SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)

Accredited with 'A' grade by NAAC
Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai - 600 119.
www.sathyabama.ac.in

DEPARTMENT OF BIOMEDICAL ENGINEERING
BOARD OF STUDIES – 2017 - 2018 (ODD Semester)

Minutes of the Meeting

02-06-2017

1. SEC1320 Fundamentals of Microprocessor & Microcontroller – syllabus has been revised as per industrial demands.

2. SBM1302 – Analytical Instrumentation Unit III – Electrophoresis topic has been included for the benefit of student life sciences projects.

3. SEC1324 – Digital signal processing & its applications – DSP application has been included which will aid in the design of filters used in Biomedical equipments.

Members of Board of studies – Biomedical Engineering

EXTERNAL MEMBERS

Dr. **G. Harikrishnan**,

Associate Professor & Research Coordinator,
Department of Electrical & Electronics Engg.,
Sree Vidyanikethan Engg. College, Tirupati

INTERNAL MEMBERS

S.No.	Name of the Internal Member	Signature
1	Dr. Daniel Alex Anand	
2	Dr. T. Sudhakar	
2	Dr. J. Premkumar	
3	Dr. Anima Nanda	
4	Dr. S. Krishnakumar	
5	Ms. Sindu Divakaran	
6	Ms. Bethanney Janney	
7	Ms. A. Sabarivani	

HOD/BIOMEDICAL

HEAD OF THE DEPARTMENT
DEPARTMENT OF BIOMEDICAL ENGINEERING
SATHYABAMA
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SBMX1009	ANALYTICAL INSTRUMENTATION	L	T	P	CREDITS	TOTAL MARKS
		3	1	0	4	100

UNIT-I INTRODUCTION TO ANALYTICAL INSTRUMENTS 10

Analytical methods and instrumentation types, Electromagnetic spectrum, Interaction of radiation with matter, Absorption spectra, Beer-Lambert's Law. **Spectrophotometers**: UV and visible ranges, single and Double Beam Instruments, FTIR and Raman Spectra – Basic principles, biomedical applications.

UNIT-II AUTOMATED BIOCHEMICAL ANALYSIS 10

System concepts – system components - sampler control units - sampling mechanisms, dialyzer - samac-II.
Gas Analyzers: Paramagnetic Oxygen Analyzer.

UNIT-III MASS SPECTROMETER 10

Magnetic deflection - Time of flight - quadrupole - Basic Principles and biomedical applications.
RadioChemical Analytical Instruments: Radiation types - Ionization chamber - GM Counter - Proportional counter.

UNIT-IV MICROSCOPIC TECHNIQUES 10

Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic force Microscopy (AFM) and Scanning Tunneling Microscopy (STM) – Basic Principles and Applications.

UNIT-V CHROMATOGRAPHY 10

Principles, Types of chromatography - Liquid Chromatography - High Pressure Liquid Chromatography – applications in biomedical field.

TOTAL NUMBER OF PERIODS: 50

TEXT BOOK:

1. R.S. Khandpur, "A Handbook of Analytical Instrumentation", 2nd Edition Tata McGraw Hill Publication (Unit I-V)

REFERENCES:

1. D.A. Skoog, F.J. Holler & T.A. Nieman, "Principles of Instrumental Analysis", 5th Edition
2. Williard H.H., Merrit, Dean J.A, Seattle F.L, CBS, "Instrumental Methods of Analysis"
3. Ewing G.W., "Instrumental Methods of Analysis", McGraw Hill, 1992
4. Robert D. Braun "Introduction to Instrumental Analysis", McGraw Hill, 1987.

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max. Marks: 80 Exam Duration: 3 hrs
Part A: 10 questions of 2 marks each - No Choice 20 marks
Part B: 5 questions from each of the FIVE units of internal Choice, Each carries 12 marks 60 marks

SEC1320	FUNDAMENTALS OF MICROPROCESSOR AND MICROCONTROLLER	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- The prime objective of this course is to introduce to the students the fundamentals of microprocessor and microcontroller.
- The students will be equipped with the basic knowledge of microprocessor and microcontroller interfacing and their applications.

UNIT 1 INTRODUCTION TOINTEL 8085 9 Hrs.

Evolution of Microprocessor - Architecture of 8085 - Instruction format - Addressing modes - Basic timing diagram of opcode fetch, memory read, memory write, I/O read and I/O write - Interrupts of 8085 - Software Interrupts, Hardware interrupts, Priorities of interrupts8085 based system design

UNIT 2 INTEL 8085 INTERFACING **9 Hrs**

Interfacing devices- 8255 Programmable Peripherals Interface- Architecture & various modes of operation - 8251 USART Architecture and programming features - 8237, DMA Controller Architecture & Programming features. Interfacing with ADC and DAC, LCD, keyboard Interface.

UNIT 3 INTRODUCTION TO 8086 **9 Hrs**

Architecture of 8086 - Registers set of 8086 - Special function of general purpose register - Addressing modes of 8086 - Instruction set - pin diagram of 8086 - Timing diagram- memory read, memory write, I/O read and I/O write - Minimum and Maximum mode of operation Interrupts of 8086.

UNIT 4 MICROCONTROLLER **9 Hrs.**

Introduction to 8 - bit Microcontrollers - 8051 Microcontroller Architecture - Registers set of 8051 - modes of Timer operation - Serial Port operation - Interrupt Structure of 8051 - Memory and Input / Output Interfacing of 8051.

UNIT 5 APPLICATIONS **9 Hrs**

Application of microprocessors: Stepper Motor Control, Temperature control, TTL to RS232 Conversion - RS232 to TTL Conversion - Interfacing EPROMs & SRAMs with 8085. Interfacing Biosignal to Microprocessor- block diagram.

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, blishing, New Delhi, 2000
2. Kennith J. Ayala, 8051 Microcontroller, Thomson, 2005.Edition, Penram International
3. ugles V. Hall, Microprocessor and Interfacing, Tata MC Graw Hill Publication, 2nd Edition, 1992.
4. Charless M. Gilmore, "Microprocessor Principle and application, McGraw Hill publication, 1995.
5. A.NagoorKani, Microprocessor & Microcontroller, Tata Mc Graw Hill, 3rd Edition, 2012
6. B. Ram, Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai Publications, 2001

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 80 **Exam Duration : 3 Hrs.**

PART A : 10 questions of 2 marks each - No choice **20 Marks**

PART B : 2 questions from each unit of internal choice; each carrying 12 marks **60 Marks**

SBMX1009	ANALYTICAL INSTRUMENTATION	L	T	P	CREDITS	TOTAL MARKS
		3	1	0	4	100

UNIT-I INTRODUCTION TO ANALYTICAL INSTRUMENTS **10**

Analytical methods and instrumentation types, Electromagnetic spectrum, Interaction of radiation with matter, Absorption spectra, Beer-Lambert's Law. **Spectrophotometers**: UV and visible ranges, single and Double Beam Instruments, FTIR and Raman Spectra – Basic principles, biomedical applications.

UNIT-II AUTOMATED BIOCHEMICAL ANALYSIS **10**

System concepts – system components - sampler control units - sampling mechanisms, dialyzer - samac-II.
Gas Analyzers: Paramagnetic Oxygen Analyzer.

UNIT-III MASS SPECTROMETER **10**

Magnetic deflection - Time of flight - quadrupole - Basic Principles and biomedical applications.
RadioChemical Analytical Instruments: Radiation types - Ionization chamber - GM Counter - Proportional counter.

UNIT-IV MICROSCOPIC TECHNIQUES **10**

Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic force Microscopy (AFM) and Scanning Tunneling Microscopy (STM) – Basic Principles and Applications.

UNIT-V CHROMATOGRAPHY **10**

Principles, Types of chromatography - Liquid Chromatography - High Pressure Liquid Chromatography – applications in biomedical field.

TOTAL NUMBER OF PERIODS: 50

TEXT BOOK:

1. R.S. Khandpur, "A Handbook of Analytical Instrumentation", 2nd Edition Tata McGraw Hill Publication (Unit I-V)

REFERENCES:

1. D.A. Skoog, F.J. Holler & T.A. Nieman, "Principles of Instrumental Analysis", 5th Edition
2. Williard H.H., Merrit, Dean J.A, Seattle F.L, CBS, "Instrumental Methods of Analysis"
3. Ewing G.W., "Instrumental Methods of Analysis", McGraw Hill, 1992
4. Robert D. Braun "Introduction to Instrumental Analysis", McGraw Hill, 1987.

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max. Marks: 80 Exam Duration: 3 hrs
Part A: 10 questions of 2 marks each - No Choice 20 marks
Part B: 5 questions from each of the FIVE units of internal Choice, Each carries 12 marks 60 marks

SBM1302	ANALYTICAL INSTRUMENTATION	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- The course offers a wide portfolio of study programs in the areas of technology, engineering and other application fields.
- It provides an introduction to the fundamental principles of chemical measurement used in medical diagnosis, quality assurance and control and research studies.
- It helps understand and appreciate the role of instruments in solving problems in physical, chemical and biological source and discover the impact of the relevant scientific and technological advancements.

UNIT 1 SPECTROPHOTOMETER **12 Hrs**

Analytical methods and instrumentation types, Electromagnetic spectrum, Interaction of radiation with matter, Absorption spectra, Beer-Lambert's Law. Spectrophotometers: UV and visible ranges, single and Double Beam Instruments, FTIR and Raman Spectra - Basic principles, biomedical applications.

UNIT 2 MASS SPECTROPHOTOMETER AND RADIOCHEMICAL INSTRUMENTS **12 Hrs.**

Spectrofluorimeter, Flame photometry - flame emission spectrometer, atomic absorption spectrometer, Mass Spectrometer - Magnetic deflection - Time of flight - quadrupole - GCMS - Basic Principles and biomedical applications. Radio Chemical Analytical Instruments - Radiation types - Ionization chamber - GM Counter - Proportional counter.

UNIT 3 AUTOMATED BIOCHEMICAL ANALYZER AND ELECTROPHORESIS **12 Hrs.**

System concepts - system components - sampler control units - sampling mechanisms, dialyzer - samac-II, Principles of Electrophoresis, Paper electrophoresis, Agarose Gel Electrophoresis, Isoelectric focusing, SDS PAGE, Pulse Field Electrophoresis

UNIT 4 MICROSCOPIC TECHNIQUES AND GAS ANALYZER **12 Hrs.**

Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic force Microscopy (AFM) and Scanning Tunneling Microscopy (STM), X ray Diffraction (XRD) - Basic Principles and Applications, Gas Analyzers: Paramagnetic Oxygen Analyzer, Flow Analyzer-Ultrasound & NMR Blood flow analyzer.

UNIT 5 CHROMATOGRAPHY **12 Hrs.**

Principles, Types of chromatography - Paper Chromatography, Thin Layer Chromatography, Column Chromatography, Ion exchange Chromatography, Gel permeation Chromatography, Gas Chromatography - High Pressure Liquid Chromatography - applications in biomedical field.

Max. 60 Hours.

TEXT / REFERENCE BOOKS

1. D.A. Skoog, F.J. Holler & T.A. Nieman, Principles of Instrumental Analysis, 5th Edition, 1998.
2. Williard H.H., Merrit, Dean J.A, Seattle F.L, CBS, Instrumental Methods of Analysis, 1995.
3. Ewing G.W., Instrumental Methods of Analysis, McGraw Hill, 1992.
4. Robert D. Braun Introduction to Instrumental Analysis, McGraw Hill, 1987.
5. R.S. Khandpur, A Handbook of Analytical Instrumentation, 2nd Edition Tata McGraw Hill Publication, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 80 **Exam Duration : 3 Hrs.**

PART A: 10 questions of 2 marks each - No choice **20 Marks**

PART B : 2 questions from each unit of internal choice; each carrying 12 marks **60 Marks**

SBMX1006	DIGITAL SIGNAL PROCESSING & ITS APPLICATION	L	T	P	CREDITS	TOTAL MARKS
		3	1	0	4	100

UNIT- I INTRODUCTION 10

Characterization and classification of signals-examples of signals-continuous versus discrete signals-analog versus digital signals – convolutions – sampling and quantization-concepts of signal processing-typical applications- advantages of digital signal processing compared with analog processing – Applications of signal processing in Biomedical Engineering.

UNIT- II DISCRETE TIME SYSTEMS 10

Representations – classifications – Analysis of Discrete-Time Linear Invariant Systems- Z-TRANSFORM – inverse Z transform - Properties

UNIT- III FREQUENCY ANALYSIS OF SIGNALS 10

Discrete Fourier Transform and its properties – computation of DFT – Radix 2 FFT algorithms – DIF and DIT algorithms. Examples of Biomedical signal processing – Estimation of heart rate in ECG (Harmonic Analysis) – Filtering in Ultrasound (Matched and Wiener filter) – Analysis of EMG signal (Independent component analysis).

UNIT- IV 10

FIR Filter Designing -Digital Filters: FIR filters-designing FIR filters – Hamming window – Hanning window functions – Rectangular Window

UNIT- V 10

IIR filter Design - Butter worth and Chebyshev Filters – Frequency transformation in analog and digital domain, Realization of digital filters – Direct form I, II.

TOTAL NUMBER OF PERIODS: 50

TEXT BOOK:

1. Ramesh Babu "Digital Signal Processing" Scitech Publications, 3rd Edition (Unit-I,II,IV.V)

REFERENCES:

1. Salivahanan, "Digital Signal Processing", Tata Mc Graw Hill, 2000
2. John G. Proakis,Vinay K. Ingle, John G. Proakis "A Self-Study Guide for Digital Signal Processing",
3. Nagoorkani, "Digital Signal Processing", RBA Publications,
4. Alan V. Oppenheim, Ronald W. Schafer, "Digital Signal Processing", Prentice-Hall, 1975
5. Eugene N. Bruce, "Biomedical Signal Processing and Signal Modeling" John Wiley & Sons, 2000.(Unit III)

UNIVERSITY EXAM QUESTION PAPER PATTEREN

Max. Marks: 80 Exam Duration: 3 hrs
Part A: 10 questions of 2 marks each –No Choice- 20 marks
Part B: 5 questions from each of the FIVE units of internal Choice, Each carries 12 marks. - 60 marks

Questions May ask in Part B as 20 % THEORY; 80 % PROBLEM

SEC1321	DIGITAL SIGNAL PROCESSING AND ITS APPLICATIONS	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- This course will introduce the basic concepts and techniques for processing signals on a computer.
- By the end of the course, the student will be familiar with the most important methods in DSP, including digital filter design, transform-domain processing and importance of Signal Processors.
- The course emphasizes intuitive understanding and practical implementations of the theoretical concepts.

UNIT 1 INTRODUCTION TO DISCRETE TIME SIGNALS & SYSTEMS 9 Hrs.

Representations - Classification of DT Signals & DT Systems - Concepts of Signal processing - Advantages of digital signal processing compared with analog processing - Typical applications - Analysis of DT-LTI Systems - Z- Transform and its properties - Inverse Z-Transform - Long division method - Partial fraction method - Residue or Contour integration method - Convolution method

UNIT 2 FREQUENCY ANALYSIS OF SIGNALS 9 Hrs.

Discrete Fourier Transform and its properties - Relationship of the DFT to other transforms - General computation of DFT - convolution - Linear convolution, Circular convolution - Introduction to Fast Fourier Transform - Radix-2 FFT algorithms - Decimation in time (DIT), Decimation in Frequency (DIF) algorithms

UNIT 3 FIR FILTER DESIGN 9 Hrs.

Introduction - Digital filters Linear phase FIR filters - Designing of FIR Filters - Fourier series method of designing FIR filters - Design of FIR filters using windows - Rectangular window - Hamming Window - Hanning Window functions - Frequency sampling method of designing of FIR filters - Frequency response and Design.

UNIT 4 IIR FILTER DESIGNING 9 Hrs.

Introduction - Frequency selective filters - Digital versus Analog filters - Advantages & disadvantages of digital filters - Butterworth and Chebyshev Filters - Frequency Transformation in analog & Digital domain - Low pass to Low pass - Low pass to High pass - Low pass to Band pass - Low pass to Band stop - Realization of digital filters - Direct form I & II.

UNIT 5 DSP APPLICATION 9 Hrs.

Multirate signal processing: Decimation - Efficient transversal structure & Polyphase structure of Decimator – Interpolation - Efficient transversal structure & Polyphase structure of Interpolator - Polyphase Decimation & Interpolation using Z-Transform - Adaptive Filters: Introduction, Applications of adaptive filtering to equalization - Medical applications - ECG, EEG analysis

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. John G. Proakis & Dimitris G.Manolakis, Digital Signal Processing - Principles, Algorithms & Applications, Fourth Edition, Pearson Education / Prentice Hall, 2007.
2. Allan V. Oppenheim et al, Signals and Systems, 2nd Edition., Prentice Hall of India Pvt. Ltd., 1997.
3. Haykin. S and Van Been. B., Signals and Systems, 2nd Edition, John Wiley & Sons, 2003.
4. Emmanuel C..Ifeachor, & Barrie.W.Jervis, Digital Signal Processing, Second Edition, Pearson Education / Prentice Hall, 2002.
5. Sanjit K. Mitra, Digital Signal Processing - A Computer Based Approach, Tata Mc Graw Hill, 2007.
6. A.V.Oppenheim, R.W. Schafer and J.R. Buck, Discrete-Time Signal Processing, 8th Indian Reprint, Pearson, 2004.
7. Andreas Antoniou, Digital Signal Processing, Tata Mc Graw Hill, 2006.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 80 **Exam Duration : 3 Hrs.**

PART A : 10 questions of 2 marks each - No choice **20 Marks**

PART B : 2 questions from each unit of internal choice; each carrying 12 marks **60 Marks**

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QUALITY SYSTEM CERTIFICATION DNV·GL ISO 9001:2015

DEPARTMENT OF BIOMEDICAL ENGINEERING

BOARD OF STUDIES – 2017 - 2018 (EVEN Semester)

Minutes of the Meeting

01-11-2017

1. SBMX1008 – Artificial organs & prosthesis has been revised as a new subject as artificial organs & tissue engineering SBM1306 Unit IV & V has completely revised.

2. The Courses SBM1305 (Biological control systems) – new topics has been added in order to meet the demands of technological advancements.

3. Professional training I S24PT1 has been included in order to gain the hands on and exposure to the industrial needs. SEC1219 course code has been changed to SEC1221 Linear Electronic circuits since the derivation part in all has been deleted from 2016 batch onwards.

Members of Board of studies – Biomedical Engineering

EXTERNAL MEMBERS

2. Dr. **G. Harikrishnan**,
   Associate Professor & Research Coordinator,
   Department of Electrical & Electronics Engg.,
   Sree Vidyanikethan Engg. College, Tirupati

INTERNAL MEMBERS

S.No.	Name of the Internal Member	Signature
1	Dr. Daniel Alex Anand	
2	Dr. T. Sudhakar	
2	Dr. J. Premkumar	
3	Dr. Anima Nanda	
4	Dr. S. Krishnakumar	
5	Ms. Sindu Divakaran	
6	Ms. Bethanney Janney	
7	Ms. A. Sabarivani	

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S.No.	Course Code	Course Name	Deleted Topics	Added Topics
1	SBM1306	Artificial organs & Tissue engineering	NIL	UNIT 4 TISSUE ENGINEERING Tissue engineering - Basic principles and considerations, Bioreactor - design and applications, Biomaterials - Protein surface interaction, Protein adsorption, Engineering Biomaterials for Tissue Engineering - 10 to 100 micron size scale UNIT 5 STEM CELLS The Biology of Stem cells - Embryonic stem cells, adult stem cells, aging of stem cells, The importance of Stromal cells, Tissue engineering of Bone marrow
2	SBM1305	Biological control systems	Nil	Unit I - Signal flow graphs, Mathematical Models of Physical systems: Differential equations, Transfer functions and block diagrams of simple electrical networks, Translational and Rotational mechanical systems Unit II - P, PI, PD and PID controllers

SBMX1008	ARTIFICIAL ORGANS AND PROSTHESIS	L	T	P	CREDITS	TOTAL MARKS
		3	0	0	3	100

UNIT-I **10**

Evolution of organ replacement technology. Organ replacement outlook, Biology of transplantation of tissue products matching. Types of tissue grafts, design considerations, evaluation process.

UNIT-II **10**

Artificial heart and lung assist devices, Cardiac pace makers, Pacemaker Implantation, cardioverter. Artificial blood, artificial skin, artificial pancreas.

UNIT-III **10**

The Nephron and Mass Transfer, artificial kidney, dialysis membrane, Dialysis Procedure and the Dialysis System, Dialyzer Cartridge Reuse.

UNIT-IV **10**

Transplants types, immunological considerations, blood transfusions. Individual organs – Kidney, liver, heart, lung, bone, skin, hair and pancreas. Regeneration and ethical considerations.

UNIT-V **10**

Engineering concerns-pressure gradient, effective orifice area. Regurgitation, flow, patterns and turbulent shear stresses. Heart valve prosthesis – mechanical and tissue valves, orthotic devices, fundamentals and engineering principles of limb prosthesis.

TOTAL NUMBER OF PERIODS: 50

TEXT BOOK:

1. Gerald E. Miller, "Artificial organs", 1st edition, A Publication in the Morgan & Claypool Publishers series, United States of America. (unit – II & III)

REFERENCES:

1. J.B. Park and R.S. Lakes, "Biomaterials: An Introduction" 2nd Edition, Plenum press, New York, 1992. (Unit – IV)
2. Joseph D Bronzino, "The Biomedical Engineering hand Book" Vol-11, CRC press, 2000. (Unit – I & V)

UNIVERSITY EXAM QUESTION PAPER PATTERN

Max. Marks: 80 — Exam Duration: 3 hrs
Part A: 10 questions of 2 marks each - No Choice — 20 marks
Part B: 5 questions from each of the FIVE units of internal Choice, Each carries 12 marks — 60 marks

SBM1306	ARTIFICIAL ORGANS AND TISSUE ENGINEERING	L	T	P	Credits	Total Marks
		3	0	0	3	100

COURSE OBJECTIVE

- To provide a general introduction to the use of artificial materials in the human body for the purpose of aiding healing, correcting deformities and restoring lost function.
- It is expected that the student will have successfully completed elementary course in the mechanics of deformable bodies and an introductory course to material science prior to undertake a course in biomaterials.

UNIT 1 ORGAN REPLACEMENT **9 Hrs**

Evolution of organ replacement technology. Organ replacement outlook, Biology of transplantation of tissue products matching. Types of tissue grafts, design considerations, evaluation process.

UNIT 2 ARTIFICIAL ORGANS **9 Hrs**

Artificial heart valves, Heart valve prosthesis - mechanical and tissue valves, Cardiac pace makers, Pacemaker Implantation, Artificial Lung, Artificial skin, Artificial pancreas, Artificial kidney, Dialysis - The Nephron and Mass Transfer, Dialysis Procedure and the Dialysis System, Dialyzer Cartridge Reuse.

UNIT 3 TRANSPLANTS **9 Hrs**

Transplants types, immunological considerations, blood transfusions. Individual organs - Kidney, liver, heart, lung, bone, skin, and pancreas. Regeneration and ethical considerations

UNIT 4 TISSUE ENGINEERING **9 Hrs**

Tissue engineering - Basic principles and considerations, Bioreactor - design and applications, Biomaterials - Protein surface interaction, Protein adsorption, Engineering Biomaterials for Tissue Engineering - 10 to 100 micron size scale

UNIT 5 STEM CELLS **9 Hrs**

The Biology of Stem cells - Embryonic stem cells, adult stem cells, aging of stem cells, The importance of Stromal cells, Tissue engineering of Bone marrow

Max. 45 Hours

TEXT / REFERENCE BOOKS

1. Gerald E. Miller, Artificial organs, 1st edition, A Publication in the Morgan & Claypool Publishers series, United States of America, 2006.
2. J.B. Park and R.S. Lakes, Biomaterials: An Introduction 2nd Edition, Plenum press, New York, 1992.
3. Joseph D Bronzino, The Biomedical Engineering hand Book Vol-11, CRC press, 2000.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks:80 **Exam Duration: 3 Hrs.**

PART A : 10 questions of 2 marks each - No choice **20 Marks**

PART B: 2 questions from each unit of internal choice; each carrying 12 marks **60**

SBM1305	BIOLOGICAL CONTROL SYSTEMS	L	T	P	Credits	Total Marks
		3	1	0	4	100

COURSE OBJECTIVE

- To study physical system with mathematical and electrical analogues. To study the system efficiency and stability using time domain and frequency domain techniques to study some basic biological systems like cardiovascular, endocrine etc.,

UNIT 1 SYSTEM CONCEPTS **12 Hrs.**

Types of systems - Open loop systems, closed systems, Effects of feed back, Block diagram algebra and Signal flow graphs, Mathematical Models of Physical systems: Differential equations, Transfer functions and block diagrams of simple electrical networks, Translational and Rotational mechanical systems.

UNIT 2 TIME RESPONSE ANALYSIS OF CONTROL SYSTEMS **12 Hrs.**

Standard test signals, Time response of first order and second order systems with unit step as input, Time domain specification, steady state errors and static error constants, P, PI, PD and PID controllers, Concept of stability and Algebraic Criteria

UNIT 3 THE CONCEPT OF STABILITY & ROOT LOCUS TECHNIQUE **12 Hrs.**

The concept of stability, Routh stability criterion qualitative stability and conditional stability. the Root locus concept, construction of root loci.

UNIT 4 FREQUENCY RESPONSE ANALYSIS **12 Hrs.**

Frequency response of the systems - Correlation between time and frequency responses - Gain and phase margins, Bode plots, Polar Plots, Nyquist stability Criteria.

UNIT 5 BIOMEDICAL APPLICATIONS **12 Hrs.**

Examples of Biological control Systems: Cardiovascular Control System, Endocrine Control Systems, Pupil Control System, Skeletal Muscle Servomechanism, Oculo - motor system, sugar level Control Mechanism. Temperature control, Blood pressurecontrol.

Max. 60 Hours

TEXT / REFERENCE BOOKS

1. J.Nagrathand Gopal, Control Systems: Engineering, New Age International (P) Limited, Publishers, 5th Edition, 2008
2. Kaushia Ogata, Modern Control Engineering, 3rd Edition, Prentice Hall of India Pvt Ltd, 1998.
3. Milsum John H, Biological Control System Analysis, 2nd Edition, McGraw Hill Publications, 1996.
4. M. Gopal, Control Systems: Principles and Design, Tata McGraw-Hill publishing company Ltd, 1997.
5. N.K Sinha, Control Systems, 3rd Edition, New Age International (P) Limited Publishers, 1998.
6. Milhom T.H., Applications of Control Theory to Physiological Systems, Saunder Publications, 1980.
7. Prof. NageswaraRao, Control Systems, 3rd Edition, A.R. Publications, 2003.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 80 **Exam Duration : 3 Hrs.**

PART A: 10 questions of 2 marks each - No choice **20 Marks**

PART B : 2 questions from each unit of internal choice; each carrying 12 marks **60 Marks**