With effect from the academic year 2013-2014

SCHEME OF INSTRUCTION & EXAMINATION
B.E. III/IV
(BIOMEDICAL ENGINEERING)

SEMESTER-I

S.NO	Syllabus Ref. No	SUBJECT	SCHEME OF INSTRUCTION		SCHEME OF EXAMINATION			CREDITS
			PERIODS PER WEEK		DURATION IN HOURS	MAXIMUM MARKS		
			L/T	D/P		UNIV.MARKS	SESSIONALS	
THEORY								
1.*	**BM 301 UE**	**Physiological Control Systems**	4	-	3	75	25	4
2. **	**BM 404 UE**	**Microprocessors and Microcontrollers in Medical Applications**	4	-	3	75	25	4
3.****	**BM 303 UE**	**Biomedical Equipment-I**	4	-	3	75	25	4
4.***	**EC 254 UE**	**SIGNAL ANALYSIS AND TRANSFORM TECHNIQUES**	4	-	3	75	25	4
5.	MT 301 UE	Mathematics-IV*	4	-	3	75	25	4
6.		ELECTIVE I	4	-	3	75	25	4
PRACTICALS								
1.******	BM 331 UE	Biomedical Equipment Laboratory	-	3	3	50	25	2
2.	EC 341 UE	Digital Electronics Laboratory	-	3	3	50	25	2
		TOTAL	24	6		550	200	28

*. Syllabus same as MT 251 UE

ELECTIVE-I:

1. BM 304 UE **Nanotechnology for medical applications**
2. BM 305 UE **Biomaterials(revised)**
3. BM 306 UE Bio Transport Processes

***Title of the subject is changed from Biological control systems to Physiological control systems, chapter 4 & 5 are modified.**

**** MPMC has been shifted from IV/IV - 1st semester to III/IV -I semester**

***** SATT has been shifted from 2/4 – 2nd semester to III/IV -I semester**

******Cardio-pulmonary Equipment title is changed to Biomedical Equipment-I and the syllabus is revised**

*******Biomedical Equipment Laboratory syllabus is revised.**

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BM 301 UE

PHYSIOLOGICAL CONTROL SYSTEMS

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	4

UNIT-I

Open and closed loop systems. Mathematical models of physical systems. Transfer functions. Block diagram algebra. Signal flow graphs. Feedback characteristics of control systems. Control systems and components. DC and AC servomotors. Principles of stepper motors.

UNIT-II

Standard test signals. Time response of first order and second order systems. Design specifications of second order systems. Proportional controller. Proportional derivative controller. Proportional-Integral controller Proportional-Integral-Derivative controller Performance indices of control systems. Necessary conditions for stability. Hurwitz and Routh stability criteria. Relative stability.

UNIT-III

Concept and construction of root locus. Root contours. Frequency response analysis, Correlation between time and frequency response, Bode plots. Stability in frequency domain. Nyquist stability criteria.

UNIT-IV

Difference between general control systems and physiological control systems, examples of positive and negative feedback physiological control systems. Body temperature Regulation. Blood glucose regulation. Pupil Control System. Visual Fixation System. Oculo-motor System, Muscle stretch reflex, Skeletal muscle Servo-mechanism.

UNIT-V

Cardiovascular Control Systems-Regulation of heart rate, blood pressure and cardiac output. Respiratory Control system-Chemical regulation of ventilation, Cheyne Stokes breathing

Suggested Reading:

1. A. Nagoor Kani "*Digital Signal Processing",* 2nd Ed.
2. NagrathI.J and Gopal M., *Control Systems Engineering*, 3rd Ed, New Age Publishers, 2002
3. Michael C. Khoo, *Physiological Control Systems-Analysis, Simulation and Estimation*, IEEE Press, 2000
4. Suresh R. Devasahayam "*Signals and Systems in Biomedical Engineering".*

With effect from the academic year 2013-2014

BM 404 UE

MICROPROCESSORS AND MICROCONTROLLERS IN MEDICAL APPLICATIONS

Instruction:	4 Periods per week
Duration of University Examination:	3 Hours
University Examination	75 Marks
Sessional:	25 Marks
Credits	4

OBJECTIVES:

a. Distinguish between microprocessors and microcontrollers and their applications.
b. To know the hardware circuitry of each processors and microcontroller.
c. To know the assembly level language programming on microprocessors and Microcontroller in medical applications.

UNIT I

8085 Microprocessor: Architecture, Instruction cycle, basic timing diagrams, Addressing Modes, Instruction Set, Memory and I/O interfacing, interrupts, I/O ports and data transfer concepts**.** Introduction to 8086, Architecture, Memory segmentation.

UNIT II

Peripheral Interfacing: Programmable peripheral interface chip (8255), Programmable communicator chip (8251), Programmable Internal timer chip (8253), Programmable interrupt controller (8259), DMA (8257) controller Introduction to 32-Bit Microprocessors.

UNIT III

Programming of 8085 Microprocessor: General Programmes, debugging of Programmes, interfacing with 8085- ADC, DAC, seven Segment display, stepper motor, traffic control, digital multiplexer, digital demultiplexer, square wave generation using micro processor

UNIT IV

8051 Microcontroller**:** Architecture, Internal and External Memories, Counters and Timers, Register Set, Synchronous and Asynchronous Serial Communication, Interrupts, Instruction Set, Basic C Programming in 8051 Microcontroller.

UNIT V

Interfacing of medical sensor circuits: Carbon dioxide and oxygen sensors, respiration, force, flow, differential voltage and current probes and humidity sensors.

Suggested Reading:

1. Kenneth J. Ayala, *the 8051 Microcontroller-Architecture, Programming and Applications, 2nd Ed*., Penram International Publishing, 2005.
2. D.V. Hall, *Microprocessors and Interfacing, Programming and Hardware,* Tata Mc-Graw Hill, 1999.
3. Goankar R.J**,** *Micro processor architecture , programmable applications with 8085.*

BM 303 UE

BIOMEDICAL EQUIPMENT -I

Instruction:	4 Periods per week
Duration of University Examination:	3 Hours
University Examination:	75 Marks
Sessional:	25 Marks
Credits:	4

COURSE OBJECTIVES:

a. State the Physiological reasons for using a particular piece of Biomedical Equipment.
b. Describe the operating principles of a wide range of biomedical equipment.
c. Perform tests to assess the performance and safety of such Equipments.
d. Learn the maintenance of biomedical equipment.

UNIT-I

Critical physiological parameters to be monitored. Intensive coronary care unit layout.
Assist devices of the heart: Principles of external counter pulsation techniques. Intra-aortic Balloon pump.Prosthetic heart valves, Mechanical and tissue Valves. Types of mechanical valves: Ball and Cage, tilting disc and Bileaflet valves. Types of tissue valves: Homografts or Allografts(human cadaver)and Heterografts or Xenografts(Porcine or Bovine). Testing of prosthetic heart valves.

UNIT-II

Cardiac Pacemakers: Need for a Pacemaker, Types-Asynchronous ,Synchronous(demand), External and implantable. Asynchronous pacemakers: Working principle, block diagram.
Synchronous/Demand Pacemaker: Working principles. Modes of triggering-ventricular triggered(QRS triggered)and atrio-ventricular synchronized pacemaker(P wave triggered), Programmable pacemaker. Implantable Pacemaker: Technical and qualitative requirements of power supplies, lead wires and electrodes, packaging. Microprocessor based implantable pacemaker, Rate responsive pacemaker.

UNIT-III

Defibrillators: Need for Defibrillators, D.C. Defibrillator, Need for Synchronous ,Types of electrodes and their features, Types of Waveforms, Automatic/Advisory External Defibrillators(AED), Implantable defibrillators. Cardioverters: Working principle. Defibrillator analyzers.

UNIT-IV

Heart lung Machine: Governing principles. Qualitative requirements. Functional details of Bubble, Thin Film and membrane-type of blood oxygenators. Respiratory measurements: Principles and techniques of impedance Pnuemography and pneumotachograph. Ventilators: Artificial Ventilation, Types of ventilators, Modern Ventilators, High frequency Ventilators, Humidifiers, Nebulizers and Aspirators.

UNIT-V

Haemodialyzer: Artificial Kidney, Dialyzers, Membranes for Haemodialysis, Haemodialysis Machine, Monitoring circuits for hemodialysis machine, Portable Kidney Machines.
Lithotriptors:Need for Lithotriptor, First Lithotriptor Machine, Modern Lithotriptor Systems, Extra-corporeal shock-wave Therapy.

Suggested Reading:

1. John G. Webster, "*Medical Instrumentation-Application and Design*", John Wiley and sons Inc., 3rd Ed., 2003
2. Khandpur R.S., *Hand Book of Biomedical Instrumentation*, Tata Mc.Graw Hill Pub Co.Ltd., 2nd ed., new Delhi, 2003
3. Joseph J. Carr ad John M. Brown, *Introduction to Biomedical Equipment Technology*, Pearson Education, 2001
4.Gerald E. Miller, *Artificial Organs*, Morgan and Claypool, 2006

With effect from the academic year 2012-2013

EC 254 UE

SIGNAL ANALYSIS AND TRANSFORM TECHNIQUES

(Common to BME and CSE)

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	4

UNIT I

Definitions and classification of Signals and systems:- The environmental signal, analogy between vector and signal, Signal representation by discrete set of orthogonal; functions, Orthonormality and completeness, Exponential and trigonometric Fourier series, convergence, Dirichelet's conditions, the discrete Spectrum, Application of Fourier series to electrical networks.

UNIT II

Signal representation by continuous exponentials:- The direct and inverse Fourier transform, continuous spectrum, Existence and properties of Fourier transform, singularity functions, Parsevals theorem.

UNIT III

Convolution integral:- Convolution integral, convolution as summation, graphical method of convolution, network functions, poles and zeros, time domain behavior from pole zero plot and stability.

UNIT IV

Discret Signals:- Sampling of continuous time sampling, sampling theorem and problems, discrete time signals and systems-Linear shift invariant, linear, stable, causal and memory less. Linear Constant-Coefficient Difference equations, frequency domain representation of systems, Realization of discrete time system-direct, cascade and parallel Forms.

UNIT V

Z Transform and Properties:- Z transform, Properties of the region of convergence for the Z-Transform, Inverse Z Transform, Z transform properties, Inverse Z-Transform using Contour Integration, partial fraction expansion, Long division methods, Parseval's relation and analysis of discrete time systems using Z-Transform

Suggested Reading:

1. Lathi B.P.Signals, *Systems.and communication*, BSP-2001
2. Alan V. Oppenheim and Ronald W. Schafer, *Discrete Time Signal processing*, PHI-1992.
3. Ashok Ambardar, *Analog and Digital Signal Processing*, Thomson Asia, Pte Ltd, 2004.

With effect from the academic year 2013-2014

BM 251 UE

MATHEMATICS-IV

Instruction:	4 Periods per week
Duration of University Examination:	3 Hours
University Examination	75 Marks
Sessional:	25 Marks
Credits	4

UNIT I

Functions of Complex Variables: Elementary functions of complex variables, limit and continuity of function, Analytic function, Cauchy-Riemann equations, Complex integration, Cauchy's theorem, Derivatives of analytic functions, Cauchy's integral formula and its applications.

UNIT II

Taylor's and Laurent's Series Expansions: Zeroes and singularities, Residues, Residue theorem, Evaluation of real integrals using residue theorem, conformal mapping, Bilinear transformation.

UNIT III

Z-Transforms: Introduction, Basic Theory of Z-transforms, Z-transforms of some standard sequences, Existence of Z-Transforms, Linearity property, translation Theorem, Scaling property, initial and Final Value Theorems, Differentiation of Z-Transform, Convolution Theorem, Solution of Difference equations using Z-transforms.

UNIT IV

Statistics: Random variable, Distributions, Density functions, Conditional distributions, bay's theorem, Mathematical expectation, Expected values, moments and Moment generating functions, Distributions: Poisson, Normal, Gamma and Chi-Square distribution, Fitting these curves of the data.

UNIT V

Curve Fitting by Method of Least Squares: Correlation and Regression, Lines of Regression, Tests of Significance, Chi-Square, F and T-Tests

Suggested reading:

1. R.V.Churchill, *"Complex Variables & Its Applications"*, Mc Graw–Hill Book Company, INC, 2008
2. R.K.Jain & S.R.K.Iyengar, *"Advanced Engineering Mathematics"*, Narosa Publications, 2008
3. I.Miller and J.E.Fireeund, *"Probabilities and Statistics for Engineers"* 3rd Edition, Pearson Publishers, 2000
4. P.N.Arora, Sumeet Arora, S.Arora, *"Statistical Methods"*, 2nd Edition, S.Chand & Co. Ltd, 2008.
5. Keryszig E, *"Advanced Engineering Mathematics"*, 8th Edition, John Wiley & Sons Ltd, 2006
6. H.K.Dass, *"Advanced Engineering Maths"*, S.Chand & co. Pvt. Ltd, 2008

With effect from the academic year 2013-2014

NANO TECHNOLOGY FOR MEDICAL APPLICATIONS

Instruction	4Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks

UNIT-I Introduction to Nano Technology:

Nano materials :Definition, Characteristics and Properties of Nano materials. Fullerness and carbon forms.

UNIT-II Introduction to Nanotechnology:

Nanoparticles and Colloids, structure and bonding in nanoparticles, Nanomaterials fabrication by Bottom-up and Top- down approaches, Classification of nanodevices based on the characteristics, Quantum dots and their properties.

UNIT-III Carbon nanotubes:

Carbon nanoparticles, types of carbon nanotubes, single-walled, multi-walled, torus, nanobud, properties of carbon nanotubes, and synthesis by Arc discharge, laser ablation, chemical vapor deposition techniques

UNIT-IV Nanomedicine:

Medical use of Nanomaterials, Drug delivery systems.Cancer treatment, Surgery.Drug tracking systems.Targeted drug delivery systems.

UNIT-V Nano molecular imaging:

Applications of Nanomaterials in Medical imaging.Neuro-electronic interfaces.

Suggested Books:

1. Lynn E. Foster, Foreword by George Allen, Foreword by Joe Lieberman, Nanotechnology: Science, Innovation, and Opportunity, Nanomedicine: Basic Capabilities, Vol. 1 by Robert A. Freitas Jr. 1999 Rev
2. NeelinaMalsch , Biomedical nanotechnology by CRC press release, *MalschTechnoValuation, Utrecht, The Netherlands*
3. GeroDecher, Joseph B. Schlenoff, Multilayer Thin Films, Wiley-VCH Verlag GmbH & Co. KGaA, 2003
4. David S. Goodsell, Bionanotechnology : Lessons from Nature, Wiley-Liss , 2004.
5. Kenneth J. Klabunde ,Nanoscale Materials in Chemistry. , John Wiley & Sons, Inc., 2001

With effect from the academic year 2013-2014

BM UE **BIO MATERIALS AND TISSUE REPLACEMENT**

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	4

Course objectives:

- To understand the need and properties of the biomaterials.
- To understand the properties, biocompatibility issues and applicationsof various classes of biomaterials.
- To understand the biomaterials-tissue interactions.
- To understand the various soft tissue and hard tissue replacements.

UNIT – I

Properties of Biomaterials: Biomaterial–definition and need, Types of Biomaterial,Requirements of an ideal biomaterial, Biocompatibility.
Characterization of materials – Mechanical, chemical, thermal, electrical, optical and other properties.

UNIT – II

Materials used as biomaterials and their properties: Properties of metallic biomaterials – stainless steels, Co-based alloys, Ti and Ti–based alloys, Ni-Ti alloys.
Properties of Ceramic biomaterials -Aluminum Oxides, Calcium Phosphate, Glass ceramics and carbons.
Properties of Polymeric biomaterials–Polyamides, Polyethylene, Polypropylene,Polyacrylates, Poly Vinyl Chloride.
Properties of composite biomaterials and biological/natural materials.

UNIT – III

Tissue response to biomaterials and testing of biomaterials: Inflammation, wound–healing and foreign body response, systemic toxicity and hypersensitivity,Blood compatibility, Carcinogenicity, implant–associated infection.In-Vitro and In-Vivo assessment of tissue compatibility and testing of blood–materials interaction.
Degradation of metals, polymers and ceramics in general and in the biological environment.

UNIT – IV

Soft tissue replacements: Sutures, Surgical tapes and Staples, Tissue Adhesives,Percutaneous Devices, Artificial Skin, Maxillofacial implant, Ear and Eye Implants, Fluid Transfer Implants.Vascular Implants,Heart Valve Implants, Heart and Lung Assist Devices,Dialysis Membrane, Drug delivery systems. Burn Dressings, Skin substitutes, Artificial Cartilage.

UNIT – V

Hard tissue replacements: Wires,Pins, Screws,Fracture Plates-Cortical and Cancellous Bone Plates. Intramedullary devices, spinal fixation devices.Lower extremity Implants, Upper Extremity Implants, Endosseous Tooth Implants–Subperiosteal and staple /Transosteal implants, Interface of orthopedic implants.Bone cement fixation, Porousingrowth (Biological) fixation, Direct bonding between bone and implant, Interference and passive fixation.

Text Books:

1. Joon B.Park and Roderic S.Lakes, "Biomaterials – An introduction" Plenum Press, 2nd Edition,1992.
2. Buddy D.Ratner, Allan S. Hoffman, Frederick, J.Schoen and Jack E. Lemons, "Biomaterials Science – An Introduction to materials in Medicine", Academic Press, 1996.

References:

1. John Enderle, Susan Blanchard and Joseph Bronzino, "Introduction to Biomedical Engineering", 2nd Edition, Elsevier Academic Press, 2009.
2. Roger Narayan, "Biomedical Materials", Springer, 2009.
3. NPTEL Video lecture: Introduction to Biomaterials.

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BM 304 UE

BIOTRANSPORT PROCESSES

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessionals	25 Marks
Credits	4

Unit I
System concepts for transport processes. Effort variables, flow vsariables, relationship between flow and effort variables. Chemical balances, force balances, general flow balances, Kirchoff's laws, system applications.

UNIT II
Fluid flow systems. Conservation of mass, conservation of energy, momentum balance, Newtonian and non-newtonian flows. Rheology and flow of blood. Transport through cell membranes.

UNIT III
Heat transfer systems. Modes of heat transfer, conduction, convection and radiation. Heat generation and Heat storage. Mixed heat transfer, heat production, heat loss, models for heat transfer within the body.

UNIT IV
Mass transfer principles. Mass balance, molecular diffusion, convection, mass generation and mass storage, mixed mode mass transfer, simultaneous heat and mass transfer. Mass transfer in kidneys, lungs and in artificial organs(dialysers and oxygenators)

UNIT V
Compartmental models. Approaches to pharmacokinetic modeling and drug delivery, one and two compartmental models. Physiological applications-intravenous injection, constant intravenous infusion, determination of rehional blood flow volumes and blood flow rates.

Suggested Reading:
Arthur T. Johnson, "*Biological Process Engineering- An analogical approach to fluid flow, heat transfer, mass transfer applied to biological systems*", John Wiley and Sons, 1999.
David O. Cooney, "*Biomedical Engineering Principles-An introduction to fluid, heat, mass transport processes*", Marcel Dekker Inc., 1976

With effect from the academic year 2013-2014

BIOMEDICAL EQUIPMENT LAB

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

List of Experiments

1. ECG Recorder Experiment
2. pulse Oximetry Experiment
3. Syringe pump Experiment
4. Audiometry to find the Hearing ability of the subjects
5. Ultrasound Diathermy
6. Shortwave Diathermy
7. Spirometry to test the capacity of Human lungs
8. Multi channel physiological Data acquisition System by using physiopack
9. Nerve conduction Velocity Experiment
10. EEG Recording
11. Recording of Evoked potentials
12. pH-meter
13. Conductivity meter
14. Pacemaker simulator
15. Bedside monitor

Equipment for Demonstration

1. X-Ray machine
2. Portable Ventilator
3. Suction Apparatus
4. Infusion Pump
5. Clinical Instruments (Biochemistry Analyzer, spectrophotometer)
6. Anesthesia Machine

II. Mini Project and Design exercises:

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

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BM 341 UE

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:

Clippers and Clampers-Series and Parallel

Astable, Monostable and Bistable Multivibrators

Logic Gates-AND, OR, NOT, NAND, NOR

Half Adder, Full Adder, Half Subtractor, Full Subtractor

Flip Flops-SR, JK, D, T, JK-Master Slave

A/D and D/A converters

Multiplexers and Demultiplexers

Shift register-Series/Parallel-in to Series/Parallel-out

CMOS-TTL and TTL-CMOS interfacing

BCD-7 segment Display

PLL and Voltage Controlled Oscillator

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.