition, Wiley Eastern, 2007. 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Open loop-and closed loop control systems: Transfer function -T.F of simple linear time invariant systems - Mechanical andElectromechanical systems – Force voltage and force current analogy - block diagram representation - blockdiagram reduction - signal flow graph - Mason's gain formula - characteristics equation.	9	15%
II	Control system components: DC and AC servo motor – synchro - magnetic amplifier - gyroscope - stepper motor - Tacho meter.	5	15%
FIRST INTERNAL EXAMINATION			
III	Time domain analysis of control systems: Transient and steady state responses - test signals - time domain specifications - first and second order systems - impulse and step responses - steady state error analysis - static error coefficient of type 0,1,2 systems - Dynamic error coefficients	7	15%
IV	PID controllers, Concept of stability: stability of feedback system - Routh's stability criterion - Root locus -General rules for constructing Root loci - effect of addition of poles and zeros.	7	15%
SECOND INTERNAL EXAMINATION			
V	Frequency domain analysis: Introduction - Bode plot-Polar plot-	6	20%

	gain margin - phase margin.		
VI	Introduction to state space: State concept, state equation of simple systems, physical and phase variables, Eigen value and eigenvectors, conversion of state space model to transfer function.	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100

Exam Duration: 3Hrs.

Part A: 8 compulsory questions.

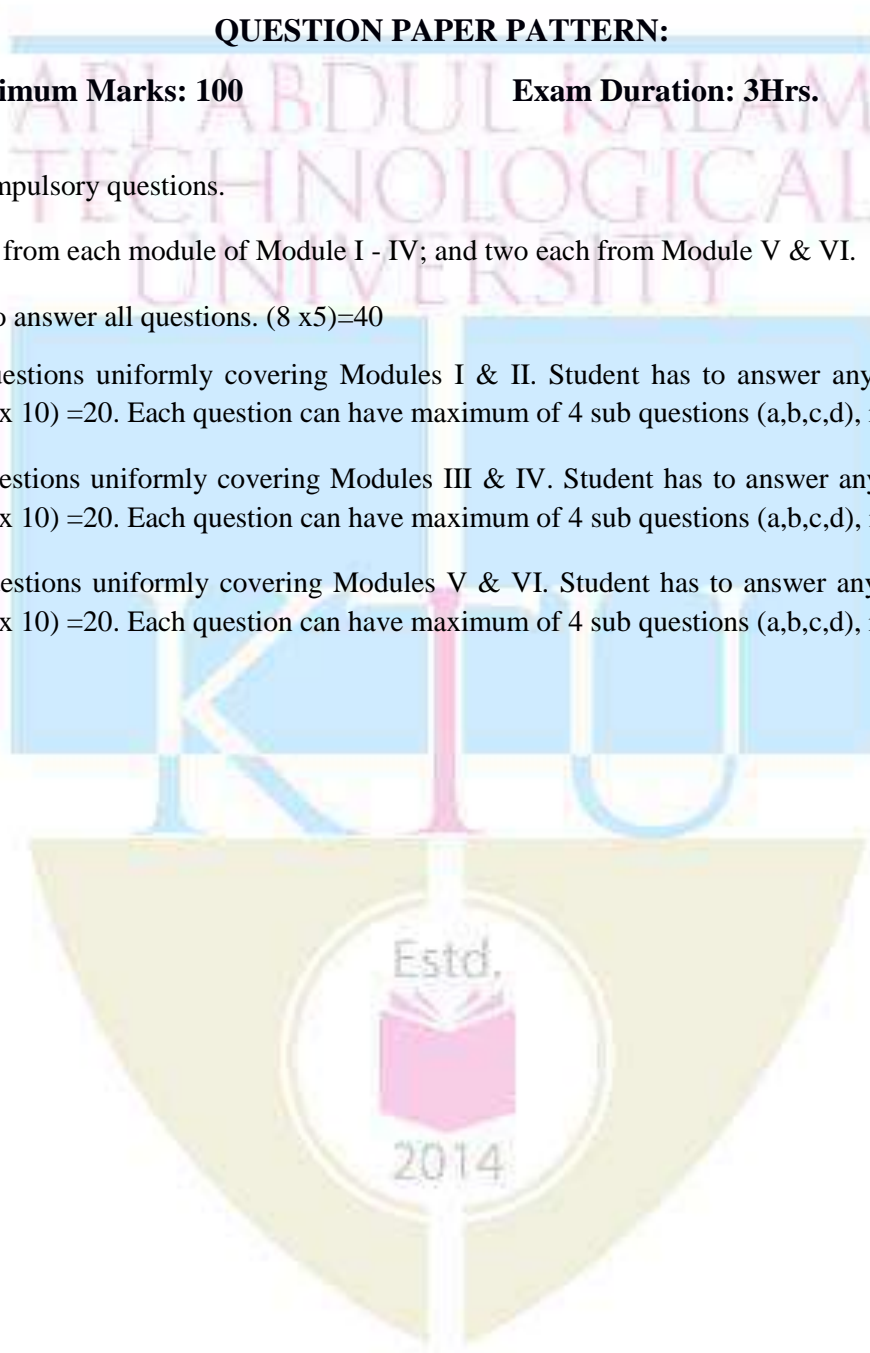
One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. $(8 \times 5) = 40$

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: $(2 \times 10) = 20$. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: $(2 \times 10) = 20$. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: $(2 \times 10) = 20$. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.



Course code	Course Name	L-T-P -C	Year of Introduction
EE486	SOFT COMPUTING	3-0-0-3	2016
Prerequisite: NIL			
Course Objectives			
<ul style="list-style-type: none"> To provide the concepts of soft computing techniques such as neural networks, fuzzy systems, genetic algorithms 			
Syllabus			
Introduction To Soft Computing And Neural Networks , Fuzzy Sets And Fuzzy Logic: Fuzzy Sets, Neuro-Fuzzy Modelling , Machine Learning, Machine Learning Approach to Knowledge Acquisition			
Expected outcome.			
The students will be able to get ideas on :			
<ol style="list-style-type: none"> Artificial Intelligence, Various types of production systems, characteristics of production systems. Neural Networks, architecture, functions and various algorithms involved. Fuzzy Logic, Various fuzzy systems and their functions. Genetic algorithms, its applications and advances 			
Text Books:			
<ol style="list-style-type: none"> James A. Freeman and David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques”, Pearson Edn., 1991 Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, “Neuro-Fuzzy and Soft Computing”, Prentice-Hall of India, 2008 S.Y Kung , Digital Neural Network , Prentice-Hall of India, 1993 			
References:			
<ol style="list-style-type: none"> Amit Konar, “Artificial Intelligence and Soft Computing”, First Edition, CRC Press, 2000. David E. Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson Edn., 2006 George J. Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic-Theory and Applications”, Prentice Hall, 1995 Mitchell Melanie, “An Introduction to Genetic Algorithm”, Prentice Hall, 1998 Simon Haykin, “Neural Networks: A Comprehensive Foundation”, Prentice Hall 			
Course Plan			
Module	Contents	Hours	End Sem Exam Marks
I	Introduction To Soft Computing And Neural Networks : Evolution of Computing - Soft Computing Constituents – From Conventional AI to Computational Intelligence - Adaptive Networks – Feed forward Networks – Supervised Learning	7	15%
II	Neural Networks – Radial Basis Function Networks - Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance architectures. Fuzzy Sets And Fuzzy Logic: Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations - Fuzzy Rules and Fuzzy Reasoning	7	15%
FIRST INTERNAL EXAMINATION			

III	Fuzzy Inference Systems – Fuzzy Logic – Fuzzy Expert Systems – Fuzzy Decision Making Neuro-Fuzzy Modeling : Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees	7	15%
IV	Data Clustering Algorithms – Rulebase Structure Identification Neuro-Fuzzy Control.	7	15%
SECOND INTERNAL EXAMINATION			
V	Machine Learning : Machine Learning Techniques – Machine Learning Using Neural Nets – Genetic Algorithms (GA)	7	20%
VI	Applications of GA in Machine Learning - Machine Learning Approach to Knowledge Acquisition. Support Vector Machines for Learning – Linear Learning Machines – Support Vector Classification – Support Vector Regression - Applications.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100

Exam Duration: 3Hrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P -C	Year of Introduction
EE488	INDUSTRIAL AUTOMATION	3-0-0-3	2016
Prerequisite : NIL			
Course Objectives <ul style="list-style-type: none"> • Explain the General function of Industrial Automation • Identify Practical Programmable Logic Controller Applications • Identify Types of Industrial Sensors • Explain Robotics 			
Syllabus Types of motion actuators, electrical and mechanical sensors, ladder diagrams, cascade method, Huffman method, Programmable Logic Controllers, Microcomputers: interfacing and programming, Principles of Robotics and applications			
Expected outcome. The students will be able to <ol style="list-style-type: none"> i. Know about motion devices and various in automation ii. Draw ladder diagrams for applications iii. Understand assembly language programs iv. Know about Robotic components 			
Text Book: 1. Pessen , Industrial Automation : Circuit Design and Components , Wiley			
References: 1. Bartelt , Industrial Automated Systems, Instrumentation and Motion Control, , Cengage 2. Mukhopadyay et al , Industrial Instrumentation, Control and Automation, Jaico Publishing House			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Motion Actuators: Types of Motion and Motion Conversion, Electric Linear Actuators, Electric Rotary Actuators, Fluid-Power Linear Actuators, Fluid-Power Rotating Actuators	6	15%
II	Sensors: Binary vs. analog sensors, Electric Position sensors: Limit switches, photovoltaic sensors, ultrasonic sensors, inductive and capacitive and magnetic proximity sensors, Pneumatic position sensors: limit valves, back-pressure sensors, coiled spring sensors. Level, pressure, temperature and flow switches	6	15%
FIRST INTERNAL EXAMINATION			
III	Electric Ladder Diagrams: Ladder diagrams, sequence charts, Ladder diagram design using sequence charts, cascade method,: single and multi path sequencing systems with and without sustained outputs, Huffman method: sequential systems, stable and unstable states, state assignment.	6	15%
IV	Programmable Controllers: PLC construction, Programming the PLC, constructing ladder diagrams for PLCs,	6	15%
SECOND INTERNAL EXAMINATION			

V	Microcomputers :Microcomputers for control applications, architecture, computer interfacing, programmable interface adaptors, Ramping a step motor example.	8	20%
VI	Robotics and Numerical Control : Basic Robot Definitions, Basic manipulator configurations, Numerical Control Systems, Robot Kinematics, Robot Grippers, Robot Sensors, Robot Programming, General Considerations for Robot Applications	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100

Exam Duration: 3Hrs.

Part A: 8 compulsory questions.

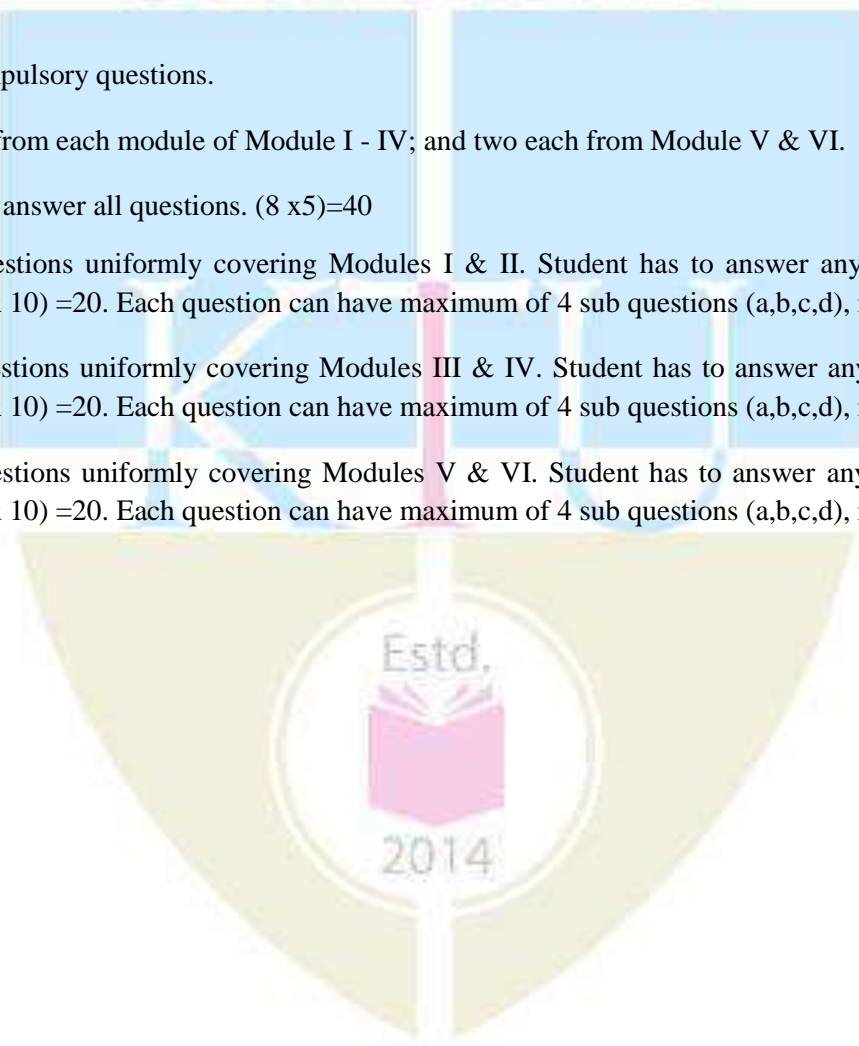
One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. $(8 \times 5) = 40$

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: $(2 \times 10) = 20$. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: $(2 \times 10) = 20$. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: $(2 \times 10) = 20$. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.



Course code	Course Name	L-T-P -C	Year of Introduction
EE494	Instrumentation Systems	3-0-0-3	2016
Prerequisite: NIL			
Course Objectives			
<ul style="list-style-type: none"> • To introduce the measurement techniques of force, torque, speed, pressure, flow & temperature. • To introduce different types of electronic circuits for measurements and their applications. 			
Syllabus			
General Concepts ,Generalised Configurations and Functional Description of Measuring Instruments, Measuring Devices, Force and Torque Measurements, Shaft Power Measurements, Pressure and Sound Measurements, Dynamic Testing of Pressure-Measuring Systems, Flow Measurement, Temperature Measurement, Bridge Circuits ,Amplifiers ,Filters, Integration and Differentiation, Voltage-Indicating and Recording Devices,Electromechanical Servo type XT and XY Recorders.			
Expected outcome.			
The students will be able to			
<ol style="list-style-type: none"> i. Understand and analyze Instrumentation systems. ii. Select proper measurement system for various applications. 			
Text Book:			
1. Ernest O Doebelin and Dhanesh N Manik, Measurement Systems, Mc Graw Hill, 6e.			
References:			
<ol style="list-style-type: none"> 1. Neubert H K P, Instrument Transducers, Oxford University Press, 1975 2. Turner and Hill, Instrumentation for Engineers and Scientists, Oxford University Press, 1999 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	General Concepts : Need for Measurement Systems, Classification of Types of Measurements Applications Generalised Configurations and Functional Description of Measuring Instruments : Functional Elements of an Instrument , Active and Passive Transducers , Analog and Digital Modes of Operation ,Null and Deflection Methods, Input-Output Configurations of Instruments and Measurement Systems	6	15%
II	Measuring Devices : Motion Measurements : Fundamental Standards, Relative Displacements: Translational and Rotational , Relative Velocity : Translational and Rotational, Relative - Acceleration Measurements Force and Torque Measurements : Standards and calibration , Basic Methods of Force Measurements , Characteristics of Elastic Force Transducers, Torque Measurement on Rotating Shafts	8	15%
FIRST INTERNAL EXAMINATION			
III	Shaft Power Measurements : Shaft Power Measurements (Dynamometers), Vibrating-Wire Force Transducers	8	15%

	Pressure and Sound Measurements: Standards and Calibration , Basic Methods of Pressure Measurements, Deadweight Gages and Manometers , Elastic Transducers, Vibrating-Cylinder and Other Resonant Transducers		
IV	Dynamic Testing of Pressure-Measuring Systems, High Pressure Measurement, Low Pressure(Vacuum) Measurement, Sound Measurements Flow Measurement :Local Flow Velocity , Magnitude and Direction , Gross Volume Flow Rate	6	15%
SECOND INTERNAL EXAMINATION			
V	Temperature Measurement : Standards and Calibration , Thermal-Expansion Methods ,Thermoelectric Sensors (Thermocouples),Electric-Resistance Sensors, Junction Semiconductor Sensors ,Digital Thermometers ,Radiation Methods	6	20%
VI	Bridge Circuits ,Amplifiers ,Filters, Integration and Differentiation Voltage-Indicating and Recording Devices : Standards and Calibration , Analog Voltmeters and Potentiometers Electrical Instruments : RMS Voltmeter , Ohm Meter , Phase Meter , Q Meter Digital Voltmeters and Multimeters ,Signal Generation Square Wave Generation , Electromechanical Servo type XT and XY Recorders	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100

Exam Duration: 3Hrs.

Part A: 8 compulsory questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x 5)=40

Part B: 3 questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part C: 3 questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Part D: 3 questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) =20. Each question can have maximum of 4 sub questions (a,b,c,d), if needed.

Course code	Course Name	L-T-P -Credits	Year of Introduction
FS482	RESPONSIBLE ENGINEERING	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives			
<ul style="list-style-type: none"> To enable the students to create an awareness on responsibilities and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others. 			
Syllabus			
Human Values - Engineering Ethics – Engineering as Social Experimentations – Engineer’s responsibility for safety – Responsibilities and Rights – Global Issues.			
Expected outcome.			
<ul style="list-style-type: none"> The students will be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society 			
Text Books:			
<ol style="list-style-type: none"> Mike W. Martin and Roland Schinzing, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004. 			
Data Book (Approved for use in the examination): Nil			
References:			
<ol style="list-style-type: none"> Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009 John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003 Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001 Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” Mc Graw Hill education, India Pvt. Ltd., New Delhi 2013. 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	HUMAN VALUES Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.	8	15%
II	ENGINEERING ETHICS Senses of ‘Engineering Ethics’ – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg’s theory – Gilligan’s theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories	6	15%
FIRST INTERNAL EXAMINATION			

III	ENGINEERING AS SOCIAL EXPERIMENTATION Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.	7	15%
IV	ENGINEER'S RESPONSIBILITY FOR SAFETY Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl Case Studies and Bhopal	7	15%
SECOND INTERNAL EXAMINATION			
V	RESPONSIBILITIES AND RIGHTS Collegiality and Loyalty – Respect for Authority - Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.	6	20%
VI	GLOBAL ISSUES Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – Code of Conduct – Corporate Social Responsibility.	6	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks: 100

Exam Duration: 3 hours

Part A – 8 questions (Module 1 to 4 one question each, Module 5 & 6 two questions each) of 2 marks each. All questions are compulsory (8x2 = 16)

Part B – 8 questions (Module 1 to 4 one question each, Module 5 & 6 two questions each) of 3 marks each. All questions are compulsory (8x3 = 24)

Part C – 12 questions (two questions from each module) of 10 marks each. Student has to answer one question from each module. (6x10=60)

Note: Each question can have a maximum of 4 sub parts, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
FT482	Food Process Engineering	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives			
<ul style="list-style-type: none"> To introduce different thermal and non-thermal food processing principles. 			
Syllabus			
Raw material Preparation, Blanching, Pasteurization, Sterilization, Size reduction, Drying, Psychrometry, Refrigeration, Baking, Frying, Extrusion, Sedimentation, Centrifugation, Minimal Processing, Packaging, Cleaning			
Expected outcome.			
<ul style="list-style-type: none"> The students will gain knowledge on various food processes like pasteurization, drying, refrigeration, centrifugation etc. 			
Text Books:			
<ol style="list-style-type: none"> James G brennan , <i>Food processing Handbook</i>, Wiley – VCH, 2e. P G Smith , <i>Introduction to Food Process Engineering</i>, Springer, 2e, 2011 Zeki Berk <i>Food process engineering and technology</i>, Elsevier, 2013 			
References:			
<ol style="list-style-type: none"> Geankoplis, C.J. “<i>Transport Processes and Separation Process Principles</i>”, 4th Edition, Prentice Hall, 2003. McCabe W.L., Smith J.C. “<i>Unit Operations in Chemical Engineering</i>”, 7th Edition, McGraw – Hill Int., 2001, Richardson, J.E. et al., “<i>Coulson & Richardson’s Chemical Engineering</i>” Vol.2 (<i>Praticle Technology & Separation Processes</i>) 5Th Edition, Butterworth – Heinemann / Elsevier, 2003. 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Raw material Preparation and Thermal processing: Food process, Raw material properties, physical, functional, preparation; Cleaning; wet and dry, Peeling methods, sorting and grading, Blanching, Pasteurization, HTST, LTLT, UHT, pasteurizers, microbial inactivation, F, D, Z values	7	15%
II	Size Reduction: Size reduction of solids, principles, laws of size reduction, kicks. Bond, rittinger, equipment; roller mill, impact mill, attrition mill, tumbling mills, methods, particle size distribution, energy consumption, homogenization	7	15%
FIRST INTERNAL EXAMINATION			
III	Drying and Psychrometry: water activity, moisture content, drying rate curve, EMC, isotherms, Driers; Tray, tunnel, puff, fluidized bed, spray. Rotary drier etc. Freeze drying Drying time prediction. Dehydrated products Rehydration	7	15%

	characteristics psychrometry, basic principles, psychrometric chart, terms, numerical solving		
IV	Refrigeration: Methods, equipment , VA, VC refrigeration systems, components; compressor, condenser, evaporator, refrigerant, COP Chilling and freezing , freezing kinetics-models, effect of low temperature on food spoilage, prediction of freezing time; Plank's,Pham's method, Thawing, Frozen food storage, freezer types. Refrigerated transportation; land, marine, air transportation Precooling methods	7	15%
SECOND INTERNAL EXAMINATION			
V	Baking and Frying process Baking Process, Frying process- principle, heat and mass transfer, machinery, products, frying oils, kinetics of oil uptake Extrusion, principle, extruded products Sedimentation and centrifugation; principle, basic equations, settling tank, baffled. Centrifugation, tubular, disc bowl,decanter, basket centrifuge.	7	20%
VI	Minimal processing : Ohmic heating, RF heating, Pulsed Electric field heating, High pressure processing, Food Irradiation, Ultrasound, Hurdle Technology Food filling and packaging systems, packaging materials, CAP, MAP, Vacuum.	7	20%
END SEMESTER EXAM			

Question paper pattern:

Maximum marks:100

Exam Duration : 3 hours

The question paper shall consist of three parts.

Part A : Three questions of 15 marks each uniformly covering modules 1 & 2. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part B : Three questions of 15 marks each uniformly covering modules 3 & 4. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part C : Three questions of 20 marks each uniformly covering modules 5 & 6. The students have to answer any two full questions. Each question can have maximum of 4 sub questions

Course code	Course Name	L-T-P - Credits	Year of Introduction
FT484	Food Storage Engineering	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives			
<ul style="list-style-type: none"> To introduce different storage mechanisms for food. 			
Syllabus			
Traditional and modern storage structures, Silos, warehouses, cold storages, Storage of raw and processed foods, Supporting equipments; dryers, freezers etc.			
Expected outcome.			
Student will have knowledge on various food storage structures and mechanisms			
Text Books:			
<ol style="list-style-type: none"> P G Smith , <i>Introduction to Food Process Engineering</i>, Springer, 2e, 2011 Zeki Berk, <i>Food process engineering and technology</i>, Elsevier, 2013 			
References:			
<ol style="list-style-type: none"> Dennis R. Heldman, Richard W. Hartel , <i>Principles of Food Processing</i>, Aspen Publishers, Inc 1997 G. Boumans, <i>Grain Handling and Storage, Volume 5 1st Edition</i>, Elsevier Science, 1985 Himangshu Barman, <i>Post Harvest Food Grain Storage</i>, Agrobios (India), 2008 James G Brennan , <i>Food processing Handbook</i>, Wiley-VCH, 2e. 2006 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Food and grain storage, introduction, scope, importance, basic requirements, safe and scientific storage. Selection of site for storage, pre and post storage operations; cleaning, drying, inspection etc., spoilage, control measures	7	15%
II	Traditional and small scale storage: Traditional storage methods, mud bin, drums, gunny bags etc., small scale storage structures, brick, concrete types, Local storage, morai, bhukari, kothar, kuthla structures, improved storage; bunker, cover and plinth, Factors affecting storage	7	15%
FIRST INTERNAL EXAMINATION			
III	Modern and large scale storage: Bulk storage, warehouses; considerations, types. Silos; types- deep, shallow, Airys, Janseens equations, numericals	7	15%

IV	Refrigerated storage: Cold storage, refrigeration load calculations, cold storage components, vapour barriers,	7	15%
SECOND INTERNAL EXAMINATION			
V	Storage of food Frozen storage, CAS, MAS, hermetic storage, Storage conditions for raw and processed fruits, vegetables, meat, dairy etc. Storage requirements	7	20%
VI	Supporting structure : Supporting equipment; Drying before storing, dryers, humidifier, dehumidifier, freezers, conveyors for solid and liquid food storage. Aeration, ventilation Economic aspects of storage.	7	20%
END SEMESTER EXAM			

Question paper pattern:

Maximum marks:100

Exam Duration : 3 hours

The question paper shall consist of three parts.

Part A : Three questions of 15 marks each uniformly covering modules 1 & 2. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part B : Three questions of 15 marks each uniformly covering modules 3 & 4. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part C : Three questions of 20 marks each uniformly covering modules 5 & 6. The students have to answer any two full questions. Each question can have maximum of 4 sub questions

Course code	Course Name	L-T-P - Credits	Year of Introduction
FT486	Food Additives and Flavourings	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives			
<ul style="list-style-type: none"> To know the role and activity of chemical and natural food additives. 			
Syllabus			
Food additives and their permissible limits, Additives used for colouring preservation, Antioxidants, Additives for emulsification, stabilization, Acidulants sweeteners, Flavouring agents, Sensory valuation			
Expected outcome.			
<ul style="list-style-type: none"> The students will get knowledge of food additives and their permissible limits 			
Text Books:			
<ol style="list-style-type: none"> <i>Branen, Davidson, Salmines , Food Additives, , 2nd edition Marecl Delker Publishers, 2002</i> <i>Fennema,, Food Chemistry, 4th edition CRC Press, 1996</i> 			
References:			
<ol style="list-style-type: none"> <i>Alexander, R.J.. Sweeteners: Nutritive. St. Paul, MN: Eagan Press. 1998</i> <i>Cremer, M.L. Quality Food in Quantity. Management and science. Berkely C.A: McCutchan Publishing Company, 1998.</i> <i>Ensminger, AH., ME. Ensminger, J.E. Konlande and J.R. Robson, Foods and Nutrition Encyclopaedia 2 Vols. Clovis, C.A: Pegasus Press, 1983.</i> <i>Francis F.J. Colorants. St. Paul, MN: Eagan Press, 1998,</i> <i>Pruthi, J.S , Spices & Condiments, National Book Trust of India, 2014.</i> <i>Reinecius , Flavour chemistry and technology, 2nd edition Taylor & Francis, 2006.</i> <i>Stauffer C.E.. Emulsifiers. St. Paul, MN.: Eagan Press., 1999</i> <i>Thomas O.J. and WA Atwell. Starches. St. Paul, MN.: Eagan Press, 1999</i> 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction: Food Additives- definition, intentional and incidental additives, evaluation of additives, maximum permissible limit, methods for finding tolerance limits, approval of food additive, Risk assessment, levels of toxicity, acute and chronic studies, government regulations with respect to additives	6	15%

II	Additives used in food preservation and processing Additives used in food preservation and processing preservative, antioxidants, colouring agents: functions, chemistry, mode of action ,uses in food formulations	7	15%
FIRST INTERNAL EXAMINATION			
III	Emulsifiers, Stabilizers: Emulsifiers, Stabilizers, Ant caking agents, Enzymes, Gases,: Function and Applications, mode of action, chemistry, physical and chemical properties, permissible level in foods	7	15%
IV	Acidulants, Sweeteners: Acidulants, Sequestrants, , Sweeteners ,Nutritive additives: Function and Applications, Safety issues, mode of action, chemistry, physical and chemical properties, permissible level in foods	7	15%
SECOND INTERNAL EXAMINATION			
V	Sensory instruments Food Flavour, its importance ,substances responsible for flavour, flavour isolation methods, essential oil, oleoresins, spray dried products, different flavour products, extracts, essences, flavour emulsions, flavour analysis(GC, Electronic Nose), scoville unit	8	20%
VI	Flavouring agents Flavouring agents used in food industry, natural, natural identical and artificial flavouring agents, process flavour, flavour enhancer/modifier, commonly used flavouring agents in food	7	20%
END SEMESTER EXAM			

Question paper pattern:

Maximum marks:100

Exam Duration : 3 hours

The question paper shall consist of three parts.

Part A : Three questions of 15 marks each uniformly covering modules 1 & 2. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part B : Three questions of 15 marks each uniformly covering modules 3 & 4. The students have to answer any two full questions. Each question can have maximum of 4 sub questions.

Part C : Three questions of 20 marks each uniformly covering modules 5 & 6. The students have to answer any two full questions. Each question can have maximum of 4 sub questions

Course code	Course Name	L-T-P-C	Year of Introduction
IC482	BIOMEDICAL SIGNAL PROCESSING	3-0-0-3	2016
Prerequisite: NIL			
Course Objectives			
<ul style="list-style-type: none"> • To study various biomedical signals and their data reduction • To learn frequency domain and time series analysis of biomedical signals • To study spectral estimation of biomedical signals • To study event detection and waveform analysis 			
Syllabus			
Introduction to biomedical signals- ECG analysis – Data reduction – Signal averaging- Frequency domain analysis-Time series analysis- Spectral analysis- Event detection and waveform analysis.			
Expected Outcome			
The students will be able to			
<ul style="list-style-type: none"> • Visualise difficulties involved in biomedical signal processing • Do time series and frequency domain analysis of biomedical signals • Conduct spectral estimation of biomedical signals • Perform event detection and waveform analysis of biomedical signals 			
References			
<ol style="list-style-type: none"> 1. Arnon Cohen, Biomedical Signal Processing Time and Frequency Domains Analysis (Volume I), CRC press. 2. D.C.Reddy, Biomedical Signal Processing Principles and Techniques, Tata Mc Graw-Hill 3. Rangaraj M Rangayyan, Biomedical Signal Analysis A case study approach, John Wiley publications. 4. Willis J. Tompkins, Biomedical Digital Signal Processing, PHI. 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction: Introduction to biomedical signals, Biomedical signal acquisition and processing, Difficulties in signal acquisition	4	15%
II	ECG: ECG signal origin, ECG parameters-QRS detection different techniques, ST segment analysis, Arrhythmia, Arrhythmia analysis, Arrhythmia monitoring system.	6	15%
FIRST INTERNAL EXAM			
III	ECG Data Reduction: Direct data compression Techniques: Turning Point, AZTEC, Cortes, FAN, Transformation Compression Techniques: Karhunen - Loeve Transform, Other	8	15%

	data compression Techniques: DPCM, Huffman coding, Data compression Techniques comparison. Signal averaging: Basics of signal averaging, Signal averaging as a digital filter, A typical averager, Software and limitations of signal averaging.		
IV	Frequency Domain Analysis: Introduction, Spectral analysis, linear filtering, cepstral analysis and homomorphic filtering. Removal of high frequency noise (power line interference), motion artifacts (low frequency) and power line interference in ECG,	8	15%
SECOND INTERNAL EXAM			
V	Time Series Analysis: Introduction, AR models, Estimation of AR parameters by method of least squares and Durbin's algorithm, ARMA models. Spectral modelling and analysis of PCG signals. Spectral Estimation: Introduction, Blackman- tukey method, The periodogram, Pisarenko's Harmonic decomposition, Prony' method, Evaluation of prosthetic heart valves using PSD techniques. Comparison of the PSD estimation methods.	9	20%
VI	Event Detection and waveform analysis: Need for event detection, Detection of events & waves, Correlation analysis of EEG signals, The matched filter, Detection of the P wave , Identification of heart sounds, Morphological analysis of ECG waves, analysis of activity.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN:

Maximum Marks: 100

Exam Duration: 3 Hours

Part A

Answer any two out of three questions from Module 1 and 2 together. Each question carries 15 marks and can have not more than four sub divisions. (15 x 2 = 30 marks)

Part B

Answer any two out of three questions from Module 3 and 4 together. Each question carries 15 marks and can have not more than four sub divisions. (15 x 2 = 30 marks)

Part C

Answer any two out of three questions from Module 5 and 6 together. Each question carries 20 marks and can have not more than four sub divisions. (20 x 2 = 40 marks)

Course code	Course Name	L-T-P - Credits	Year of Introduction
IE482	FINANCIAL MANAGEMENT	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: <ul style="list-style-type: none"> • To build an understanding of concepts, vital tools and techniques applicable for financial decision-making by a business firm. • To understand the use of basic financial management concepts. • To become familiar with the various types of financing available to a firm. 			
Syllabus: Nature and Scope of Financial Management; Time Value of Money, Cash Flow Statement and its Interpretation, Financial Statement Analysis, Sources of Finance, Capital Structure; Dividend Decision; Fixed and Current, Short-term financial planning, working capital–planning and management, Capital Budgeting.			
Expected outcome. The students will be able to <ol style="list-style-type: none"> i. Obtain an overview of financial system. ii. Analyze financial statements using standard financial ratios. iii. Apply techniques to project financial statements for forecasting long-term financial needs. iv. Understand the role of short-term financial needs. v. Apply time value, risk, and return concepts. 			
Text books <ol style="list-style-type: none"> 1. Khan, M. Y. and Jain P. K., Financial Management, Text, Problems & Cases, Tata McGraw Hill Company, New Delhi, 2007. 2. Pandey I. M., Financial Management, Vikas Publishing House Pvt. Ltd., 2009. 3. Prasanna Chandra, Financial Management: Theory and Practice, Tata McGraw Hill, 2011 			
References: <ol style="list-style-type: none"> 1. Bhalla. V. K., Financial Management and Policy: Text and Cases, 9th Edition, Anmol Publications Pvt. Ltd, 2009. 2. Brigham. Eugene F. and Houston. Joel F., Fundamentals of Financial Management, 10th Edition, Cengage Learning, 2006. 3. Gitman, L. J., Principles of Managerial Finance, New York, 2006. 4. Sheeba Kapil, Financial Management, Pearson Education, 2010. 5. Van Horne and C. James, Principles of Financial Management, Pearson, 2002. 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Nature and Scope of Financial Management; Financial Objectives; goal of financial management, FM decisions, Time Value of Money.	7	15%
II	Funds Flow Analysis; Cash Flow Statement and its Interpretation, Financial Statement Analysis, Ratio Analysis, Time Series.	7	15%
FIRST INTERNAL EXAMINATION			

III	Planning for Sources of Finance; Capital Structure; Net Income Approach; Net Operating Income Approach; Traditional Approach and MM Approach, Cost of Capital; EBIT – EPS Analysis, Capital Gearing/Debt-Equity Ratio	7	15%
IV	Retained Earning Vs. Dividend Decision; Gordon Model; Walter Model; MM Approach; Fixed and Current, Short-term financial planning.	7	15%
SECOND INTERNAL EXAMINATION			
V	Working capital–Gross and net working capital, planning and management, Operating Cycle, Determination of working capital.	7	20%
VI	Capital Budgeting – Evaluation techniques for capital budgeting, capital budgeting decision criteria, NPV–IRR comparisons, capital rationing.	7	20%
END SEMESTER EXAM			

End Semester Examination Question Paper Pattern:

Examination duration: 3 hours

Maximum Marks: 100

Part A (Modules I and II):

Candidates have to answer any 2 questions from a choice of 3 questions. Each full question carries a total of 15 marks and can have a maximum of 4 sub questions (a, b, c, d). No two full questions shall be exclusively from a single module. All three questions shall preferably have components from both modules. Marks for each question/sub question shall be clearly specified. Total percentage of marks for the two modules put together as specified in the curriculum shall be adhered to for all combinations of any two questions.

Part B (Modules III and IV): (Same as for part A marks)

Part C (Modules V and VI):

(Same as for part A, except that each full question carries 20 marks)

Note: If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.

Course code	Course Name	L-T-P - Credits	Year of Introduction
IE484	INTRODUCTION TO BUSINESS ANALYTICS	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives:			
<ul style="list-style-type: none"> • To knowhow the use of business analytics to formulate and solve business problems and to support managerial decision making. • To familiarize the practices needed to develop, report, and analyze business data. 			
Syllabus:			
Descriptive Analytics - Visualizing and Exploring Data, Descriptive Statistical Measures, Probability Distributions and Data Modeling, Sampling and Estimation, Statistical Inference			
Predictive Analytics - Trend lines and Regression Analysis, Forecasting Techniques, Introduction to Data Mining, Monte Carlo Simulation and Risk Analysis			
Prescriptive Analytics - Linear Programming Problem-Formulation, Solution methods; Transportation Problem-Formulation and solution; Assignment Problem- Formulation and solution; Dynamic Programming problem; Integer Programming Problem- Formulation and solution.			
Expected outcome:			
The students will:			
<ol style="list-style-type: none"> i. gain the knowledge of fundamental concepts and tools needed to understand the emerging role of business analytics in organizations. ii. be able to apply basic business analytics tools, interpret analytic models and results for making better business decisions. 			
References:			
<ol style="list-style-type: none"> 1. James R. Evans, Business Analytics, Pearson Education Limited, 2017 2. Amir D. Aczel and J. Sounderpandian, Complete Business Statistics, Tata McGraw Hill, 2006 3. Wayne L. Winston, Operations Research: Applications and Algorithms, PWS-Kent Pub. 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction to Business Analytics-Evolution, Scope, Models Descriptive Analytics - Data Visualization, Statistical Methods for Summarizing Data, Measures of Central Tendency, Measures of Dispersion, Measures of Shape, Measures of Association, Probability Distributions and Data Modeling- Discrete and Continuous Probability Distributions, Random Sampling from Probability Distributions, Data Modeling and Distribution Fitting	7	15%
II	Sampling and Estimation - Statistical Sampling, Estimating Population Parameters, Sampling Distributions, Confidence Intervals, Prediction Intervals Statistical Inference- Hypothesis Testing, Confidence Intervals, One sample and Two sample tests, z-test, t-test, Chi-square test. Analysis of Variance: Theory and computations of ANOVA, ANOVA table, Two-way ANOVA, Blocking designs, Design of Experiments	7	15%
FIRST INTERNAL EXAMINATION			

III	Predictive Analytics- Modeling Relationships and Trends in Data, Simple Regression and Correlation: Introduction, Estimation using the regression line, Correlation Analysis. Multiple Regression: The k-variable multiple regression model, The F-test of a Multiple Regression model.	7	15%
IV	Forecasting Techniques- Qualitative and Judgmental Forecasting, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality Introduction to Data Mining, Monte Carlo Simulation and Risk Analysis	7	15%
SECOND INTERNAL EXAMINATION			
V	Prescriptive Analytics - Linear Programming Problem-Formulation, Graphical solutions, Simplex method, Revised Simplex method and Sensitivity Analysis; Transportation Problem-Formulation and solution; Assignment Problem- Formulation and solution	7	20%
VI	Deterministic Dynamic Programming problem Bellman's principle of optimality - computational procedure for Shortest Route problem, Reliability Problem, Equipment Replacement Problem etc; Integer Programming Problem- Formulation, Branch and Bound algorithm, Cutting Plane Algorithm	7	20%
END SEMESTER EXAM			

End Semester Examination Question Paper Pattern:

Examination duration: 3 hours

Maximum Marks: 100

Part A (Modules I and II):

Candidates have to answer any 2 questions from a choice of 3 questions. Each full question carries a total of 15 marks and can have a maximum of 4 sub questions (a, b, c, d). No two full questions shall be exclusively from a single module. All three questions shall preferably have components from both modules. Marks for each question/sub question shall be clearly specified. Total percentage of marks for the two modules put together as specified in the curriculum shall be adhered to for all combinations of any two questions.

Part B (Modules III and IV): (Same as for part A marks)

Part C (Modules V and VI): (Same as for part A, except that each full question carries 20 marks)

Note: If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.

Course code	Course Name	L-T-P - Credits	Year of Introduction
IE486	DESIGN AND ANALYSIS OF EXPERIMENTS	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives:			
<ul style="list-style-type: none"> • To introduce the concept of experimentation • To equip students to understand the necessity of experimentation • To provide basic methods of designing an experiment 			
Syllabus:			
Statistical fundamentals, hypothesis testing, analysis of variance, block design, statistical analysis of models, full factorial and fractional factorial designs, introduction to Taguchi method.			
Expected outcome .			
The students will be able to:			
<ul style="list-style-type: none"> • Understand the need for a design for experimentation • Apply the basic principles to do an experiment design • Make inferences out of the outcomes of experimental design. 			
References:			
<ol style="list-style-type: none"> 1. Montgomery, D.C., Design and Analysis of experiments, 8th Ed, John Wiley and Sons, 2013. 2. Montgomery, D.C., Statistical Quality Control, 6th Ed., John Wiley & Sons, Inc. 2009 3. Nicolo Belavendram, Quality by Design; Taguchi techniques for industrial experimentation, Prentice Hall, 1995. 4. Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996. 5. Phadke, Quality Engineering Using Robust Design, Pearson Education Singapore Pte Ltd; First edition, 2008 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Basic Statistical Concepts, sampling and sampling distributions, comparisons of populations by sample statistics – known populations parameters and unknown population parameters, paired comparisons	7	15%
II	Importance of experiments, experimental strategies, basic principles of design, terminology, steps in experimentation, sample size, normal probability plot, linear regression model.	7	15%
FIRST INTERNAL EXAMINATION			
III	Hypothesis testing – z-test, t-test, chi-square test and F-test, Single factor experiments – ANOVA, model adequacy testing	7	15%
IV	Completely randomized design, Randomized block design, Latin square design. Statistical analysis, estimation of model parameters, model adequacy testing and interpretation of results	7	15%
SECOND INTERNAL EXAMINATION			
V	Two and three factor full factorial experiments, 2^K factorial Experiments, confounding and Blocking designs.	7	20%
VI	Fractional factorial designs, Introduction to Response Surface Methodology, theory of experiments with random factors,	7	20%

	introduction to Taguchi design method. Use of software packages in design of experiments.		
END SEMESTER EXAM			

Question Paper Pattern:

Examination duration: 3 hours

Maximum Marks: 100

Part A (Modules I and II):

Candidates have to answer any 2 questions from a choice of 3 questions. Each full question carries a total of 15 marks and can have a maximum of 4 sub questions (a, b, c, d). No two full questions shall be exclusively from a single module. All three questions shall preferably have components from both modules. Marks for each question/sub question shall be clearly specified. Total percentage of marks for the two modules put together as specified in the curriculum shall be adhered to for all combinations of any two questions.

Part B (Modules III and IV): (Same as for part A marks)

Part C (Modules V and VI):

(Same as for part A, except that each full question carries 20 marks)

Note: If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.



Course code	Course Name	L-T-P - Credits	Year of Introduction
IE488	TOTAL QUALITY MANAGEMENT	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives:			
<ul style="list-style-type: none"> • To impart knowledge on principles and practices of TQM to achieve quality. • To enable use of TQM tools for continuous quality improvement. • To provide ideas on implementation of quality standards. • To introduce the latest TQM tools and techniques. 			
Syllabus:			
Introduction to quality, Contributions of quality Gurus, Quality control tools, Cost of Quality, Taguchi loss function, Basic concepts of TQM, Principles of Total Quality Management, Total quality control, Quality assurance, Vendor rating, Quality improvement programmes, Quality planning, Quality function deployment, Six sigma approach, Failure mode & effect analysis, TPM, BPR , Quality standards.			
Expected outcome.			
The students will be able to			
<ol style="list-style-type: none"> i. Understand the principles and practices of TQM. ii. Use various TQM tools for continuous quality improvement. iii. Implement quality standards. iv. Become aware of the latest TQM tools and techniques. 			
References:			
<ol style="list-style-type: none"> 1. Sharma D D, <i>Total Quality Management</i>, Sultan Chand & Sons, 2014 2. R.P. Mohanty & R R Lakhi, <i>Total Quality Management</i>, Jaico Pub, New Delhi, 1994 3. Poornima M.Charantimath , <i>Total Quality Management</i>, Pearson Education, 2011. 4. Lon Roberts , <i>Process Re-Engineering</i> , Tata McGraw Hill, New Delhi, 1994 5. Mohamed Zairi , <i>TQM for Engineers</i> , Gulf Pub. Co., 2nd Edition, New Delhi. 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Introduction-Need for quality, Definition of quality, Major contributions of Deming, Juran and Crosby to Quality Management, Quality control tools, Cost of Quality, Taguchi loss function.	7	15%
II	Basic concepts of Total Quality Management - Evolution of TQM, TQM framework, Barriers to TQM, Principles of Total Quality Management- Quality statements, Customer focus, Customer orientation,	7	15%

	Customer satisfaction, Customer complaints, Customer retention, Total quality control, total waste elimination, total employee involvement.		
FIRST INTERNAL EXAMINATION			
III	Quality assurance- Total quality assurance, Management principles in quality assurance, Objectives of quality assurance system, Hierarchical planning for Quality Assurance, Vendor rating, Quality improvement: elements, programmes – KAIZEN, PDCA cycle, 5S, Quality circles.	7	15%
IV	Quality planning- SWOT analysis, Strategic planning, strategic grid, organizational culture, Total Quality Culture, Quality function deployment- QFD concept, the voice of customer, developing a QFD matrix, QFD process.	7	15%
SECOND INTERNAL EXAMINATION			
V	Six sigma approach- Methodology, Training, application to various industrial situations, Failure mode & effect analysis- Concepts, Types & Applications in TQM.	7	20%
VI	TPM- Concepts, Improvement needs, Performance measures, BPR, Quality standards – Need of standardization, ISO 9000 series, ISO 14000 series, Other contemporary standards.	7	20%
END SEMESTER EXAM			

Question Paper Pattern:

Examination duration: 3 hours

Maximum Marks: 100

Part A (Modules I and II):

Candidates have to answer any 2 questions from a choice of 3 questions. Each full question carries a total of 15 marks and can have a maximum of 4 sub questions (a, b, c, d). No two full questions shall be exclusively from a single module. All three questions shall preferably have components from both modules. Marks for each question/sub question shall be clearly specified. Total percentage of marks for the two modules put together as specified in the curriculum shall be adhered to for all combinations of any two questions.

Part B (Modules III and IV): (Same as for part A marks)

Part C (Modules V and VI): (Same as for part A, except that each full question carries 20 marks)

Note: If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.

Course code.	Course Name	L-T-P -C	Year of Introduction
IT482	Information Storage Management	3-0-0-3	2016
Prerequisite: NIL			
Course Objectives			
<ul style="list-style-type: none"> • To understand data creation and the amount of data being created • To impart the value of data to a business, challenges in data storage and data management, • To introduce solutions available for data storage, Core elements of a data center infrastructure, role of each element in supporting business activities 			
Syllabus			
Storage system architecture, Networked storage, Information availability and monitoring a data center, remote data replication technologies, securing storage and storage virtualization,			
Expected outcome.			
The students will understand the concept of data storage in distributed environment in data center, challenges in data storage and management technologies.			
Text Books:			
<ol style="list-style-type: none"> 1. Robert Spalding, “Storage Networks: The Complete Reference”, Tata McGraw Hill, New Delhi, 2006. 2. Somasundaram G, Alok Shrivastava, “ISM – Storing, Managing and Protecting Digital Information”, EMC Education Services, Wiley India, New Delhi, 2012. 			
References:			
<ol style="list-style-type: none"> 1. Gerald J Kowalski, Mark T Maybury, “Information Storage and Retrieval Systems: Theory and Implementation”, BS Publications, New Delhi, 2009. 2. Marc Farley Osborne, “Building Storage Networks”, Tata McGraw Hill, New Delhi, 2001. 3. Meeta Gupta, “Storage Area Network Fundamentals”, Pearson Education, New Delhi, 2002. 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Data, Information, Evolution of storage architecture, Data center infrastructure, Information lifecycle. Overview: Virtualization - Cloud, Data center environment: Application - Desktop - Memory virtualization - Connectivity - Disk drive interface	7	15%
II	Storage media - Flash drives, RAID: Implementation - Methods - Levels, Intelligent storage system	5	15%
FIRST INTERNAL EXAMINATION			
III	Introduction to DAS and SCSI, SAN: Evolution - Components - Connectivity options - Ports - FC architecture - Zoning - FC topologies, SAN based virtualization: Block level - VSAN, IP SAN: iSCSI - FCIP components - FCIP topology and frame structure, FCOE: Components – Benefits	7	15%
IV	NAS: Benefits – Components - Implementations - File sharing	7	15%

	protocols - I/O operations - Factors affecting NAS performance - File level virtualization, Object based storage: Operation Benefits - Fixed content and archives - Archive types, CAS: Architecture - Operations - Use cases, Unified storage		
SECOND INTERNAL EXAMINATION			
V	Introduction: Information availability - BC terminology - Planning lifecycle - Business impact analysis - Technology solutions, Backup and restore: Purposes - Methods - Architecture - Operations - SCB - Topologies - Targets - Deduplication, Local Replication: Terminology - Data consistency - Technologies - Restore and restart considerations, Remote replication: Modes - Technologies - Advanced replication technologies	8	20%
VI	Securing the storage infrastructure: Security terminology - Security framework – Risk triad - Security domains -Implementations - Managing the storage infrastructure: Monitoring - Activities - Challenges - Solutions Data Warehousing with Oracle BI	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks: 100

Exam Duration: 3 hours

The question paper shall consist of Part A, Part B and Part C.

Part A shall consist of three questions of 15 marks each uniformly covering Modules I and II. The student has to answer any two questions (15×2=30 marks).

Part B shall consist of three questions of 15 marks each uniformly covering Modules III and IV. The student has to answer any two questions (15×2=30 marks).

Part C shall consist of three questions of 20 marks each uniformly covering Modules V and VI. The student has to answer any two questions (20×2=40 marks).

Note : Each question can have a maximum of 4 subparts, if needed

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME471	Optimization Techniques	3-0-0-3	2016
Prerequisite - ME372 Operations Research			
Course Objective:			
<ul style="list-style-type: none"> To learn the various optimization techniques for effective decision making. 			
Syllabus:			
Linear programming – integer programming– network models – goal programming – dynamic programming – nonlinear programming – nontraditional optimization.			
Expected Outcome:			
<ul style="list-style-type: none"> The students will be able to understand optimization techniques and apply them in solving practical problems 			
Text Books:			
<ol style="list-style-type: none"> Miller, D. M. and Schmidt, J. W., Industrial Engineering and Operations Research, John Wiley & Sons, Singapore, 1990. Paneerselvam, R., Operations Research, Prentice Hall of India, New Delhi, 2008. Pannerselvam, R., Design and Analysis of Algorithms, Prentice Hall of India, New Delhi, 2007. Taha, H. A., Operations Research, Pearson, 2004. 			
Reference Books:			
<ol style="list-style-type: none"> Banks, J., Carson, J. S., Nelson, B. L., and Nicol, D. M., Discrete-Event System Simulation, Third Edition, Pearson Education, Inc., 2001 Goel, B. S. and Mittal, S. K., Operations Research, Pragati Prakashan, Meerut, 1999. Ravindran, Phillips and Solberg, Operations Research Principles and Practice, Willey & Sons, 1987 Srinivasan, G. “Operations Research-Principles and Applications”, latest edition, PHI Pvt. Ltd. 			
Course Plan			
Module	Contents	Hours	End Sem. Exam. Marks
I	Review of linear programming– revised simplex method	1	15%
		1	
	Dual simplex method	1	

		1	
	Sensitivity analysis – changes affecting feasibility – changes affecting optimality	1	
		1	
		1	
II	Integer programming – importance – applications	1	15%
	Branch and bound technique	1	
		1	
	Gomory’s cutting plane method	1	
		1	
	Solution to travelling salesman problem	1	
FIRST INTERNAL EXAMINATION			
III	Network models – minimal spanning tree problem	1	15%
	PRIM’s algorithm	1	
	Kruskal’s algorithm	1	
	Shortest route problem –applications	1	
	Systematic method	1	
	Dijkstra’s algorithm	1	
	Floyd’s algorithm	1	
IV	Goal programming – goal programming formulation-application.	1	15%
		1	
	Simplex method for solving goal programming	1	
		1	
	Dynamic programming – terminologies – forward and backward recursion –applications	1	
	Shortest path problems	1	
		1	
SECOND INTERNAL EXAMINATION			
V	Nonlinear programming – convex, quasi-convex, concave and unimodal functions – theory of constrained optimization	1	20%
		1	
		1	
	Lagrangean method	1	
		1	
	Kuhn-Tucker conditions	1	
		1	
VI	Nontraditional optimization – computational complexity- Introduction to metaheuristics – areas of application	1	20%
		1	
	Genetic algorithm (GA) – terminologies – steps and examples	1	
	Tabu search (TS) – steps and examples	1	
	Simulated annealing (SA) – steps and examples	1	
	Ant colony optimization (ACO) – steps and examples - Particle Swarm Optimization (PSO)-Steps and examples	1	
		1	

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3x10 marks =30 marks)

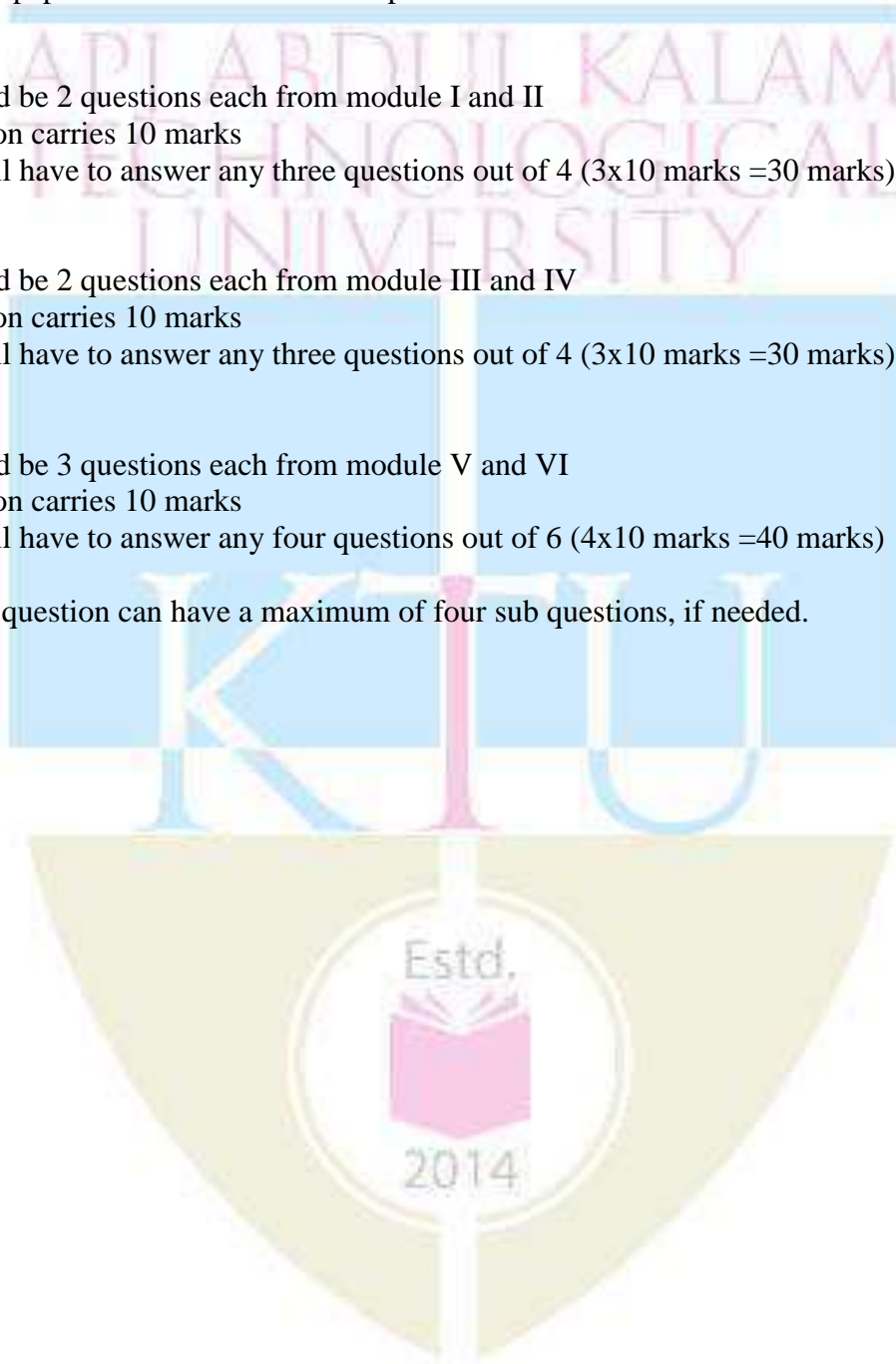
Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4x10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.



Course code	Course Name	L-T-P-Credits	Year of Introduction
ME482	Energy Conservation and Management	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: :			
<ol style="list-style-type: none"> 1. To enable analysis of the energy data of industries, energy accounting and balancing 2. To know energy audit and methodologies for energy savings 3. To understand utilization of the available resources in optimal ways 			
Syllabus:			
Energy, Power, Past & Present scenario of World; National Energy consumption Data, Components of EB billing, Boilers, Furnaces and Thermic Fluid Heaters, Pumps, Fans, Blowers, Energy audit, Energy Economics			
Expected Outcomes:			
The students will be able to			
<ol style="list-style-type: none"> i. carryout energy accounting and balancing ii. suggest methodologies for energy savings 			
Text books:			
<ol style="list-style-type: none"> 1. Callaghn, P.W. Design and Management for Energy Conservation, Pergamon Press, Oxford,1981. 2. Witte. L.C., P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilisation, Hemisphere Publ, Washington, 1988. 			
References:			
<ol style="list-style-type: none"> 1. Dryden. I.G.C., The Efficient Use of Energy Butterworths, London, 1982 2. Energy Manager Training Manual (4 Volumes) available at www.energymanagertraining.com, a website of Bureau of Energy Efficiency (BEE), A statutory body under Ministry of Power, Government of India, 2004. 3. Murphy. W.R. and G. Mc KAY, Energy Managemen”, Butterworths, London 1987. 4. Turner. W.C., Energy Management Hand book, Wiley, New York, 1982. 			
Module	Contents	Hours	End Sem. Exam. Marks
I	Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization –Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing	7	15%

II	Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.	7	15%
FIRST INTERNAL EXAMINATION			
III	Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution & Usage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories	7	15%
IV	Energy efficiency in Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets	7	15%
SECOND INTERNAL EXAMINATION			
V	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 metering	7	20%
VI	Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concepts	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P-Credits	Year of Introduction
ME484	Finite Element Analysis	3-0-0-3	2016
Prerequisite : Nil			
Course Objectives: :			
<ol style="list-style-type: none"> To introduce the concepts of Mathematical Modeling of Engineering Problems. To appreciate the use of FEA to a range of Engineering Problems. 			
Syllabus:			
Historical Background, Mathematical Modeling of field problems in Engineering ,Governing Equations, Basic concepts of the Finite Element Method, Solution of problems from solid mechanics and heat transfer, Fourth Order Beam Equation, Second Order 2D Equations involving Scalar Variable Functions, Equations of elasticity, Natural co-ordinate systems			
Expected Outcomes:			
<ul style="list-style-type: none"> The students will be able to understand different mathematical techniques used in FEM analysis and use them in Structural and thermal problems 			
Text books:			
<ol style="list-style-type: none"> Reddy. J.N., An Introduction to the Finite Element Method, 3rd Edition, Tata McGraw-Hill, 2005 Seshu, P, Text Book of Finite Element Analysis, Prentice-Hall of India Pvt. Ltd., New Delhi, 2007. 			
Reference books:			
<ol style="list-style-type: none"> Bhatti Asghar M, Fundamental Finite Element Analysis and Applications, John Wiley & Sons,2005 (Indian Reprint 2013) Chandrupatla & Belagundu, Introduction to Finite Elements in Engineering, 3rd Edition, Prentice Hall College Div, 1990 Logan, D.L., A first course in Finite Element Method, Thomson Asia Pvt. Ltd., 2002 Rao, S.S., The Finite Element Method in Engineering, 3rd Edition, Butterworth Heinemann, 2004 Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, Concepts and Applications of Finite Element Analysis, 4th Edition, Wiley Student Edition, 2002. 			
COURSE PLAN			
Module	Contents	Hours	End Sem. Exam. Marks
I	Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique	7	15%
II	Basic concepts of the Finite Element Method. One Dimensional	7	15%

	Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices		
FIRST INTERNAL EXAMINATION			
III	Solution of problems from solid mechanics and heat transfer Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.	7	15%
IV	Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.	7	15%
SECOND INTERNAL EXAMINATION			
V	Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.	7	20%
VI	Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.	7	20%
END SEMESTER EXAMINATION			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: Each question can have a maximum of four sub questions, if needed.

Course code	Course Name	L-T-P - Credits	Year of Introduction
MP469	Industrial Psychology and Organisational Behaviour	3-0-0-3	2016

Course Objectives

- To create a knowledge about human psychology
- To learn about theories of motivation and group behavior.
- To understand the socio-cultural aspects in organizations

Syllabus

Introduction- psychology as a science- study of behaviour- stimulus- response behaviour- heredity and environment- human mind- cognition- character- thinking- attention- memory- emotion- traits- attitude- personality. Organizational behaviour- definition –development- fundamental concept- organizational behaviour system- models - understanding a social-system - managing communication- Motivation- motivation driver - goal setting- expectancy model- comparison models- interpreting motivational models- leadership- path goal model. Special topics in industrial psychology- managing group in organization- group and inter group dynamics- managing change and organizational development- nature planned change- resistance characteristics

Expected outcome.

The students will be able to

- know the importance of psychology
- have insight into individual and group behavior
- deal with people in better way
- motivate groups and build teams.

Text Book:

Davis K. & Newstrom J.W., *Human Behaviour at work*, Mcgraw Hill International, 1985

References:

1. Blum M.L. Naylor J.C., Horper & Row, *Industrial Psychology*, CBS Publisher, 1968
2. Luthans, *Organizational Behaviour*, McGraw Hill, International, 1997
3. Morgan C.t., King R.A., John Rweisz & John Schoples, *Introduction to Psychology*, McHraw Hill, 1966
4. Schermerhorn J.R.Jr., Hunt J.G & Osborn R.N., *Managing, Organizational Behaviour*, John Willy

Course Plan

Module	Contents	Hours	End Sem. Exam Marks
I	Introduction- psychology as a science- area of applications – study of individual- individual differences- study of behaviour- stimulus- response behaviour- heredity and environment- human mind- cognition- character- thinking- attention- memory- emotion- traits- attitude- personality	6	15%
II	Human mind- cognition- character- thinking- attention- memory- emotion- traits- attitude- personality	6	15%
FIRST INTERNAL EXAMINATION			
III	Organizational behaviour- definition –development- fundamental concept- nature of people nature of organization – an organizational behaviour system- models- autocratic model- hybrid model-	6	15%

IV	Understanding a social-system social culture- managing communication- downward, upward and other forms of communication	6	15%
SECOND INTERNAL EXAMINATION			
V	Motivation- motivation driver- human needs- behaviour modification- goal setting- expectancy model- comparison models- interpreting motivational models- leadership- path goal model- style – contingency approach	9	20%
VI	Special topics in industrial psychology- managing group in organization- group and inter group dynamics- managing change and organizational development- nature planned change- resistance characteristic of OD-OD process	9	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions

Course code	Course Name	L-T-P-Credits	Year of Introduction
MP482	PRODUCT DEVELOPMENT AND DESIGN	3-0-0-3	2016
Prerequisite: Nil			
Course Objective			
<ul style="list-style-type: none"> • To create confidence in developing new products. • To acquaint with methods and tools for product design and development. • To equip with practical knowledge in conceptualization, design and development of new product. 			
Syllabus			
Introduction to product design, the need of a product, the product life cycle, the product design process. The application of Value Engineering principles in product design. Application of various tools such as CAD, CAE and DFM. The Ergonomics aspects in context of the product design. The fundamental concept of rapid prototyping techniques.			
Expected Outcome			
The students will be able to			
<ol style="list-style-type: none"> i. create new products suiting the requirements of society. ii. enhance value addition in products iii. coordinate multiple factors like market, design, ergonomics manufacturing in creating a new product. 			
References:			
<ol style="list-style-type: none"> 1. Andreas Gebhardt, Rapid Prototyping, Carl Hanser – Verlag, Munich, 2003. 2. Baldwin E N & Neibel B W “Designing for Production.” Edwin Homewood Illinois. 3. Bralla J G (Ed.), “Handbook of Product Design for Manufacture, McGraw Hill, NewYork, 1986 4. D. T. Pham, S.S. Dimov, Rapid Manufacturing-The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer – Verlag, London, 2001. 5. David G Ullman, “The Mechanical Design Process.” McGraw Hill Inc Singapore 1992 6. Hollins B & Pugh S “Successful Product Design.” Butter worths London, 1990 7. Jones J C “Design Methods.” Seeds of Human Futures. John Willey, 1970 8. Karl T Ulrich, Steven D Eppinger , “ Product Design & Development.” Tata McGraw Hill, 2003. 9. Kevin Otto & Kristin Wood Product Design: “Techniques in Reverse Engineering and new Product Development.”, Pearson Education New Delhi, 2000 10. N J M Roozenberg , J Ekels , N F M Roozenberg “ Product Design Fundamentals and Methods .” John Willey & Sons 1995. 			
Course Plan			
Module	Contents	Hours	End Sem. exam marks
	Introduction: Classification/ Specifications of Products. Product life cycle. Product mix. Introduction to product design. Modern product	7	15%

I	development process. Innovative thinking. Morphology of design.		
II	Conceptual Design: Generation, selection & embodiment of concept. Product architecture. Industrial design: process, need. Robust Design: Taguchi Designs & DOE. Design Optimization	7	15%
First Internal Exam			
III	Design for Manufacturing and Assembly: Methods of designing for Manufacturing and Assembly. Designs for Maintainability. Designs for Environment. Product costing. Ethics in product design, legal factors and social issues.	7	15%
IV	Value Engineering / Value Analysis. : Definition. Methodology, Case studies. Economic analysis: Qualitative & Quantitative.	7	15%
Second Internal Exam			
V	Ergonomics in product design. Aesthetics in product design. Concepts of size and texture, colour .Psychological and Physiological considerations. Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design.	7	20%
VI	Concurrent Engineering, Rapid prototyping: concepts, processes and advantages. Tools for product design – Drafting / Modelling software. Patents & IP Acts. Overview, Disclosure preparation.	7	20%
End Semester Exam			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions

Course code	Course Name	L-T-P – Credits	Year of Introduction
MP484	Project management	3-0-0-3	2016
Prerequisite: Nil			
Course Objectives			
<ul style="list-style-type: none"> To familiarize the major aspects of project management consisting of : Project Planning, Project Analysis, Project Selection, Project Implementation and Project Review 			
Syllabus			
Planning, capital budgeting, generation of project ideas, Project analysis, Market and demand analysis, Manufacturing process and technology, Project charts, financial analysis, breakeven point, cash flow statement, time value of money, appraisal criteria, Project organisation, network techniques, PERT Model, CPM Model, Network costs			
Expected outcome.			
The students will be able to			
<ol style="list-style-type: none"> Understand Project planning Analyse market and demand Familiarise basic concepts of project costing and cash flows Apply network analysis models of PERT and CPM under different situations 			
Text Book:			
<ul style="list-style-type: none"> Prasanna Chandra, Projects Planning, Analysis, Selection, Implementation and Review, Fourth Edition, Tata McGraw –Hill, 2017 			
References:			
<ol style="list-style-type: none"> Dennis Lock, Project Management, Gower Publishing, 9e, 2007 Gido & Clements, Successful Project Management, South-Western College Pub; 6 edition ..2014. Harold.T..Amarine John.A.Ritchey, Colin L. Moodie, Joseph F Kmec Manufacturing Organization and Management, Pearson Education, 1992 Parameswar P Iyer, Engineering Project management, Vikas Publishers, 1996 Prasanna Chandra, Financial Management Theory and Practice, McGraw –Hill Education, 2017 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I	Planning - Capital Expenditures – Phases of Capital Budgeting – Levels of decision Making –Facets of Project analysis- Feasibility Study – Objectives of Capital Budgeting – Resource Allocation framework- Key Criteria- Elementary Investment strategies – Portfolio planning tools – Generation of project Ideas – Monitoring the environment – Corporate appraisal – Scouting for project ideas – Preliminary Screening – Project rating index – Sources of Positive net present value	7	15%
II	Analysis – Market and demand analysis – Situational analysis and specification of objectives – Collection of secondary information -	7	15%

	Conduct of market survey – Characterization of Market – demand Forecasting – Market planning – Technical analysis- Material inputs and utilities		
FIRST INTERNAL EXAMINATION			
III	Manufacturing process/technology – Product Mix – Plant capacity – Location and site -machineries and equipments – Structures and civil works – Project charts and layouts – Work schedule – Financial Analysis – Cost of project – means of finance – Estimates of sales and Production – Cost of production – Working capital requirements and its financing – Profitability projections – Breakeven point – projected cash flow statements and balance sheets	7	15%
IV	Project Cash flows – Basic Principles for measuring cash flows – Components of cash flow – Cash flow illustrations – Viewing a project from different points of view – Time value of money – Future Value of a single amount – Future value of an annuity – Present value of a single amount –Present Value of an annuity	7	15%
SECOND INTERNAL EXAMINATION			
V	Cost of capital – Cost of debt capital – cost of preference capital – Rate of return – Cost of external equity and retained earnings - Determination of weights – Appraisal criteria – Net present value – Cost benefit ratio- Internal rate of return- Urgency – payback period	7	20%
VI	Implementation- Forms of Project organization – Project planning – Project control – Human aspects of project management , Network Techniques – Development of Network – Time estimation – Critical path determination – Scheduling under limited resources – PERT Model –CPM Model – Network Cost System – Project review- Initial; review – Performance evaluation – Abandonment analysis	7	20%
END SEMESTER EXAM			

Question Paper Pattern

Maximum marks: 100

Time: 3 hrs

The question paper should consist of three parts

Part A

There should be 2 questions each from module I and II

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

There should be 2 questions each from module III and IV

Each question carries 10 marks

Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

There should be 3 questions each from module V and VI

Each question carries 10 marks

Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions

Course code	Course Name	L-T-P - Credits	Year of Introduction
MR482	Mechatronics	3-0-0-3	2016
Prerequisite : NIL			
Course Objectives <ul style="list-style-type: none"> To provide basic knowledge on principles and design of Mechatronics systems. 			
Syllabus Introduction to Mechatronics – Sensors and transducers – Open loop and closed loop control systems - continuous and discrete processes - servo mechanism – principles - components - error detectors - potentiometers- types-Design of modern CNC machines and Mechatronic elements - Machine structure - guide ways – drives – bearings - Measuring system for NC machines - Closed loop controllers - Mechatronics in Robotics - Man-machine interface. Fundamentals of ANN – Stages in designing mechatronic systems - case studies of mechatronics.			
Expected outcome . <ul style="list-style-type: none"> The student will acquire basic knowledge on design, and application of Mechatronics systems 			
Text Book: W. Bolton, <i>Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering</i> , Addison Wesley Longman Limited.			
References: <ol style="list-style-type: none"> R. C. Dorf, R. H. Bishop, <i>Modern Control Systems</i>, Addison Wesley Krishna Kant, <i>Computer Based Industrial Control</i>, Prentice Hall of Indian Private Limited HMT Limited, <i>Mechatronics</i>, Tata McGraw Hill Publishing Company Limited Herbert Taub, Donald Schilling, <i>Digital Integrated Electronics</i>, McGraw Hill International Editions Dan Necsulescu, <i>Mechatronics</i>, Pearson Education Asia, 2002(Indian reprint). 			
Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction to Mechatronics – scope - Mechatronics and Engineering Design. Sensors and transducers – classification-thermal- electrical- optical- acoustic- pneumatic- magnetic- and piezo electric sensors- Smart sensors.	7	15%
II	Open loop and closed loop control systems - continuous and discrete processes - servo mechanism – principles - components - error detectors - potentiometers- types.	7	15%
FIRST INTERNAL EXAMINATION			

III	Design of modern CNC machines and Mechatronic elements - Machine structure - guide ways – drives – bearings - anti friction bearings- hydrostatic bearing- hydrodynamic bearing. Measuring system for NC machines - direct and indirect measuring system.	7	15%
IV	Closed loop controllers - proportional- derivative and integral controls - PID controller – digital controllers - controller tuning - adaptive control of machine tools. programmable logic controllers- architecture.	7	15%
SECOND INTERNAL EXAMINATION			
V	Mechatronics in Robotics - robot position and proximity sensing - tactile sensing. Man-machine interface. Fundamentals of ANN – perceptions – back propagation.	7	20%
VI	Stages in designing mechatronic systems - traditional and mechatronic design -possible design solutions - case studies of mechatronic systems - pick and place robot - automatic car park system – engine management system.	7	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN

Maximum Marks : 100

Exam Duration:3 hours

PART A: FIVE MARK QUESTIONS

8 compulsory questions –1 question each from first four modules and 2 questions each from last two modules (8 x 5= 40 marks)

PART B: 10 MARK QUESTIONS

5 questions uniformly covering the first four modules. Each question can have maximum of three sub questions, if needed. Student has to answer any 3 questions (3 x10 = 30 marks)

PART C: 15 MARK QUESTIONS

4 questions uniformly covering the last two modules. Each question can have maximum of four sub questions, if needed. Student has to answer any two questions (2 x15 = 30 marks)

Course Code	Course name	L-T-P- C	Year of Introduction
MT482	INDUSTRIAL SAFETY	3-0-0-3	2016
Prerequisite: Nil			
Course Objective			
<ul style="list-style-type: none"> To understand the impact of safe industrial operations , its benefits and safety legalization. 			
Syllabus			
Introduction to Industrial safety- responsibility of safety- safety committees- occupational health hazards – Ergonomics hazards- Musculoskeletal disorders- Safety management- PQRS theory – Work place design concepts – Need of machine maintenance- Safety controls- Legal provisions regarding safety – Accident prevention – Rules – Workmen compensation act – public liabilities insurance- Fatal accident act.			
Expected Outcome.			
The students will			
<ol style="list-style-type: none"> gain a general concept of safety, become aware of safety responsibilities of various agencies, know the occupational health hazards and human factors contributing to industrial accidents, learn the concepts of safety management, understand the need for timely maintenance of equipments, the need and measures for industrial safety control become familiar with the general legal rules for an industrial safety practitioner. 			
TEXT BOOKS/REFERENCES			
<ol style="list-style-type: none"> Frank P. Lees, Loss of prevention in Process Industries , Vol. 1 and 2, Butterworth-Heinemann Ltd., London (1991). Grimaldi and Simonds , Safety Management, AITBS Publishers, New Delhi (2001) Industrial Safety -National Safety Council of India. R.K.Jain and Sunil S.Rao, Industrial Safety, Health and Environment Management Systems, Khanna Publishers, New Delhi (2006) Slote.L. Handbook of Occupational Safety and Health, John Willey and Sons, New York The Factories Act with amendments 1987, Govt. of India Publications DGFASLI, Mumbai 			
Course Plan			
Module	Contents	Hours	End Sem. Exam Marks
I.	Introduction to industrial safety Concept of Safety, Goals of safety engineering, Need for safety engineering, definitions of Accident, injury, unsafe actions & Conditions. Responsibility of Safety - Society, Govt., Management, Union & employees. Duties of safety officer. Safety Committee - Membership, Functions & Scope of Safety committee.	5	15%

II	Safety and Health Management: Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety. Ergonomics - Introduction, Definition, Objectives, Advantages. Ergonomics Hazards - Musculoskeletal Disorders and Cumulative Trauma Disorders.. Importance of Industrial safety, role of safety department, Safety committee and Function.	7	15%
FIRST INTERNAL EXAMINATION			
III	Safety Awareness & Training: Training for Safety: Assessment of needs. Design & development of training programme. Training methods and strategies. Training of manager, supervisors & workers. Evaluation of training programmes. Human behaviour and safety: Human factors contributing to accidents.	7	15%
IV	Safety Assessment and Control Safety Management: Role of management in Industrial Safety. Safety Management- Principles & Practices. Safety Organization: Role of safety committee and its formation, Safety awareness programme: motivation, education and training, Appraisal of plant safety and measurement of safety performance, Total loss control concept, Introduction to productivity, Quality, Reliability, and Safety (PQRS) theory. Concept of workplace and its design. Improving safety and productivity through work place design control measures. Technical and engineering control measures. Control measures against human error. Preventive maintenance. Role of Preventive maintenance in safety and health. Standards and code of practices for plant and equipment.	9	15%
SECOND INTERNAL EXAMINATION			
V	Industrial Safety and Control Control of Physical Hazards: (Purpose of lighting. Advantages of good illumination. Lighting and safety. Lighting and the work. Control of Chemical Hazards Hazardous properties of chemicals and appreciation of information provided in Material safety data sheets. Classification of dangerous materials with pictorial symbols, common hazard and common precautions for each class Control of Electrical Hazards Dangers from electricity. Safe limits of amperages, Voltages Safe distance from lines. Capacity and protection of conductors, Joints and connections, Means of cutting of power overload and short circuit protection. Statutory provisions regarding fire safety. Factors contributing towards fire. Chemistry of fire. Classification of fires. Common causes of industrial fires.	9	20%
VI	Safety Legalisation Legal Provisions regarding safety, Accident prevention & Compensation to affected employees as under Factories Act-1948, Factories Act(Amendment)1987, Maharashtra Factories Rule-	5	20%

1963,The Mines Act-1952,Maharashtra Safety Officers Rule-1982,The Workmen Compensation Act-1923,ESI Act, Public Liabilities Insurance Act-1991,Fatal Accident Act.		
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END SEMESTER EXAMINATION

QUESTION PAPER PATTERN

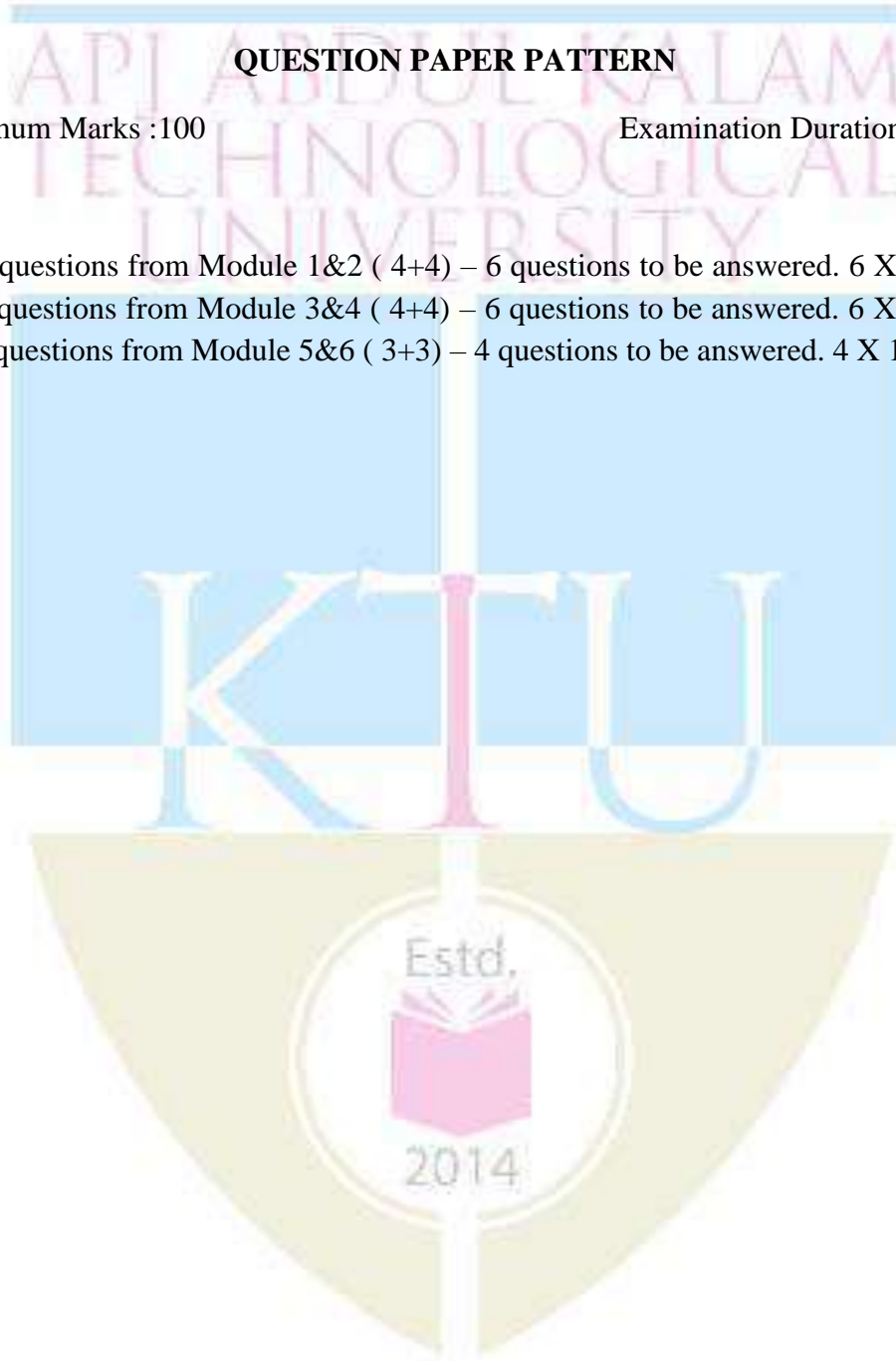
Maximum Marks :100

Examination Duration: 3 hrs.

PART A: 8 questions from Module 1&2 (4+4) – 6 questions to be answered. 6 X 5 = 30 marks

PART B: 8 questions from Module 3&4 (4+4) – 6 questions to be answered. 6 X 5 = 30 marks

PART C: 6 questions from Module 5&6 (3+3) – 4 questions to be answered. 4 X 10 = 40 marks



Course code	Course Name:	L-T-P-Credits	Year of Introduction
SB482	DREDGERS AND HARBOUR CRAFTS	3-0-0-3	2016
Prerequisites: -Nil-			
Course Objectives:			
<ul style="list-style-type: none"> To impart various aspects of dredging To introduce various aspects of operation of dredgers and harbor crafts 			
Syllabus:			
Types of Dredging Equipment, Types of Dredgers, Trailing suction hopper dredger, The cutter suction dredgers, Plain suction dredgers, Barge unloading dredgers, Bucket dredgers, Grab or Clamshell dredgers, Backhoe or dipper dredgers, Navigation Aids Vessels, Tugs and Towboats, Firefighting tugs, Barges, pilot boats, Salvage/buoy vessels, Construction Support Vessels, Fireboats, Patrol and Rescue Vessels, Pollution Response Vessels, Floating docks			
Expected Outcome:			
The students will be able to:			
<ol style="list-style-type: none"> Understand different types of dredging and dredging equipment Analyse the design aspects of 7 types of dredgers Know the operational aspects of dredgers Understand the design and operational philosophy of harbor craft, including floating dock 			
Text Books: Ship Design and Construction, Volume II, SNAME 2004			
Reference Books:			
<ul style="list-style-type: none"> Lloyds Register of Shipping, Rules and Regulations for the Classification of Ships - July 2015; R N Bray, A D Bates, J M Land, Dredging – A Handbook for Engineers, Butterworth Heinemann, 1996 D Esima, Dredging in Coastal Waters, Taylor & Francis Group, 2005 Rolt Hammond, Modern Dredging Practice, Muller, London, 1969 Denis Yell, ICE Design and Practice guide – Dredging, ASCE, 1995 			
Course Plan:			
Module	Content	Hours	End Sem. Exam Marks
I	Introduction, Types of Dredging Equipment, Types of Dredgers	2	15%
	Harbour/ Port support vessels	2	
	Small Workboats	2	
II	Dredging process	2	15%
	Introduction to dredging equipment, Types, Mechanical Dredgers, Hydraulic dredgers	2	
	Trailing suction hopper dredger– General description, design, technical construction, strength and stability, Dredging process	3	

FIRST INTERNAL EXAMINATION			
III	The cutter suction dredgers - General description, design, Dredging equipment, Drives, Spud systems, technical construction, Dredging process	3	15%
	Plain suction dredgers – Types, working method, design, layout, Technical construction, Dredging process	3	
	Barge unloading dredgers - General description, design, , layout, Technical construction, Dredging process	3	
IV	Bucket dredgers - General description, Area of application, method of working, design, Technical construction, Dredging process	3	15%
	Grab or Clamshell dredgers – Working method, Areas of application, Design aspects, layout, production capacity	3	
	Backhoe or dipper dredgers - General considerations, Working method, Area of application, Main Layout, Production capacity	3	
SECOND INTERNAL EXAMINATION			
V	Major features of following harbor crafts:- Navigation Aids Vessels	2	20%
	Tugsand Towboats, Firefighting tugs	2	
	Barges, pilot boats	2	
VI	Major features of following harbor crafts:- Salvage/buoy vessels	1	20%
	Construction Support Vessels	2	
	Fireboats, Patrol and Rescue Vessels	2	
	Pollution Response Vessels, Floating docks	1	
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN:

Maximum Marks : 100

Exam Duration: 3 Hours

PART A

- Answer all 8 questions of 3 marks each.
- 1 question each from modules I to IV and 2 questions each from modules V & VI.

PART B

- Answer any 2 complete questions out of 3 for each module.
- Each question from module I to IV carries 6 marks.
- Each question from module V & VI carries 7 marks.
- Each complete question can have maximum of 4 subsections.