With effect from the academic year 2016-2017

SCHEME OF INSTRUCTION & EXAMINATION
(BIO-MEDICAL ENGINEERING)

B.E. SEMESTER-IV

S. No	Course Code	Course Title	Scheme of Examination		L	T	P	Hrs/ Wk	Credits
			CIE	SEE					
1.	PC401BM	Biomedical Instrumentation	30	70	3	0	0	3	3
2.	PC402BM	Transducer & Biosensors Engineering	30	70	3	0	0	3	3
3.	ES403BM	Signals & Systems for Biomedical Engineers	30	70	3	1	0	4	3
4	HS901BT	Environmental Sciences	30	70	3	0	0	3	3
5.	BS406MT	Mathematics III	30	70	3	1	0	4	3
6.	ES422EC	Digital Electronics	30	70	3	1	0	4	3
	Practicals								
7.	PC451BM	Biomedical Instrumentation Lab	25	50	0	0	3	3	1
8.	PC452BM	Virtual Instrumentation and Simulation Lab	25	50	0	0	3	3	1
9.	ES441EC	Digital Electronics Lab	25	50	0	0	3	3	1
		Total	**255**	**570**	**18**	**03**	**09**	**30**	**21**

With effect from the academic year 2016-2017

PC401BM

BIOMEDICAL INSTRUMENTATION

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessionals	30 Marks
Credits	3

Objectives:

- The study of Biopotentials and electrodes are used to construct instrumentation systems to acquire and process different physiological signals.
- The use of display devices and recorders are also considered, and can be used to display or record type acquired signals.
- The students learn about analytical instruments and their working features along with their medical applications.

Outcomes:

- Students can acquire and process different physiological signals
- Students will learn about analytical instruments and their working features
- They understand the usage of various display devices and recorders.

UNIT-I

Introduction to Medical Instrumentation: Block diagram of a medical instrumentation system, Bio-signals: Origin and characteristics of Biopotentials-ECG, EEG, EGG, EMG, ENG, EOG, and ERG. Problems encountered with measurements from human beings. Generalized medical instrument specifications, Electrode-Electrolyte Interface, Half cell potential, Offset Voltage. Types of Electrodes- external. Internal and Microelectrodes. Mathematical Treatment of Electrodes: Equivalent circuits and applications.

UNIT-II

Medical display Devices and recorders: Display Devices: Basic requirements for the display and recording of Bio-signals, Types of medical display devices. Medical recorders: Classification of recorders, PMMC writing systems. General features of ink-jet, thermo-sensitive and optical recorders. Oscilloscopes: Basic description, Cathode Ray Oscilloscope (CRO), Dual beam oscilloscope, Analog storage oscilloscope, Digital storage oscilloscope, Medical, Multibeam & Non-fade display systems. Liquid crystal displays: Introduction, Passive-matrix and active –matrix addressed LCDs.

UNIT-III

Cardiac Instrumentation: Electrocardiography: Block diagram. Circuits, electrodes and their placement. Lead configuration and general ECG waveforms, ECG monitors: Single channel& multi-channel ECG systems. Holter monitors, Stress test systems. Blood Pressure measurement: Introduction to blood pressure. Direct and indirect methods of Blood Pressure measurements. Blood Flow measurement: Introduction to hemodynamics. Electromagnetic and Ultrasonic techniques of Blood flow measurement. Heart sounds: Origin of Heart Sounds, types of microphones for heart sound measurement. Contact and non-contact type of measurement. Phonocardiography.

UNIT-IV

Neuro-muscular Instrumentation: Electroencephalography: EEG-Block diagram and circuits, electrodes and their placement. Lead configuration and general EEG graphs. Evoked potentials and their measurement. Filters for EEG rhythm analysis, Electromyography: Introduction to EMG signals. EMG-Block diagram and circuits. Electrodes and their placement. Nerve conduction velocity determination using EMG. Stimulators for EMG recording.

UNIT-V

Medical Analytical Instrumentation: Methods of chemical analysis. Absorption Photometry, emission photometry, Flurometry, Colorimeter, spectrophotometer, Flame photometer, Mass spectrophotometer, Electrophoresis, chromatography, blood gas analyzer, Semi and fully automated analyzers.

Suggested Readings:

1. Webster J.G., *Medical Instrumentation Application and Design*. Houghton Mifflin, 2009.
2. Carr and Brown, *Introduction to Bio medical equipment technology*, 2011.
3. Khandpur R.S. *Hand Book of Biomedical Instrumentation*, Tata McGrawHill,2003
4. Khandpur R.S. *Hand Book of Analytical Instrumentation*, Tata McGrawHill,2010
5. John Enderle, Susan M. Blanchard, and Joseph Bronzino, *Introduction to Biomedical Engineering*, Second Edition,2005

With effect from the academic year 2016-2017

PC402BM

TRANSDUCER AND BIOSENSORS ENGINEERING

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessionals	30 Marks
Credits	3

Objectives:

- This course facilitates the students to understand the basic characteristics of transducer.
- They learn the classification of transducers such as temperature, pressure, displacement and piezoelectric transducers.
- Signal conditioning and processing, controllers, display, recording; direct digital control, programmable logic controllers, and PC based instrumentation.

Outcomes:

- Able to understand the characteristics of various transducers and classify transducers
- Students will learn the signal conditioning and processing of Electrochemical transducers
- Fabrication techniques of MEMS and their characteristics are learnt.

UNIT-I

Transducers and their classification: Principles of transduction and measurement, Sensor, Transducer, Basic requirements of transducers. Passive and Active transducers. Classification based on application and operating principle medically significant measurands- strain, force, pressure, acceleration, flow, volume, temperature and Biopotentials, Functional specifications of medical sensors; static and dynamic characteristics of first and second order transducers, Primary sensors.

UNIT II

Resistive and self generating Transducers: Principle of operation, associated circuits and applications of Resistive sensors: Potentiometers, Strain gages, RTDs, Thermistors, LDR, governing equations, materials and constructional details of various resistive transducers. Principle of operation, associated circuits and applications of Self-generating sensors. Thermoelectric sensors, thermocouples, piezoelectric sensors, photovoltaic sensors, governing equations, materials and constructional details of various self generating sensors.

UNIT III

Capacitive and inductive transducers: Principle of operation, associated circuits and applications of Capacitive sensors, governing equations, materials and constructional details of capacitive transducers, Principle of operation, associated circuits and applications of Inductive transducers, governing equations, materials and constructional details of Inductive transducers , LVDT and Hall effect transducers.

UNIT IV

Chemical transducers: Electrochemical transducers-Electrode potential and reference electrodes. Potentiometric sensors. Amperiometric sensors. Electro-chemical gas sensors.

Optically – based Chemical Transducers –Spectrophotometric chemical analyzers, Fiber optic chemical transducer.

Chemical Transducers of Acoustic and Thermal Properties. Biosensors – Enzyme-based bio-sensors, Immuno Sensors, microbial sensors.

UNIT V

Bio-MEMS: Introduction to MEMS, Micro and nano scale devices, Fabrication techniques of MEMS and their characteristics, Solid state transducers, optical transducers, electrochemical transducers, biomedical microelectronics. Clinical applications.

Suggested Reading:

1. Ramon Pallas-Areny and John G.Webster, *Sensors and signal conditioning*, John Wiley and Sons, 2001.
2. Tatsuo Togawa, Toshiyo Tamura & P. Ake Oberg, *Biomedical Transducers and Instruments*, CRC Press, Boca Raton, 1997.
3. Richard S.C. Cobbold, *Transducers for Biomedical Measurements: Principles and Applications*. John Wiley and Sons Inc., 1974
4. Hsu.Tai.ram *MEMS Book*, 2010.

With effect from the academic year 2016-2017

ES403BM

SIGNALS AND SYSTEMS FOR BIOMEDICAL ENGINEERS

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessionals	30 Marks
Credits	3

Objectives:

- To Identify and use the following elementary signals: exponentials, sinusoids, complex exponentials, exponentially damped sinusoids step functions, impulses, sifting and time scaling properties of impulses.
- To evaluate the time domain signal corresponding to DTFS, FS, DTFT, and FT representations using the defining equations.
- To determine whether an input/output description for a system has the following properties: stability, memory, memory less, causality, invertibility (simple cases), time invariance, and linearity.
- To evaluate the convolution sum and integral given an input and the impulse response.

Outcomes:

- Students can identify and use the following elementary signals: exponentials, sinusoids, complex exponentials, exponentially damped sinusoids step functions, impulses, sifting and time scaling properties of impulses
- Students can analyze time domain signal corresponding to DTFS, FS, DTFT, and FT representations using the defining equations

UNIT I: Introduction

signal and system, classification of signals, Energy and power signals, Periodic and Aperiodic signals, Even and odd signals, Impulse function, Unit step function, Ramp function, Rectangular function, constant function, Signum function, Right hand sided exponential function, and left hand sided exponential function, operations on signals, Types of systems, linear and Non-linear systems, Time variant and time invariant systems, Causal and non-causal systems, Invertible and non-invertible systems, stable and unstable systems.

UNIT II: Fourier Series and Fourier transform

Analogy between vector and signal, Signal representation by discrete set of orthogonal; functions, Exponential and trigonometric Fourier series, convergence, Dirichelet's conditions, the discrete Spectrum, limitations of Fourier series. The direct and inverse Fourier transform, continuous spectrum, Existence and properties of Fourier transform, Parseval's theorem, Fourier transform of periodic functions, Limitations of Fourier transform.

UNIT III: LTI systems

Convolution integral, Properties of convolution, convolution as summation, graphical method of convolution, Applications of convolution, Correlation, Auto correlation , Cross correlation, applications of correlation, Sampling of continuous time sampling, sampling theorem and problems, Nyquist rate, Aliasing effect, Reconstruction methods of signals.

UNIT IV: DFT & DTFT

The Discrete Fourier Transform: Discrete Fourier Transform, Properties of Discrete Fourier Transform. Linear convolution using Discrete Fourier Transform, Discrete Time Fourier Transform, Z transform, Properties of the region of convergence for the Z-Transform, Inverse Z Transform, Z transform properties, Realization of discrete time system-direct, cascade and parallel Forms.

UNIT V: FFT

Fast Fourier transform; Twiddle factor, properties of twiddle factor, decimation-in-time and decimation-in frequency. FFT algorithms for radix-2 case, in place computation, bit-reversal. Inverse FFT, Power Spectral Density estimation of signals and its applications.

Suggested Reading:

1.Alan V. Oppenheim and Willsky.Allan.S, *Signals and systems*, 2nd edition, PHI-2009.
2.Luis F Chaparro, *Signals and systems using MAT LAB*, Academic press, 2011.
3.Alan V. Oppenheim and Ronald W Schafer, *Digital Signal Processing*, PHI-2008.
4.A.Anand Kumar, *Signals and Systems,* 2nd edition, PHI Learning- 2012.
5.P.Ramesh Babu, *Digital Signal Processing*, Scitech publications private Ltd-2007.
6. Lathi B.P.Signals,*Systems.and communication*, BSP-2006.

With effect from the academic year 2016-2017

HS901BT

ENVIRONMENTAL SCIENCES

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessionals	30 Marks
Credits	3

Objectives:

- This course facilitates the students to understand the basic concepts of environmental studies. The study of eco systems, environmental pollution and the social issues are discussed. The students in future take a keen look on the environment, when new things are implemented.

UNIT –I

Environmental Studies: Definition, scope and importance, need for public awareness. Natural resources: Water resources; use and over utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. Effects of modern Agriculture, fertilizer-pesticide problems, water logging and salinity.

UNIT II

Ecosystems: Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in ecosystem, food chains, ecological pyramids, aquatic ecosystem(ponds, streams, lakes, rivers, oceans, estuaries).

Energy resources: Growing energy needs renewable and non-renewable energy sources. Land Resources, land as a resource, land degradation, soil erosion and desertification.

UNIT III

Biodiversity: Genetic species and ecosystem diversity, bio-geographical classification of India. Value of biodiversity, threats to biodiversity, endangered and endemic species of India, conservation of biodiversity.

UNIT IV

Environmental Pollution: Causes, effects and control measures of air pollution, water Pollution, soil pollution, noise pollution, noise pollution, thermal pollution and solid waste management.

Environment protection act: Air, water, forest and wild life Acts, enforcement of Environmental legislation.

UNIT V

Social Issues and the Environment: Water conservation, watershed management, and environmental ethics. Climate change, global warming, acid rain, ozone layer depletion.

Disaster management: Types of disasters, impact of disasters on environment, infrastructure and development. Basic principles of disaster mitigation, disaster management, and methodology, disaster management cycle, and disaster management in India.

Suggested readings:

1.De A. K., *Environmental Chemistry*, Wiley Eastern Ltd.

2.Odum E.p., *Fundamentals of Ecology*, W.B.Sunders Co., USA.

3.Rao M.N and Datta A.K., *Waste water Treatment*, Oxford and IBK Publications.

4.Benny Joseph, *Environmental Studies*, Tata McGraw Hill, 2005

5.Sharma V.K., *Disaster Management, National Center for Disaster management*, IIPE, Delhi,1999.

With effect from the academic year 2016-2017

BS406MT

MATHEMATICS-III

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessionals	30 Marks
Credits	3

Objectives:

- To introduce the concept of functions of complex variables and their properties
- To formulate partial differential equations and to introduce a few methods to solve first order linear and non-linear partial differential equations
- To study Fourier series and its applications to partial differential equations

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

- Determine the analyticity of a complex functions and expand functions as Taylor and Laurent series
- Evaluate complex and real integrals using residue theorem
- Expand function as a Fourier series
- Find solutions of first order and second order partial differential equations

UNIT-I

Functions of Complex Variables: Limits and continuity of function, differentiability and analyticity, necessary & sufficient conditions for a function to be analytic, Cauchy- Riemann equations in polar form, harmonic functions, complex integration, Cauchy's integral theorem, extension of Cauchy's integral theorem for multiply connected regions, Cauchy's integral formula, Cauchy's formula for derivatives and their applications.

UNIT-II

Residue Calculus: Power series, Taylor's series, Laurent's series, zeros and singularities, residues, residue theorem, evaluation of real integrals using residue theorem, bilinear transformation, conformal mapping.

UNIT-III

Fourier series: Fourier series, Fourier series expansions of even and odd functions, convergence of Fourier series, Fourier half range series.

UNIT-IV

Partial differential equations: Formation of first and second order partial differential equations, solution of first order equations, Lagrange's equation, Nonlinear first order equations, Charpit's method, higher order linear equations with constant coefficients.

UNIT-V

Fourier series applications to partial differential equations: Classification of linear second order partial differential equations, separation of variables method (Fourier method), Fourier series solution of one dimensional heat and wave equations, Laplace's equation.

Suggested Reading:

1. R.K.Jain & S.R.K Iyengar, Advanced Engineering Mathematics, Narosa Publication, 4th Edition, 2014.
2. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications, 43rd Edition, 2014.
3. Gupta & Kapoor, Fundamentals of Mathematical statistics, Sultan chand & sons, New Delhi, 2014.
4. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, 2012.
5. James Brown and Ruel Churchill, Complex variables and Applications, 9th Edition, 2013.

With effect from the academic year 2016-2017

ES422EC

DIGITAL ELCTRONICS

Instruction:	4 Periods per week
Duration of University Examination:	3 Hours
University Examination:	70 Marks
Sessional :	30 Marks
Credits:	3

Objectives:

- This course facilitates the students to study the properties for **Boolean algebra** and simplification of Boolean equations using **K-maps**.
- The digital circuits' classification is studied and the main elements of this classification are studied. Application of these circuits to build a basic computer is discussed.
- The students also learn about different **types of memories** and how they are programmed.
- The course also discuss about the basic applications of digital electronics like **digital clock, frequency counter**.

Outcomes:

- Students understand the properties for **Boolean algebra** and simplification of Boolean equations using **K-maps**
- students understand about different **types of memories** and how they are programmed
- Students understand the conversion process in ADC and DAC

UNIT-I

Codes: BCD, ASCII code, Excess-3 code, Gray code. Error detecting and error correcting codes. Combinational Logic Design: Boolean laws & theorems. Karnaugh Map-simplification of Boolean expressions- Sum of Products (SOP) form, Product of Sums (POS) form. Realization of Boolean Expressions using universal gates.

UNIT-II

Data processing circuits: Multiplexers, De-Multiplexers, Code-converters, Encoders, Decoders.
Arithmetic Circuits: Half adder, Full adder, Half subtractors, Full subtractors.
Digital Circuit Testing tools: Logic pulser, Logic probe, Current Tracer.

UNIT-III

Sequential circuits: Flip-flops-RS, D, JK and JK Master slave. Debounce circuits.
Registers: Serial-in parallel-out, Serial-in Serial-out, parallel-in-serial-out parallel-in-parallel-out.
Counters: Asynchronous and synchronous counters, decade counters, ring counters.
Design of synchronous counters using excitation tables.

UNIT-IV

Basic computer Organization: Instruction codes, Computer registers, Timing and control, Instruction cycle, Input-output Configuration, Interrupt cycle.
Memories: Types of memories, ROM, PROM, EPROM, SRAM, DRAM, DDRAM, NVRAM, flash memory, Memory Addressing.
Applications: Digital Clock, Frequency counter, Time measurement, Displays.

UNIT-V

Introduction to DAC, ADC: Sampling, Quantization, quantization noise, aliasing and reconstruction filtering, Specifications, DAC Conversion, Binary weighted Resistor DAC, R-2R Ladder DAC, Inverted (or) Current mode DAC, Sample and hold circuits,
ADC conversion, Types of ADCs: Direct Conversion ADC/Flash type ADC, Successive approximation ADC, Integrating ADCs, Sigma-Delta ADCs, Analog Multiplexers.

Suggested Reading:

1. Donald P.Leach & Albert Paul Malvino, *Digital Principles and electronic*, 5th Ed., Tata Mc. Graw Hill Publishing Co.Ltd., New Delhi, 2003
2. R.P.Jain, *Modern Digital Electronics*, 3rd Ed., Tata Mc Graw Hill Publishing Co. Ltd., New Delhi, 2003
3. Morris Mano M. *Computer system Architecture*, 3rd Ed, Prentice Hall of India Pvt. Ltd., New Delhi, 2000

With effect from the academic year 2016-2017

PC451BM

BIO- MEDICAL INSTRUMENTATION LAB

Instruction	2 Periods per week
Duration of University Examination	2 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	1

1. Operation of Various transducers

A. Linear Variable Differential Transformer (LVDT)
B. Strain Gauge Experiment
C. Potentiometric Transducer as a displacement Transducer
D. Light Dependent Resistor (LDR) as a displacement Transducer
E. Peizo electric Transducer as a pressure transducer
F. Temperature Transducers
a) Resistive temperature detector (RTD)
b) Thermister
c) Thermocouple
G. Capacitive Transducer
a) Linear Displacement Transducer
b) Angular Displacement Transducer
H. Indirect Measurement of Blood Pressure
a) Oscillometry method
b) Auscultatory method
c) Palpatory method
I. Tuning Fork experiment to test the Hearing ability
J. Body mass Index Experiment

2. Operation of various medical Instruments

a) ECG Recorder
b) Multi-channel Data acquisition system(Polygraph)
c) EEG monitoring system
d) Bedside monitor
e) Treadmill Test
f) Pulse Oximeter
g) pH Meter
h) Conductivity meter
i) Colorimeter

With effect from the academic year 2016-2017

PC452BM

VIRTUAL INSTRUMENTATION & SIMULATION LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

Virtual Instrumentation Lab using MatLab

1. Implementation in Mat Lab
- (i) Generation of basic signals.
- (ii) Linear and circular convolution
- (iii) Realization of FIR and IIR filters
- (iv) Finding DFT, IDFT, STFT, WT of given sequence
- (v) Plotting the power spectral density.

2. Computation of convolution and correlation sequences.
3. Noise reduction techniques.
4. Design of IIR and FIR Filter
5. PSD Estimation

Labview based Instrumentation Lab

1. Introduction to LabVIEW and Data Acquisition
2. Simulation of Biosignals Using Labview
3. Design of a Bio Signal Logger.
4. Design of an Analog ECG Signal Generator
5. Acquisition of Bio potentials using Biosignals
6. Time domain and Frequency Domain Measurement of Real Time Biosignals.
7. Spectrum analysis of ECG and PCG signal
8. Design of Heart Rate Analyzer
9. Extraction of Brain Waves from EEG
10. Design of a Demand Pacemaker using LabVIEW
11. GPIB Communication using LabVIEW
12. Instrumentation of an amplifier to acquire an ECG Signal
13. Signal Processing of an ECG signal and measuring the Heart Rate
14. Implementation of Digital Filter to remove noise in biosignals
15. Spectrum analysis of Noisy and pure Biosignal
16. Acquire, Analysis and Present an EEG using Virtual Instrumentation
17. Extraction and Analysis of Brainwaves from an EEG Signal
18. Biofeedback system on EMG
19. Acquisition of PCG signal

With effect from the academic year 2016-2017

ES441EC

DIGITAL ELECTRONICS LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

I. List of Experiments:

1. Clippers and Clampers-Series and Parallel
2. Astable, Monostable and Bistable Multivibrators
3. Logic Gates-AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR
4. Half Adder, Full Adder, Half Subtractor, Full Subtractor
5. Flip Flops-SR, JK, D, T, JK-Master Slave
6. A/D and D/A converters
7. Multiplexers and Demultiplexers
8. Shift register-Series/Parallel-in to Series/Parallel-out
9. CMOS-TTL and TTL-CMOS interfacing
10. BCD-7 segment Display, DPM
11. PLL and Voltage Controlled Oscillator
12. Counters-Decade, Binary, Divide-by-N

II. Mini Project and Design exercises:

Mini project is to be executed batch-wise. Design exercises are to be carried out individually.