Course code	Course name	L-T-P-Credits	Year Of Introduction
AE482	INDUSTRIAL INSTRUMENTATION	3-0-0-3	2016

Prerequisite: Nil

Course Objectives

- 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

- The student will be able to understand the various instruments used for industrial measurement.

Text Books

1. Doebelin E.O, "*Measurement Systems: Application and Design*", 4th Edition, McGraw Hill, New York, 2003.
2. Patranabis D, "*Principles of Industrial Instrumentation*", 2ndEdition, Tata McGraw Hill, New Delhi, 1997.
3. Spitzer D. W., *Flow measurement*, ISA press, New York, 1998

Reference Books

1. Andrew W.G, "*Applied Instrumentation in Process Industries – A survey*", Vol I & Vol II, Gulf Publishing Company, Houston, 2001.
2. Douglas M. Considine, "*Process / Industrial Instruments & Controls Handbook*", 5th Edition, McGraw Hill, Singapore, 1999.
3. Liptak B.G, "*Process Measurement and Analysis*", 4th Edition, Chilton Book Company, Radnor, Pennsylvania, 2003.
4. Noltingk B.E., *"Instrumentation Reference Book"*, 2ndEdition, 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 deferential 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

- 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

1. E.O. Dobelin, Measurement Systems Application and Design, McGraw Hill, New York, 2003
2. Harry N Norton, Hand Book of transducers, PHI, 1989

Reference Books

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

- 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	
	Components of fixed wing airplane and their functions;	2	
	Airfoils, wings and other shapes.	2	15%
	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

- 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

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:

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:

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

- 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

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:

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:

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
BM482	BIOMEDICAL INSTRUMENTATION	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- 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

i. Familiar with the principle and applications various analytical, diagnostic and therapeutic instruments
ii. 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:

1. Bronzino, Hand book of Biomedical Engineering, IEEE press book.
2. Geddes& Baker,' Principles of Applied Biomedical Instrumentation', Wiley
3. John G Webster (Ed), Encyclopedia of Medical Devices and Instrumentation ,Wiley
4. R.S Khandpur – Handbook of Biomedical Instrumentation – Tata McGraw
5. 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

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

Reference Books:

1. A C Kak, Principle of Computed Tomography, IEEE Press New York
2. Atam P Dhawan , Medical Imaging Analysis, Wiley Interscience publication, 2003
3. D L Hykes, W R Hedrick &D E Starchman: Ultrasound Physics &Instrumentation, Churchill Livingstone, Melbourne, 1985.
4. Douglas A Christensen: Ultrasonic Bioinstrumentation, John Wiley, New York, 1988.
5. Gonzalez Rafel C, Wintz Paul: Digital Image Processing, Addison Wesley.1993
6. Issac N Bankman, Handbook of Medical Imaging, Processing and Analysis, Academic Press, 2008
7. M N Rehani: Physics of Medical Imaging, Macmillian India Ltd., 1991.
8. Peter Fish, The Physics of Diagnostic Ultrasound, John Wiley &sons, Eng land,1990.
9. S Webb, The Physics of Medical Imaging, IOP Publishing Ltd., 1988.
10. 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

- 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

i. Identify global and Indian energy sources.
ii. Explain capture, conversion and application of solar and wind energy.
iii. Explain conversion of biomass to energy.
iv. Explain the capture of energy from oceans.
v. Explain fuel cells and energy storage routes.

Reference Books

1. Bansal N K, Kleemann M, Michael Meliss, *Renewable Energy Sources & Conversion Technology*, Tata McGraw Hill publishing Company, New Delhi, 1990.
2. Boyle, Godfrey, *Renewable Energy*, 3/e, Oxford University Press, 2012.
3. S P Sukhatme, *Solar Energy - Principles of Thermal Collection and Storage*, 2/e, Tata McGraw- Hill Publishing company, New Delhi,1996.
4. Pramod Jain, *Wind Energy Engineering*, McGraw Hill, 2011.
5. Donald L Klass, *Biomass for Renewable Energy, Fuels and Chemicals*, 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

- To provide the necessary theoretical background for the design of most common biological waste treatment systems.

Syllabus

Characteristics and *impacts of wastewater on* 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

i. Explain the characteristics of wastewater.
ii. Identify different types of reactors for wastewater treatment.
iii. Design a completely mixed activated sludge system.
iv. Explain the design features of an upflow anaerobic sludge blanket reactor.
v. Explain the factors affecting biogas production.

Reference Books

1. G Karia, R A Christian, *Wastewater Treatment: Concepts and Design Approach*, 2/e, PHI Learning Pvt., Ltd., 2013.
2. P Venugopala Rao, *Textbook of Environmental Engineering*, Prentice-Hall of India Pvt. Ltd., 2002.
3. Metcalf & Eddy, *Wastewater Engineering: Treatment and Reuse*, 4/e, Tata McGraw-Hill Education, 2003.
4. M Narayana Rao, Amal K Datta, *Waste Water Treatment: Rational Methods of Design and Industrial Practices*, 3/e, Oxford & IBH Publishing Company Pvt. Ltd., New Delhi,
5. R S Khoiyangbam, Navindu Gupta, Sushil Kumar, *Biogas Technology: Towards Sustainable Development*, The Energy and Resources Institute (TERI), 2011.

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Wastewater-origin, characteristics, *impacts of wastewater on* 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 (15×2=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
CE482	ENVIRONMENTAL IMPACT ASSESSMENT	3-0-0-3	2016

Prerequisites: Nil

Courseobjectives:

- 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. Tchobanaglous "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

OURSE 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

i. get general ideas about the processes involved in natural and anthropogenic disasters
ii. 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

Courseobjectives:

- 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

i. Be able to understand the various occupational hazards and the techniques that can be adopted for managing hazards and related problems

ii. Become aware regarding air pollution and water pollution problems and pollution control in industries

Text Books / References:

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

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

1. To impart the basic concepts of project engineering
2. To develop understanding about process auxiliaries and utilities in process industries

Syllabus

Process Auxiliaries. Piping design, Piping insulation, Piping fittings, Valves, Pumps, Process control and instrumentation diagram.
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

Expected Outcome

After successful completion of the course the students will be able to

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:

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

Module	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 SEMESTEREXAMINATION			

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-Credits	Year of Introduction
CH484	FUEL CELL TECHNOLOGY	3-0-0-3	2016

Prerequisite : Nil

Course Objectives

- 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:

1. 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.
2. Analyze the fuel cell technology and compare different types of fuel cell systems.
3. Calculate the various losses in fuel cells and analyze the fuel cell power plant subsystems.
4. Defend the significance of fuel cell technology in the new global energy scenario.
5. Distinguish the expectances of hydrogen as a fuel and energy vector in the context of renewable energy.

References Books:

1. Andreas Zuttel; Andreas Borgschulte; Louis Schdaptach, Hydrogen as a future energy carrier, Wiley-VCH Verlag GmbH & Co., KGaA, Weinheim, 2008.
2. Costamagna, P.; Srinivasan, S, J Power Sources 2001, 102, 242-269..
3. Frano Barbir. PEM Fuel Cells: Theory and Practice. Elsevier, 2005
4. Fuel Cell Handbook,7the Edn., EG & G Technical Services, Nov 2004
5. Hordeski, M. F. Alternative Fuels: The Future of Hydrogen, The Fairmont Press: Lilburn, GA, 2007.
6. Kordesch, K.; Simader, G. Fuel Cells and Their Applications. VCH: 1996
7. Larminie, J.; Dicks, A. Fuel Cell Systems Explained. John Wiely & Sons Ltd: Chichester, 1999.
8. Ryan P. O'Hayre, Suk-Won Cha, Whitney Colella & Fritz B. Printz, Fuel Cell Fundamentals, John Wiley & Sons, Inc., New Jersey, 2006
9. Vielstich, W, Gasteiger, H. A. Lamm, A. (Eds):Handbook of Fuel Cells-Fundamentals, Technology and Applications. John Wiely & 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 conductivites, Ionic conduction in different FC electrolytes: Aquesous, polymeric and ceramic, Diffusive transport & voltage loss: Limiting current density, Nerstian and kenetic 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-C	YEAR OF INTRODUCTION
EC482	Biomedical Engineering	3-0-0-3	2016

Prerequisite: Nil

Course objectives:

- 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:

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:

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:

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 Tomograpy: 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

- 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:

i. Understand the different methods used to reduce energy consumption
ii. Know energy audit
iii. Do economic analysis of energy projects

Text Book/Refernces:

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 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
EE484	Control Systems	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- 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

i. Concept of modelling in transfer function and state space domain
ii. Ability to analyse stability of linear time invariant systems.

Text Books:

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:

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 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
EE486	SOFT COMPUTING	3-0-0-3	2016

Prerequisite: NIL

Course Objectives

- 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 :

i. Artificial Intelligence, Various types of production systems, characteristics of production systems.
ii. Neural Networks, architecture, functions and various algorithms involved.
iii. Fuzzy Logic, Various fuzzy systems and their functions.
iv. Genetic algorithms, its applications and advances

Text Books:

1. James A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques", Pearson Edn., 1991
2. Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani, "Neuro-Fuzzy and Soft Computing", Prentice-Hall of India, 2008
3. S.Y Kung , Digital Neural Network , Prentice-Hall of India, 1993

References:

1. Amit Konar, "Artificial Intelligence and Soft Computing", First Edition,CRC Press, 2000.
2. David E. Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Edn., 2006
3. George J. Klir and Bo Yuan, "Fuzzy Sets and Fuzzy Logic-Theory and Applications", Prentice Hall, 1995
4. Mitchell Melanie, "An Introduction to Genetic Algorithm", Prentice Hall, 1998
5. 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.