SOLAPUR UNIVERSITY, SOLAPUR

FACULTY OF ENGINEERING & TECHNOLOGY

BIO-MEDICAL ENGINEERING

Syllabus for

T.E. (Bio-medical Engineering) w.e.f. Academic Year 2018-19
Choice Based Credit System

SOLAPUR UNIVERSITY, SOLAPUR
FACULTY OF ENGINEERING & TECHNOLOGY
Bio-medical Engineering

Programme Educational Objectives and Outcomes

A. Program Educational Objectives (PEOs)

Graduate will –

1. To prepare our students for skilled and ethical service to their communities by creating a free and open learning environment that enhance their intellectual growth
2. To engage our students to work in collaborative projects, corporate and academic communities in effective manner.
3. To create innovative technologies for the improvement of health care sectors and contribute positively to the needs of society.

B. Program Outcomes

Engineering Graduate will be able to –

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

C. Program Specific Outcomes (PSOs)

1. Apply advanced science and engineering to solve the problems at the interface of engineering and healthcare.
2. Demonstrate understanding of the principles and working of the hardware and software aspects of biomedical systems.
3. Use professional and ethical practices, strategies and tactics for the development, operation and maintenance of biomedical technologies.
4. Provide effective and efficient real time solutions using acquired knowledge in various domains

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Engineering & Technology (Revised from 2016-17)

Credit System structure of T.E. Biomedical Engineering

W.E.F. 2018-19 (CBCS) - Semester I

Course Code	*Theory Course Name*	*Hrs./week*			*Credits*	*Examination Scheme*			
		L	*T*	*P*		*ISE*	*ESE*	*ICA*	*Total*
BM311	Medical Instrumentation I	4	-	-	4	30	70	-	100
BM312	Clinical Modeling & Simulation	4	-	-	4	30	70	-	100
BM313	Microprocessor & Microcontroller	4	1	-	5	30	70	-	100
BM314	Principles of Communications	4	-	-	4	30	70	-	100
BM315	Signals & Systems	4	1	-	5	30	70	25	125
SLH31	Self-Learning Course I-HSS	-	-	-	2	-	50	-	50
Sub Total		**20**	**2**	**-**	**24**	**150**	**400**	**25**	**575**
Course Code	***Laboratory Course Name***								
							ESE		
							POE	***OE***	
BM311	Medical Instrumentation - I	-	-	2	1	-	50	-	25	75
BM312	Clinical Modeling & Simulation	-	-	2	1	-	-	25	25	50
BM313	Microprocessor & Microcontroller	-	-	2	1	-	50	-	25	75
BM314	Principles of Communications	-	-	2	1	-	-	-	25	25
BM316	Hospital Training	-	-	-	2	-	-	-	50	50
Sub Total		**-**	**-**	**8**	**6**	**-**	**125**		**150**	**275**
Grand Total		**20**	**2**	**8**	**30**	**150**	**525**		**175**	**850**

Abbreviations: L- Lectures, P –Practical, T- Tutorial, **ISE**- In Semester Exam,
ESE - End Semester Exam, **ICA**- Internal Continuous Assessment,
ESE - University Examination (Theory &/ POE &/Oral examination)

SOLAPUR UNIVERSITY, SOLAPUR

Faculty of Engineering & Technology (Revised from 2016-17)

Credit System structure of T.E. Biomedical Engineering

W.E.F. 2018-19 (CBCS) - Semester II

Course Code	*Theory Course Name*	*Hrs./week*			*Credits*	*Examination Scheme*			
		L	*T*	*P*		*ISE*	*ESE*	*ICA*	*Total*
BM321	Medical Instrumentation II	4	-	-	4	30	70	-	100
BM322	Medical Signal Processing	4	-	-	4	30	70	-	100
BM323	Medical Imaging I	4	-	-	4	30	70	-	100
BM324	Feedback Control System	4	-	-	4	30	70	25	125
BM325	Embedded Systems	4	-	-	4	30	70	-	100
BM326	Self-Learning Course II- Technical	-	-	-	2	-	50	-	50
Sub Total		**20**	**-**	**-**	**22**	**150**	**400**	**25**	**575**
Course Code	*Laboratory Course Name*								
							ESE		
							POE	*OE*	
BM321	Medical Instrumentation II	-	-	2	1	-	50	-	25	75
BM322	Medical Signal Processing	-	-	2	1	-	-	-	25	25
BM323	Medical Imaging I	-	-	2	1	-	-	25	25	50
BM325	Embedded Systems	-	-	2	1	-	50	-	25	75
BM327	Mini Project	-	-	2	1	-	-	-	50	50
Sub Total		**-**	**-**	**10**	**5**	**-**	**125**		**150**	**275**
Grand Total		**20**	**-**	**10**	**27**	**150**	**525**		**175**	**850**

Abbreviations: L- Lectures, P –Practical, T- Tutorial, **ISE**- In Semester Exam,
ESE - End Semester Exam, **ICA**- Internal Continuous Assessment,
ESE - University Examination (Theory &/ POE &/Oral examination)

- **Note** –

1) Batch size for the practical /tutorial shall be of 15 students. On forming the batches, if the strength of remaining student exceeds 7, then a new batch shall be formed.

2) Hospital Training (evaluated at T.E. Part-I) of minimum 15 days shall be completed in vacation after S.E. Part-II & the report shall be submitted and evaluated in T.E. Part-I

3) Student shall select one Self Learning Course at T.E. Part I and T.E. Part II each from 'Humanities & Social Sciences (HSS) ' and 'Technical' Group respectively.

4) Curriculum for Humanities and Social Sciences Self Learning Modules is common for all under graduate programmes of faculty of Engineering and Technology

5) For TE Part I -

   A. Student can select a Self Learning Course from Solapur University, Solapur HSS Course List and appear for its examination as and when conducted by Solapur University, Solapur

   OR

   B. Student can enroll for National Programme on Technology Enhanced Learning (NPTEL) course, complete its assignments and appear for certificate examination as and when conducted by NPTEL.

   For more details about Self Learning Course (HSS) please refer to separate rule document available from Solapur University, Solapur
   More details about NPTEL are available at http://nptel.ac.in

6) Minimum four assignments for Self Learning Modules at T.E. Part I and T.E. Part II shall be submitted by the students which shall be evaluated by a Module Coordinator assigned by institute / department

7) Project group for T.E.(Bio-medical) Part II Mini Project shall not be of more than **three** student

8) Project group for B.E.(Biomedical) Part I and Part II shall not be of more than **three** students.

9) ICA assessment shall be a continuous process based on student's performance in – class tests, assignments, homework, subject seminars, quizzes, laboratory books and their interaction and attendance for theory and lab sessions as applicable

Solapur University, Solapur
T.E. (Bio-medical Engineering) Semester-I
BM311 MEDICAL INSTRUMENTATION - I

Teaching Scheme
Lectures – 4 Hours/week**,** 4 Credits
Practical – 2 Hours/week**,** 1Credits

Examination Scheme
ESE – 70 Marks
ISE -- 30 Marks
ICA – 25 Marks
POE - 50 Marks

This course provides Major emphasis on areas of biomaterials, biomechanics and Biofluid and medical equipments. The course intends the study of analysis of the blood using analyzer mechanics, bio-instrumentation.

Course Prerequisite:
The Learner should have basic knowledge of physiology and anatomy of human body. They must have knowledge of basic electrical and electronic components, transducers and sensors, basic physical theories of photometry.

Course Objectives:
1. The objective of this course is to introduce students to the of various biomedical diagnostic And the rapeutic instruments .It includes basic principles, constructions, working, technical specifications of various biomedical sensors, transducers and instrumentation and respective medical applications.
2. This course contents various pathological i.e. blood testing equipments, life supportive equipments and audiometers.

Course Outcomes:
By the end of this course the students will be able to:
1. Classify different biomedical sensors and transducers along with their principles, constructions and workings
2. Implement physical and technical specifications of various biomedical diagnostic and The raptic equipments with their applications.
3. Deliver a better technical support to the hospitals and healthcare industry.

Section I

Unit-I: Introduction of Bio analytical Equipments (11 Hrs)
Basic principle, technical specification, working and applications of Analytical and Laboratory Instruments
1.Spectrophotometer
2.Colorimeter
3. Flame photometer
4.pH meter.
5.Centrifuge
6.Electrolyte Analyzer
7.Blood cell counter(Microscopic method, Automatic optical method, Coulter counter)
8.Electrophoresis and its types

9.Chromatography and mass spectroscopy
10. Microscopes
11.ELISA concept (direct and indirect), reader & washer
12.Auto analyzer

Unit-II: Blood Gas Analyzer (05 Hrs)
Measurements of Blood pH, pCo2 pO2and complete Blood Gas analyzer.

Unit-III: Blood Flow Measurement (06 Hrs)
Electromagnetic, Ultrasonic, NMR and Laser Doppler flow metry, cardiac output measurement, impedance plethysmography

Section II

Unit-IV: Pulmonary Function Analyzer (11 Hrs)
Measurement of respiration rate: Lung volume and capacities, Displacement method, Thermistor method, Impedance pneumography. Spirometry, Pulmonary function analyzers and respiratory gas analyzers: Infrared gas analyzer, thermal conductivity analyzer, Nitrogen gas analyzer, Oximetry.

Unit-V: Ventilators and anesthesia machine (05 Hrs)
Artificial ventilation, Ventilator, Classification of ventilators. Respiratory Therapy Equipments Humidifiers, Nebulizers, Aspirators and Anesthesia machine

Unit-VI: Heart Lung machine (04 Hrs)
Working Principle, block diagram, functions, specifications, different parts, applications.

Unit-VII: Audiometers (04 Hrs)
Basic audiometer, Pure tone and Speech audiometer, evoked response audiometry, calibration of audiometers.

Internal Continuous Assessment
ICA will consist of at least Eight Experiments/Demonstrations on below list. Test and Assignments/Seminars be suitably graded by teachers and attached in the journal.

List of experiments
1.To study the digital photo colorimeter.
2. To study heart rate meter.
3. To study blood flow measurement.
4. To study oxygen saturation of blood.
5. To study audiometer.
6. To study pH meter.
7. To study respiration rate meter.
8. To study spirometer.
9. To study heart lung machine.
10. To study ELISA reader test.

Text Books:

1. Handbook of Biomedical Engineering By R.S. Khandpur (TMH Pub).
2. Handbook of Analytical Instruments By R.S. Khandpur (TMH Pub).
3. Medical Instrumentation, Application and Design By J.G. Webster.
4. Medical Electronics – A.G. Patil ,R K Jha, R Hariharan(Excel Books, New Delhi)

References:

1. Encyclopedia of medical devices and instrumentation - J.G. Webster Vol I, II, III, IV (John Willey).
2. Introduction to Biomedical Equipment Technology By Carr.-Brown (Pearson Education Pub)
3. Introduction to Biomedical Engineering – Joseph Bronzino (CRC Press)
4. Various Instruments Manuals

Solapur University, Solapur

T.E. (Bio-medical Engineering) Semester-I

BM312 BIOLOGICAL MODELING AND SIMULATION

Teaching Scheme
Lectures – 4 Hours/week, 4 Credits
Practical –2 Hours/week, 1 Credits

Examination Scheme
ESE – 70 Marks
ISE -- 30 Marks
ICA – 25 Marks
OE - 25 Marks

This course provides a thorough introduction to the fundamentals of biological systems. The course covers developing formal mathematical models of biological systems that are amenable to computational analysis. The course intends model of neurons, its working principle & Modeling the immune response.

Course Prerequisite:
The student shall have knowledge of Anatomy and Physiology of the human body. The student should know deep knowledge of mathematics.

Course Objectives:
1. To develop and design different human biology and physiology systems models which includes Neuro muscular functions, eye movements, thermoregulatory, immune and insulin glucose systems of human body.
2.Design various models based upon experimented data and analysis by testing various software simulators.

Course Outcomes:
1. Students are able to demonstrate different mathematical models of the human body system. Also, students are able to test these results by using HHSIM and MATLAB simulation software.
2.They will be able to design and formulate new human body system models with their validation and applications.

Section -I

Unit I: Physiological Modeling: **(10 Hrs)**
Step sin Modeling, Purpose of Modeling, lumped parameter models, distributed parameter models, compartmental modeling, modeling of circulatory system, regulation of cardiac output and respiratory system.

Unit II: Model of Neurons: **(13 Hrs)**
Biophysics tools, Nernst Equation, Donnan Equilibrium, Active Transport(Pump) GHK equation, Action Potential, Voltage Clamp, Channel Characteristics, Hodgkin-Huxley Conductance Equations, Simulation of action potential, Electrical Equivalent model of a biological membrane, impulse propagation- core conductor model , cable equations.

Unit III: Neuro muscular System: (06 Hrs)

Modeling of skeletal muscle, mono and polysynaptic reflexes, stretch reflex, reciprocal innervations, two control mechanism, Golgi tendon, experimental validation, Parkinson's syndrome.

Section -II

Unit IV: Eye Movement Model: (06 Hrs)

Four eye movements, quantitative eye movement models, validity criteria.

Unit V: Thermo regulatory systems: (05 Hrs)

Thermoregulatory mechanisms, model of thermo regulatory plant system, controller model, validation and application.

Unit VI:. Modeling the immune response: (06 Hrs)

Behavior of the immune system, linear zed model of the immune response., Pharmacokinetics Drug delivery, Modeling of Insulin Glucose feedback system

Internal Continuous Assessment

ICA will consist of at least Seven Laboratory Experiments/Demonstrations based on below list.

List of Experiments:

1. Simulations of Nernst equation using MATLAB / HHSIM.
2. Simulations Donnan equation using MATLAB / HHSIM.
3. To Study the effect of different drugs on nerve action potential curves using MATLAB / HHSIM.
4. To study the effect of different stimulus on action potential curves using MATLAB / HHSIM.
5. To design muscular stretch reflex model using MATLAB simulation.
6. To simulate Hodgkin's Huxley model using MATLAB / HHSIM.
7. Developing a model of neuron using MATLAB / NEURON1.1 software**.**
8. Study of Na conductance and K conduction currents on voltage clamp mechanism using MABLAB/HHSIM

Text Books:

1. Bioengineering, Biomedical, Medical and Clinical Engg. A.Teri Bahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey

Reference Books:

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

Solapur University, Solapur

T.E. (Bio-medical Engineering) Semester-I

BM313 MICROPROCESSOR AND MICROCONTROLLER

Teaching Scheme	**Examination Scheme**
Lectures – 4 Hours/week**, 4** Credits	**ESE –** 70 Marks
Practical –2 Hours/week, 1 Credits	**ISE --** 30 Marks
Tutorial -1 Hour/Week., 1 Credits	**ICA –** 25 Marks
	POE - 50 Marks

This course provides a thorough introduction to the architecture of Microprocessor 8085A microcontrollers 8051. The course also introduces assembly language programming and 'C' language programming concepts for 8051.The course enables a student to write programs addressing fundamental programming skills and also interfacing with different peripherals. The Project-based learning Case Study as a part of the syllabus.

Course Prerequisite:

A Student shall have knowledge of Number system, working principle of different digital Electronics devices like Gates, Flip/flop, Shift register, memory devices, and different peripherals. A Student should have knowledge of interfacing.

Course Objectives:

1. To develop the concepts of the architecture of microprocessor and microcontroller.
2. To develop an in-depth understanding of the operation of microprocessors and Microcontrollers, machine language programming &interfacing techniques
3. To explain the timing diagrams and machine cycle of instruction set of microprocessors and Microcontrollers
4. To make students able to design the microprocessor and microcontroller based systems.

Course Outcomes:

1. The students are able to differentiate the internal operation and organization of microprocessor and microcontroller.
2. The students will able to write programs for microprocessors/microcontrollers-based systems
3. Students are able to apply the interfacing techniques between hardware and software.

Section I

Unit I: Introduction of Microprocessors and Microcontroller: (4 Hrs.)

Introduction of Microprocessor and Microcontrollers, Comparison of Microprocessor and Microcontroller, CISC & RISC Microcontroller, Harvard and von Neumann architecture.

Unit II: Microprocessor INTEL 8085A: (12 Hrs.)
Microprocessor INTEL 8085A- Features, Functional Pin Configuration, Architecture, De-multiplexing of address & data bus, Generating different control signals, Instruction Sets, Addressing Modes, Classification, timing diagrams, Programming with Assembly language, single stepping, single cycle execution.

Unit III: Interrupts: (6 Hrs.)
Concepts of I/O Ports, Data transfer techniques; Memory mapped I/O &I/O Mapped I/O Schemes, Serial I/O lines of 8085 and the implementation asynchronous serial data communication using SID and SOD lines. Basic concepts, Classification-Hardware & Software Interrupts, Interrupt Structure of 8085, and Instructions related to interrupts.

Section- II

Unit IV: 8051 Microcontroller Architecture: (12 Hrs.)
8051 Microcontroller Hardware, , Memory organization, External Memory interfacing, Addressing modes, Instruction set, ,Input / Output Pins, External Memory, Counters and Timers, Serial Data Input/ output, interrupts and timer/counter of 8051. 8051 programming: Assembler directives, Assembly language programs and Time delay calculations.

Unit V: 8051 Serial Communication: (6 Hrs.)
Data communication, Basics of Serial Data Communication, 8051 Serial Communication, connections to RS-232, Serial communication Programming in assembly.

Unit VI: 8051 Interfacing and Applications: (8 Hrs.)
Basics of I/O concepts, I/O Port Operation, Interfacing 8051 to LCD, Relay, Buzzer, Keyboard, parallel and serial ADC, DAC, Stepper motor interfacing and DC motor interfacing and programming
Project Based Learning Case Study: Heartbeat Sensor Circuit and Working Operation with 8051 Features, Primary Applications and working of a heartbeat sensor. Digital Heartbeat Monitor Using Microcontroller.

Text Books:
1. The 8051 Microcontroller Architecture, programming and Applications by **Kenneth Ayala Penram** International (Third Edition)
2. The 8051 Microcontroller and Embedded systems by **Muhammad Ali Mazidi** Pearson Education Asia LPE (Second Edition)
3. Microprocessor Architecture, Programming and Applications with 8085A-**Ramesh Gaonkar- Wiley Eastern** Ltd. New Delhi

Reference Books:
1. 8051 Microcontrollers programming and practice by Mike Predcko.
2. 8051 Microcontroller by I Stott, Mackenzie, Rathel & Phan – Fourth Edition - Pearson
3. INTEL- Microprocessor Peripheral hand book, application notes, Manual
4. Fundamentals of Microprocessor and Microcomputer –B Ram-Dhanpat Rai Publication
5. Microprocessor and Peripherals-S.P.Choudhary,Sunita Choudhary-Scitech Publication
6. Microprocessor Architecture, Programming and System featuring 8085-William A.Raut-Cengage Learning Publication

Internal Continuous Assessment
ICA will consist of at least ten Laboratory Experiments/Demonstrations based list.

List of Experiments :(minimum 10 experiments)

1. Programs based on different addressing modes.
2. Programs based on logical operations
3. Programs based on addition & subtraction (8bit and 16 bit)
4. Programs based on multiplication & division (8bit and 16 bit)
5. Programs based on Block transfer and block exchange of data bytes
6. Finding the smallest and the largest element in a block of data
7. Arranging the elements of a block of data in ascending and descending order.
8. Interfacing of DAC 0808
9. Interfacing of ADC 0809
10. Interfacing of stepper motor
11. Interfacing of LCD display
12. Interfacing Digital Heartbeat sensor Using Microcontroller.

Solapur University, Solapur

T.E. (Bio-medical Engineering) Semester-I

BM314 PRINCIPLES OF COMMUNICATIONS

Teaching Scheme	**Examination Scheme**
Lectures – 4 Hours/week**,** 4 Credits	**ESE –** 70 Marks
Practical –2 Hours/week, 1 Credits	**ISE --** 30 Marks
	ICA – 25 Marks

This course provides a thorough introduction to the basic principles and techniques used in analog and digital communications. The course intends to cover various analog and digital modulation & demodulation techniques at block diagram levels and few at circuit level. The course also introduces analytical techniques to evaluate the performance of communication systems. Basics of information theory along with channel coding techniques and Bio-Telemetry systems to be covered.

Course Prerequisite:

A Student shall have knowledge of Signal and System, Noise and types of noise. Student should have knowledge of different mathematical transform such as Fourier series, Fourier Transform, and Laplace Transform.

Course Objectives:

1)Students are able to describe and analyze the mathematical techniques of generation, transmission and reception of amplitude modulation (AM), frequency modulation (FM) and phase modulation (PM) signals.
2)To understand and analyze the signal flow in a digital communication system.
3)To analyze error performance of a digital communication system in presence of noise and other interferences.

Course Outcomes:

1)Understand and identify the fundamental concepts and various components of analog communication systems.
2) Perform the time and frequency domain analysis of the signals in a communication system.
3)Students are able to apply communication techniques for various biomedical application such as telemetry system, Telemedicine etc.

Section -I

Unit I:.Introduction (6 Hrs.)

Block schematic of communication system, base band signals, RF bands, Necessity of modulation, types of modulation – AM, FM, PM and Pulse Modulation. Noise types, signal to noise ratio, noise factor, Noise figure, noise temperature. Introduction to radio wave propagation, ground wave, space wave and sky wave.

Unit II: Amplitude Modulation (10 Hrs.)

Amplitude Modulation principles, Time domain description, Frequency domain description Generation of AM wave: Square law modulator, switching modulator. Detection of AM wave: Square law detector and envelope detector (Numerical expected). Double side band suppressed Carrier modulation (DSBSC): Generation of DSBSC waves: balanced modulator, ring modulator, Coherent detection of DSBSC modulated waves, Frequency-Domain description of SSB modulated signals, Phase discrimination method for generating an SSB modulated wave. Demodulation of SSB wave. Vestigial side band modulation, of VSB modulated wave, Envelop detection of VSB wave. Comparison of modulation techniques.

Unit III: Angle Modulation (8 Hrs.)

Basic definitions, frequency modulation, narrow band frequency modulation, wide band frequency modulation, transmission band width of FM waves, and generation of FM Waves: indirect FM and direct FM Pre-emphasis and de-emphasis. Phase modulation, Time & frequency domain representation, Introduction to Phase-Locked Loop(PLL), Demodulation of PM using PLL.

Section-II

Unit IV: Pulse Modulation (7 Hrs.)

Concept of Sampling theorem & type: Natural & flat top, Pulse Amplitude Modulation(PAM), Pulse Code Modulation(PCM), delta modulation and adaptive delta modulation, Crosstalk in TDM, PWM modulator, PPM modulators,

Unit V: Digital Modulation Techniques and data formats (6 Hrs.)

Unipolar,Bipolar,RZ,NRZ,TransmissionmodesASK,FSK,PSK-coherent,Non-coherent, BPSK, DPSK, QAM. Comparison, Concept of multiplexing, TDM and FDM Transmitter and receiver.

Unit VI: Coding (5 Hrs.)

Channel Coding-Types of Errors & codes, linear block codes, error detection & correction, Hamming codes, Look-up table decoding, Binary Cyclic codes, Convolution codes, Encoders, Decoders, Code tree.

Unit VII: Bio-Telemetry System (6 Hrs.)

Components of telemetry system, Bio-telemetry and its importance, Single and multi-channel biotelemetry, ECG telemetry system, Telemetry of ECG and Respiration, Multi-patient telemetry, Ambulatory patient monitoring, Implantable telemetry systems, transmission of physiological signals over telephone line.

Text Books:

1) Communication System, Analog and Digital R.P. Singh and S.D. Spare (THM)
2) Electronic Telecommunication System(4th Edition George Kennedy and Bernard Devise MGH)
3) Louis E. Frenzel 'Principles of Electronic Communication System'- IIIrd edition - Tata McGraw Hill Publication
4) K. Sam Shanmugam – Digital &Analog Communication (JohnWiley)
5) Handbook of Biomedical Instrumentation - by R.S.Khandpur, 2 Edition, Tata McGraw Hill, 2003

Reference Books:

1. Introduction to Analog and Digital Communication Simon Haykin
2. Principle of Digital Communication Das, Mullik, Chattergy
3. Digital Communication Sirnon Haykin
4. Principles of communication Taub & Schilling (MGH)
5. Digital Communication Ch.kranthiRekha (Scitech

Internal Continuous Assessment

ICA will consist of at least Eight Laboratory Experiments/Demonstrations based on below list.

Experiment List:

1. Study of Amplitude Modulation.
2. Study of Frequency Modulation.
3. Study of Pulse Amplitude Modulation.
4. Study of Pulse Width Modulation.
5. Study of Pulse Position Modulation.
6. Study of Pulse Amplitude Modulation.-TDM
7. Study of Pulse Code Modulation - TDM.
8. Study of ASK Modulation.
9. Study of FSK Modulation.
10. Study of PSK Modulation.

Solapur University, Solapur

T.E. (Bio-medical Engineering) Semester-I

BM315 SIGNALS AND SYSTEMS

Teaching Scheme
Lectures – 4 Hours/week**,** 4 Credits
Tutorial – 1 Hours/week, 1 Credits

Examination Scheme
ESE – 70 Marks
ISE -- 30 Marks
ICA – 25 Marks

This course provides fundamentals & types of signal & systems. The course covers analysis of linear time-invariant systems, continuous signal Laplace and Fourier transform and discrete signal Z-transform. The course intends the stability criteria in Z-transform & Laplace Transform of the discrete and continuous signals respectively.

Course Prerequisite:
A Student shall have knowledge of analog and digital signals. A Student should have basic knowledge of different mathematical transform such as Fourier series, Fourier Transform, and Laplace Transform and Z-transform.

Course Objectives:
1. To understand the mathematical description of continuous and discrete time signals and systems.
2. To classify signals into different categories.
3. To analyse Linear Time Invariant (LTI) systems in time and transform domains.
4. To build basics for understanding of courses such as signal processing, control system and communication.

Course Outcomes:
1. Understand mathematical description and representation of continuous and discrete time signals and systems.
2. Develop input output relationship for linear shift invariant system and understand the convolution operator for continuous and discrete time system.
3. Understand and resolve the signals in frequency domain using Fourier series and Fourier transforms.
4. Apply different transformation as Laplace, Fourier and Z-transform and develop the ability to analyze the system.

Section-I

Unit- 1. Introduction to Signals & Systems: (8 Hrs.)

Classification of Signals: Definition of signal and systems, communication and control systems as examples. Sampling of analog signals, sampling theorem, Continuous time and discrete time signal, Classification of signals as even, odd, periodic and non-periodic, deterministic and non-deterministic, energy and power.

Operations on signals: Amplitude scaling, addition, multiplication, differentiation, integration (Accumulator for DT), time scaling, time shifting and time folding.

Systems: Definition, Classification: linear and non-linear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.

Unit - 2. Linear Time-Invariant Systems: (10 Hrs.)

System modeling: Input-output relation, definition of impulse response, convolution sum, convolution integral, computation of convolution integral using graphical method for unit step to unit step, unit step to exponential, exponential to exponential, unit step to rectangular and rectangular to rectangular only. Computation of convolution sum. Properties of convolution. System interconnection, system properties in terms of impulse response, step response in terms of impulse response.

Unit - 3. Laplace transform and its applications : (6 Hrs.)

Definition of Laplace Transform (LT), Limitations of Fourier transform and need of Laplace transform, ROC, Laplace transform of standard periodic and aperiodic functions, properties of Laplace transform and their significance, Laplace transform evaluation using properties, Inverse Laplace transform based on partial fraction expansion, stability considerations in S domain, Application of Laplace transforms to the LTI system analysis.

Section-II

Unit - 4. Fourier analysis for Continuous Time & Discrete Time: (10 Hrs.)

Fourier series (FS) representation of periodic Continuous Time (CT) signals, Dirichlet condition for existence of Fourier series, orthogonality, basis functions, Amplitude and phase response, FS representation of CT signals using trigonometric and exponential Fourier series. Applications of Fourier series, properties of Fourier series and their physical significance, Gibbs phenomenon, Discrete Time Fourier Series, properties, convergence of DTFS.

Unit - 5. Fourier Transform: (8 Hrs.)

Fourier Transform (FT) representation of aperiodic CT signals, Dirichlet condition for existence of Fourier transform, evaluation of magnitude and phase response, FT of standard CT signals, FT of standard periodic CT signals, Properties and their significance, Interplay between time and frequency domain using sinc and rectangular signals, Fourier Transform for periodic signals, introduction to Discrete Time Fourier Transform.

Unit - 6.Z transform: (6 Hrs.)

Introduction, need of Z-transform, ROC, properties of ROC, Unilateral Z-transform, properties of Z Transform:linearity,timeshifting,timereversal,timescaling,convolution,differentiation, Multiplication, Parsevals theorem, Inverse Z-transform: PFE Method, long division method, residue method, convolution method. Transfer function(Poles &Zeros), stability and causality of system in Z transform

Text Books:

1. Simon Haykin, Barry Van Veen- 'Signals& system' - IInd Edition Wiley publication
2. Charles Phillips, "Signals, Systems and Transforms", 3rd Edition, Pearson Education.

Reference Books :

1. Ramesh Babu 'Signals & system', SciTech Publication.
2. Michael J. Roberts. -'Fundamentals of signals & systems'- Tata McGraw Hill, 2007.
3. Alan V. Oppenheim, Alan S. Wilsky, S. Hamid Nawab -'Signals & system' -IInd Edition - Pearson Education.
4. A. Nagoor Kanni "Signals and Systems", 2nd edition, Mc Graw Hill.
5. Smarajit Ghosh, 'Signals & system' Pearson Education.
6. NPTEL video lectures on Signals and Systems.

Internal Continuous Assessment

ICA will consist of at least eight Assignments on given List of Tutorials.

Guidelines for Tutorial / ICA Assessment

Tutorials must be conducted batch wise. Batch size should not be more than 20 students. The main objective of this tutorial is to focus on the outcomes defined in the theory syllabus by solving the following assignments based on paper work.

List of Tutorials

1 A) Sketch and write mathematical expression for the following signals in CT and Discrete Time (DT)
   a) Sine
   b) Rectangular
   c) Triangular
   d) Exponential
   e) Unit Impulse
   f) Unit Step
   g) Ramp
   h) Signum
   i) Sinc

1B) Classify and find the respective value for the above signals
   a) Periodic / Non Periodic
   b) Energy / Power /Neither

2. Take any two CT and DT signals and perform the following operation Amplitude scaling, addition, multiplication, differentiation, integration (accumulator for DT), time scaling, and time shifting and folding.

3. Express any two system mathematical expressions in input output relation form and determine whether each one of them is, Memory less, Causal, Linear, Stable, Time invariant, Invertible.

4. Express any two system mathematical expressions in impulse response form and Determine whether each one of them is, Memory less, Causal, Linear, Stable, Time in variant, Invertible.

5. Perform Convolution Integral of Two Continuous time Signals.
   (Various Combinations can be taken for this.)

6. To find Fourier series for the signals and plot its magnitude and phase response.
   (Signals like: Half/Full wave rectified signal, Saw tooth wave etc.)

7. State and prove the various properties of CT Fourier Transform. Take rectangular and sinc Signal as examples and demonstrate the applications of CTFT properties. And also demonstrate the interplay between the time and frequency domain.

8. State and prove the properties of CT Laplace Transform. Take any example of a system in time domain and demonstrate the application of LT in system analysis.

9. State and prove the properties of Z-Transform. Make the solution of at least five examples using properties and make the caparison of Fourier, Laplace & Z-Transforms.

Solapur University, Solapur
T.E. (Bio-medical Engineering) Semester-I
BM316 HOSPITAL TRAINING

Teaching Scheme
2 Credits

Examination Scheme
ICA – 50 Marks

Course Objectives:
Students will gain the information of either one of the department (Radiology, Pathology, Physiotherapy, Biomedical, etc.) of the hospital.

Course Outcome

The hospital training must be done at least for one week or 15 days, as convenient. During this training period, students must complete study of one department according to their choice. Students must gain the information of particular department such as location, need, clinical importance, etc. Also, they will acquire knowledge related to functioning, maintenance & servicing of equipments used in the department.

Training should consist of knowledge about either one of the following departments such as

- Radiology
- Pathology
- Physiotherapy
- Biomedical
- Or any other departments such as OPDs, IPDs, etc.

Note:

1. Students are supposed to submit a report regarding their detailed study of one of the above-mentioned department.
2. Student should deliver a seminar.

Internal Continuous Assessment
ICA will be based on hospital training, report and seminar.

Solapur University, Solapur
T.E. (Bio-medical Engineering) Semester-II
BM321 MEDICAL INSTRUMENTATION-II

Teaching Scheme
Lectures – 4 Hours/week**, 4** Credits
Practical – 2 Hours/week, 1 Credits

Examination Scheme
ESE – 70 Marks
ISE -- 30 Marks
ICA – 25 Marks
POE- 50 Marks

This course provides information about bioelectric potentials and biophysical systems. The course covers Biophysical signal capturing, processing & measurement, patient monitoring systems and telemedicine concepts.

Course Prerequisite:
Students should have prior knowledge of Human Anatomy & Physiology. They should be familiar with basics of OP07.

Course Objectives:

1. The objective of this course is to study the generation of human body's cell potential, their recording techniques, and medical application.
2. This course includes the study of different diagnostic equipments along with their principles, types, workings, designing, technical specifications.

Course Outcomes:

1. After studying this course, students will able to design various biomedical instruments that include signal recording machines, monitoring equipment and their respective medical applications.
2. Students will able to design telemetry system & use this for telemedicine application.
3. Also, students will practice safety precautions while developing biomedical equipment.

Section I

Unit I: Generation of Bioelectric Potentials (04 Hrs.)
Resting potential and action potential of Nerve, Muscle & Cardiac muscle

Unit II: Biophysical Recording systems (06 Hrs.)
Typical medical recording system and General design consideration, Instrumentation Amplifier, Notch Filter, Sources of noise in low level recording circuits.

Unit III: Biophysical signal capture & their processing (12 Hrs.)

ECG –Lead systems, Block diagram of ECG machine,EEG–10-20 system, Block Diagram of EEG Machine, Evoked Potential, EMG, EOG, ERG, Phonocardiography, Vector Cardio graph, and Skin Resistance Measurement.

Unit IV: Electrical Safety in Biophysical Measurements (2 Hrs.)

Safety hazards, leakage current, protection & precautions

Section II

Unit V: Patient Monitoring System (6 Hrs.)

Measurement of Heart Rate, Pulse rate, Blood pressure, Temperature, Respiration rate.

Unit VI: .Arrhythmia and Ambulatory Monitoring Instruments (6 Hrs.)

Cardiac Arrhythmias, QRS Detection Techniques, Ambulatory monitoring instruments.

Unit VII: Fetal and Neonatal Monitoring System (6 Hrs.)

Cardiotocograph, Methods of monitoring of Fetal Heart rate and labor activity, Fetal scalp PH measurement, Baby Incubator and Infant warmer.

Unit VIII: Biotelemetry, Telemedicine concepts and its application (6 Hrs.)

Working principle, block diagram, Lab on chip for biomedical applications, MEMS for biomedical applications , Modern fitness trackers/bands

Internal Continuous Assessment

ICA will consist of at least ten Laboratory Experiments based on List of Practicals.

List of Practicals:

1. To design of notch filter using OP07.
2. To designing ECG Band pass filter using OP07.
3. To designing EMG Band pass filter using OP07.
4. To design instrumentation amplifier using OP07.
5. To design Precision Full wave rectifier using OP07.
6. To design peak detector using OP07.
7. To design square wave generator using OP07.
8. To study ECG Machine
9. To study EMG Machine
10. To study EEG Machine
11. To study Heart Rate Meter
12. To study Phonocardiography
13. Study experiment on available kits.

Text Books:

1. Handbook of Biomedical Engineering By R.S. Khandpur, PHI
2. Medical Instrumentation, Application and Design By J.G. Webster, TMH.
3. Introduction to Biomedical Equipment Technology By Carr.-Brown (Pearson Education Pub)
4. Introduction to Biomedical engineering by J Bronzino

References Books:

1. Encyclopedia of medical devices and instrumentation - J.G. Webster Vol I, II, III, IV (John Willey).
2.Various Instruments Manuals.
3. Principles of applied Biomedical Instrumentation by Geddes and Becker, Wiley inter Science publication.
4 Principles of Biomedical Instrumentation and Measurement by Richard Aston

Solapur University, Solapur
T.E. (Bio-medical Engineering) Semester-II
BM322 MEDICAL SIGNAL PROCESSING

Teaching Scheme
Lectures – 4 Hours/week**, 4** Credits
Practical – 2 Hours/week, 1 Credits

Examination Scheme
ESE – 70 Marks
ISE -- 30 Marks
ICA – 25 Marks

This course provides a study of Discrete Fourier transform. The course covers Fast Fourier transform, FIR & IIR filter design and applications. The course intends the study of analog & digital transformation in filter design.

Course Prerequisite:
The student shall have pre-acquainted knowledge of signals & systems and know the different types of analog and digital filter operations & their design process.

Course Objectives:
1. To introduce students to transforms for analysis of discrete time signals and systems.
2. To understand the digital signal processing, sampling, and aliasing.
3. To use and understand the implementation of digital filters.

Course Outcomes:
1. Analyze the discrete time signals and system using different transform domain techniques.
2. Design and implement LTI filters for filtering different real-world signals.
3. Develop different signal processing applications using DSP processor.

Section-I

Unit I: The Discrete Fourier Transform **10Hrs.**
DT signals, Sampling, sampling theorem in frequency domain, sampling of analog signals, recovery of analog signals, Discrete Fourier Transform(DFT), DFT as a linear Transformation, Relation between DFT to other Transforms. Properties of DFT: Circular convolution, Circular correlation, Linear Filtering methods based on DFT, Fast convolution techniques Overlap add & overlap save, Frequency analysis of signals using DFT

Unit II: Fast Fourier Transform **8Hrs**
FFT Algorithm, Radix -2 Decimation in Time-DIT- FFT & Decimation in Frequency DIF- FFT, IFFT, Applications of FFT Algorithms, Efficient computation of the DFT of Two Real Sequences, Efficient Computations of a 2N point Real sequence. Use of FFT in Linear Filtering and Correlation, Discrete Cosine Transform, Forward DCT, Inverse DCT, DCT as an Orthogonal Transform.

Unit III:. Realization of Digital Linear systems 6Hrs.

Structures for realization of discrete time systems, Structures for FIR Filters: Direct form, cascade form, Parallel form & Lattice Structure,
Structures for IIR filters: Direct form , cascade form, parallel form structures

Section II

Unit IV: FIR Filter design 08 Hrs.

Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and comparison of different window functions, Design of linear phase FIR filter using windows and frequency sampling method. Magnitude and Phase response of Digital filters, Frequency response of Linear phase FIR filters, Finite word length effect in FIR filter design.

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Unit V: IIR Filter design 08 Hrs.

Concept of analog filter design, IIR filter design by impulse invariance method, Bilinear transformation method, warping effect. Butterworth filter design, Characteristics of Butterworth filters, Comparison of Butterworth, Chebyshev and elliptic filters, Finite word length effect in IIR filter design

Unit VI: Adaptive Filters & DSP Applications: 08 Hrs.

System Identification or System Modeling, Adaptive channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelling, Adaptive Direct Form FIR Filters-LMS algorithm
DSP applications such as in ECG: P-wave detection, QRS complex detection, Correlation analysis of ECG signals, Analysis of Heart Rate variability, Analysis of PCG signal, Analysis of EMG signal.

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Internal Continuous Assessment

ICA will consist of at least ten Laboratory Experiments based on List of Experiments.

List of Experiments

Experiments may be performed using Matlab/DSP simulator/DSP Starter kit

1. Generation of all basic DT signals
2. Computation of DFT & IDFT using basic formula
3. To Compute the DCT & IDCT of ECG signal
4. Computation of circular convolution.
5. Design Realization of FIR/IIR Filter
6. Design of FIR filter using Windows Techniques
7. Design of FIR filter using frequency sampling method
8. Design of IIR filter using impulse invariance method
9. Design of IIR filter using bilinear transformation method
10. To detect QRS complex and measure the heart rate of a given ECG signal
11. Write a program to obtain Adaptive noise cancelling
12. Write the program to obtain Analysis of EMG Signal

Text books:

1. Digital Signal Processing – Principles, Algorithms and Applications by John G Proakis - Pearson Education.

2. Digital Signal Processing by S Salivahanan, AVallavaraj& C Gnanapriya -TMH

Reference Books:

1. ”Biomedical digital signal processing” by Tomkins, PHI publication
2. Digital Signal Processing – A Practical Approach by Ifeachor E.C. & Jervis B. W. – Pearson Education.
3. Fundamental of DSP using Matlab by Schilling-Cengage learning
4. Digital Signal Processing by Ramesh Babu - Scientic Publication
5. Discrete time signal Processing by A.V. Oppenheim& R.W. Schalfer.- John Wiley
6. Digital Signal Processing – A System Design approach by D.J. Defata- John Wiley
7. Digital Signal Processing Fundamentals Applications by Li Tan- Academic Press
8. Digital Signal Processing by M.H.Hayes.-(Schaums Outline) TMH
9. Rangaraj M Rangayyan, "Biomedical signal processing", IEEE press, first edition, 2002.

Solapur University, Solapur

T.E. (Bio-medical Engineering) Semester-II

BM323 MEDICAL IMAGING- I

Teaching Scheme
Lectures – 4 Hours/week, 4 Credits
Practical – 2 Hours/week, 1 Credits

Examination Scheme
ESE – 70 Marks
ISE -- 30 Marks
ICA – 25 Marks
OE- 25 Marks

This course provides introduction ultrasound systems in medicine and X-ray imaging. The course covers Radiography, CT-scan, Angiography, Mammography, Thermography, and Endoscopy.

Course Prerequisite:
Students should have prior knowledge of Human Anatomy & Physiology. They should be familiar with the electromagnetic spectrum. The knowledge

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Course Objectives:

1) To study the fundamentals of major medical imaging modalities, namely, X-ray, digital radiography, ultrasound, endoscopy, and thermography.
2) To Demonstrate knowledge, clinical &technical skills and decision-making capabilities with respect to diagnostic imaging pertinent of the practice of General Surgery
3) To explain the role of the radiologist as a member of an inter-professional health care team.

Course Outcomes:

1) To analyze the influence of image quality on diagnostic impact and patient management
2) To design equipments based on the principles, techniques, and different elements of the diagnostic process
3) To plan the imaging techniques with minimum risks.
4) To define the advantages and limitations and applications of various modalities

Section I

Unit I: Ultrasound in Medicine (10 Hrs.)

Introduction, Production and Characteristics of Ultrasound. Display System: A-mode, B-mode and M-mode display and applications. Ultrasound transducers and instrumentation. Real-Time Ultrasound, Continuous wave and Pulsed wave Doppler Ultrasound systems, Color flow imaging, applications. Ultrasound contrast agents and applications.

Unit II: X-ray Imaging (12 Hrs.)
Properties of X-rays, Production of X-rays, X-ray interaction with Matter, Parts of X-ray machine: X-ray tubes, Rating of X-ray tubes, X-ray generators, X-ray Image and Beam Limiting Devices, Controls, X-ray Film development technique. Types of X-Ray Films Single Coated, Dualities, Transmission of X-Rays through Body Tissues: Relative amount of Scattered Radiation in an X-Ray Beam during its passage through a Patient.

Unit III: Fluoroscopy Imaging and X-ray Image intensifier, Gain and Conversion Efficiency of Image Intensifier, Dual and Triple Field Intensifier, Digital Fluoroscopy. (**05 Hrs.)**

Section II

Unit IV: Computed Radiography and Digital Radiography, CT generations, Detectors for CT Scanning-Gas filled Ionization chamber and Solid state Detectors, (**06 Hrs.)**

Unit V: Angiography techniques & its applications (**03 Hrs.)**

Unit VI: Mammography, Principle, Equipment, Digital Mammography (**03 Hrs.)**

Unit VII: Medical Thermography: Physics of thermography, thermographic equipment, applications **(03Hrs.)**

Unit VIII: Endoscopy: Basic components of Endoscope, Imaging and its application (**04Hrs.)**

Internal Continuous Assessment
ICA will consist of at least eight tutorials based on above Syllabus.

Tutorials:
Minimum eight tutorials based on above syllabus.

Text Books:
1. Christensen's Physics of Diagnostic Radiology (Lippincott William and Wilkins Publication)
2. Medical Imaging Physics William R. Hendee (Wiley-Liss Publication)

References Books:
1. Biomedical Technology and Devices Handbook by James Moore George Zouridakis (CRC Press)
2. Biomedical Engineering Handbook by Bronzino (CRC Press)
3. Physics of Diagnostic Imaging –Dowsett

Solapur University, Solapur

T.E. (Bio-medical Engineering) Semester-II

BM324 FEEDBACK CONTROL SYSTEM

Teaching Scheme
Lectures – 4 Hours/week, 4 Credits

Examination Scheme
ESE – 70 Marks
ISE -- 30 Marks
ICA – 25 Marks

This course provides a thorough introduction to the fundamentals of control systems. The course covers transfer function and mathematical modeling of electrical systems. The course intends the study of stability analysis of the closed loop systems using various mathematical and graphical methods along with necessary compensation techniques to evaluate the performance of electrical systems. Analysis of the linear time invariant single input & single output control system in time domain and frequency domain is included.

Course Prerequisite:
Student shall have knowledge of working principle of open loop system and feedback system. Need basic knowledge of Integration and differentiation. Student should know the different mathematical transformation like Laplace transform for the analysis of the control systems.

Course Objectives:
1. To describe fundamental concepts of Control systems and its types
2. To represent and mathematical modeling of the physical system with its transfer function
3. To understand the concept of time response and frequency response
4. To learn the methods for analyzing the behavior of control systems
5. To learn the stability analysis of control system by Root locus and Bode plot

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Course Outcomes:
Student will be able to:
1. Identify the type of the system
2. Represent the mathematical model of a system and obtain its transfer function
3. Determine the response of different systems for various inputs
4. Analyze the stability of the system in time domain and frequency domain
5. Represent the system in state variable of electrical system

Section I

UNIT -1. Introduction of Control system: 6Hrs
Introduction to Control Systems - terms related to control system, Types of Control Systems – Open loop system with examples and closed loop system with examples, comparison of open loop and closed loop system, Effect of Feedback Systems.

UNIT -2. Mathematical modeling of the system: 5Hrs
Differential equation of Physical Systems -Mechanical systems, Translational systems Rotational systems, Gear trains, Electrical systems, Analogous systems,

UNIT- 3: Time Response of feedback control systems: 8Hrs
Standard test signals, Unit step response of First and second order systems, Time response specifications, Time response specifications of second order systems, steady – state errors and error constants, Introduction to PID Controllers.

UNIT- 4: Block diagrams and signal flow graphs 5Hrs.
Transfer functions, Block diagram algebra and Signal Flow graphs, Masosn's Gain Formula.

Section II

UNIT- 5: Stability analysis: 5Hrs
Concepts of stability, Necessary conditions for Stability, Routh- stability criterion, Relative stability analysis, numerical on Routh Hurwitz and Routh stability criterion.

UNIT- 6: Control system components: 5Hrs
Introduction to servomotors, types of servomotors – AC and DC servomotors, stepper motor, Tacho generators (Tachometers) – AC and DC tachometer

UNIT- 7: Root–Locus and Bode plot Techniques 10Hrs
Introduction, The root locus concepts, Construction of root loci, Introduction to bode plot, Steps to sketch the bode plot.

UNIT- 8: Introduction to State variable analysis: 4Hrs
Concepts of state, state variable and state models for electrical systems, Solution of state equations.

Internal Continuous Assessment (ICA):
ICA shall consist of minimum eight assignments based on entire curriculum

TEXT BOOK:

1. "Control Systems Engineering", I. J. Nagrath and M.Gopal, New Age International(P) Limited, Fourth edition – 2005
2. "Principles of Control system" by S.C. Goyal & U.A. Bakshi, Technical Publications, Pune
3. "Control System Engineering" by R Ananda natrajan, P Ramesh Babu, 2nd Edition, Scitech Publications

REFERENCE BOOKS:

1. **"Modern Control Engineering ",** K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002
2. **"Automatic Control Systems",** Benjamin C. Kuo and FaridGolnaagi, Wiley Studnt 8th Edition, 2009
3. **"Feedback and Control System",** Joseph J Distefano III et al., Schaum's Outlines, TMH, 2nd Edition 2007

Solapur University, Solapur
T.E. (Bio-medical Engineering) Semester-II
BM325 EMBEDDED SYSTEMS

Teaching Scheme
Lectures – 4 Hours/week, 4 Credits
Practical: - 2 Hours/week 1 Credit

Examination Scheme
ESE – 70 Marks
ISE -- 30 Marks
ICA – 25 Marks
POE- 50 Marks

This course provides a thorough introduction to the architecture of ARM7TDMI core and microcontroller LPC2148. The course also introduces assembly and C programming for LPC2148 microcontroller and enables student to write programs addressing high level programming skills and also interfacing with different peripherals. The real time operating system concepts are also introduced.

Course Prerequisite:
A student should have knowledge of microprocessor and microcontroller, CPU's Flow Management with the help of PC, Different Memory Pointers Like PC, SP, HL etc. A student should have knowledge of interfacing techniques and work of different peripherals. Students also should know assembly programming and C language programming for Previous learned Microcontrollers/Processors

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Course Objectives:
1) To study the concept of microcontroller designing and programming.
2) To give knowledge about the ARM core architecture.
3) To study the Microcontroller LPC2148 and its On-Chip Modules
4)To study the interfacing of input & output devices.
5) To give knowledge about the Real time operating system.

Course Outcomes:
1)Knowledge of Relation of Core and Microcontroller Concept ,internal organization of ARM 7 Core , LPC2148 Microcontroller
2) Knowledge of hardware and software interaction and integration
3) Gaining of Embedded System's Design and Development skills, programming skills

Section-I

Unit I: Embedded System Introduction: 10Hrs.
Introduction to Embedded System, History, Classification of embedded systems, Skill required for embedded system, Various design metrics for Embedded System, Design Metric *Time to market*-in Detail, Design challenges(Optimizing Design Metrics), applications of embedded systems and recent trends in embedded systems, embedded design and Testing, Communication protocols in general -SPI,SCI,I2C,CAN

Unit II: System Architecture: **8Hrs**

Introduction to ARM core architecture and its Characteristics, **ARM** extension family, registers, modes of operation: operating and exceptional modes, barrel shifter, CPSR, Bus architecture, pipeline architecture, **LPC 2148,** study of on-chip Modules - I/O ports, timers, VIC & interrupts, ADC,DAC,RTC,PLL, PWM,UART

Unit III: Instruction Set: **8Hrs.**

ARM instruction set: Conditional execution of Instruction, Types of instruction set, Data Processing instructions, Concept of Shifter Oprand, branch instructions, load- store instructions-Single & Multiple, software interrupt instruction, program status register instructions, loading constants, Assembly language Programming

THUMB instruction set: THUMB register usage, ARM-THUMB interworking, types of instruction set, Data Processing instructions, branch instructions, load- store instructions, software interrupt instruction

Section-II

Unit IV: Memory Selection for Embedded System: **4Hrs.**

Memory devices, Memory selection for an embedded system, Concept of Memory map of a system, Allocation of Memory to program segments and block, Concept of Direct Memory access (DMA).

Unit V: Interfacing and Programming: **10Hrs.**

Basic embedded C programs for on-chip peripherals studied in system architecture. Interfacing and C programs of Relay, LED, 7-segment, LCD, ADC, UART, I2C, switch, 4 x 4 matrix key pad, stepper motor, DC motor and RF sensors connections.

Unit VI: Real Time Operating System Concept: **8Hrs.**

Need of OS in Embedded System, Architecture of kernel, task scheduler, ISR, Semaphores, mailbox, message queues, pipes, timers, memory management, RTOS services in contrast with traditional OS, Introduction to µCOS-II RTOS

Text Books :

1.EmbeddedSystems,-Architecture,Programming and Design, Raj Kamal-TMH

2.Embeddedsystemssoftwareprimer,DavidSimon–Pearson

3.ARMSystem-on-ChipArchitecture,SteveFurber–Pearson

4. ARM System Developer's guide , Andrew N. Sloss, Dominic Symes, Chris Wright

5.JeanJLabrosse – MicroC/ OS-II, Indian Low Price Edition

6.DR.K.V.K.K.Prasad-Embedded/ real time system, Dreamtech

7.LPC214x User Manual By Philips-Datasheet

8. ARM Architecture Reference Manual by ARM

Reference Books :

1.Sriram Iyer and Pankaj Gupta- Embedded real time systems Programming, TMH
2. Embedded Microcomputer Systems – Real time Interfacing – Valvano
3.SteveHeath-EmbeddedSystemDesign,Neuwans
4.FrankVahid - Embedded Systems , Wiley India
5. Peckol - Embedded Systems , Wiley India

Internal Continuous Assessment

ICA will consist of at least Nine Experiments as per List of Experiments.

List of Experiments:

1) Arithmetic and logical operation ARM assembly language programs on Keil IDE
2) C-Program for Relay, LEDs, Switch-LED Interface
3) C-Program to explore timers / counter
4) C-Program to interface LCD
5) C-Program to interface 4X4 Keyboard and display key pressed on LCD
6) C-Program to interface Stepper Motor.
7) C-programs for Interrupts
8) C-Program to demonstrate UART operation
9) C-Program to demonstrate I2C Protocol.
10) C-Program to demonstrate CAN Protocol.

Solapur University, Solapur
T.E. (Bio-medical Engineering) Semester-II
BM327 MINI PROJECT

Teaching Scheme **Examination Scheme**
Practical: - 2 Hours/week 1 Credit **ICA – 50** Marks

Course Objectives:
The mini project, done in teams of two or three, will involve the design, implementation, and evaluation of an embedded system. Projects can be hardware based, software based, or even about proving the theoretical properties of a design. A good project should address the following aspects: target applications, related existing solutions, new features and limitations of the design, technological and economic feasibility.

Course Outcome
The mini project should consist of Simple Biomedical application Design, pre-testing of main blocks in the circuit on a breadboard, PCB making and testing of final assembly. Mini Project based on Biomedical Modeling& Simulation & Bio Statistics is also encouraged.

The Internal Continuous Assessment should include
1) Collection of appropriate data form a in components in the project.
2) Design of circuit including analog part, digital part and suitable power supply.
3) Testing of main circuit blocks on breadboard.
4) Design of PCB layout for above designed circuit
5) Fabrication of PCB & assembly of circuit on PCB.
6) Testing and result analysis of the circuit
7) Suitable cabinet design for the circuit

Guidelines for project selection-
1) Use of microcontrollers is encouraged.
2) Implementation of concepts from subjects studied is encouraged.

Note:
1) A mini project group size should not exceed three students
2) Student should deliver a seminar on mini project

SELF LEARNING COURSES-II

TECHNICAL

Solapur University, Solapur

T.E. (Bio-medical Engineering) Semester-II

SELF-LEARNING COURSE II : TECHNICAL - I

BM326 HOSPITAL MANAGEMENT

Teaching Scheme
2 Credits

Examination Scheme
ESE – 50 Marks

This course introduces Hospital Administration, Human Resource, Marketing, Hospital Information system and quality and safety aspects of the hospital.

Course Prerequisite:
The students should aware of management skills.

Objectives:
The student should be made to understand the principles, practices, and areas of application in Hospital management.

Outcomes:
At the end of the course, the student should be able to explain the principles, practices, and areas of application in Hospital Management.

Unit I: Overview Of Hospital Administration
Distinction between Hospital and Industry, Challenges in Hospital Administration , Hospital Planning, Equipment Planning , Functional Planning, Current Issues in Hospital Management , Telemedicine, Bio-Medical Waste Management

Unit II: Human Resource Management In Hospital
Principles of HRM, Functions of HRM , Profile of HRD Manager, Tools of HRD, Human Resource Inventory, Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines, Methods of Training, Evaluation of Training, Leadership grooming and Training, Promotion – Transfer.

Unit III: Marketing Research & Consumer Behaviour
Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations – Consumer Markets & Consumer Buyer Behaviour - Model of consumer behaviour - Types of buying decision behaviour - The buyer decision process - Model of business buyer behaviour – Major types of buying situations – global marketing in the medical sector - WTO and its implications

Unit IV: Hospital Information Systems & Supportive Services
Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information Systems – Medical Transcription, Medical Records Department – Central Sterilization and Supply Department –Pharmacy– Food Services - Laundry Services.

Unit V: Quality And Safety Aspects In Hospital
Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – Environment Management Systems. NABA, JCI, NABL. Security – Loss Prevention – Fire Safety – Alarm System –Safety Rules. Health Insurance & Managing Health Care – Medical Audit – Hazard and Safety in a hospital Setup.

Text Books:

1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006 (Units I, II & III).
2. G.D.Kunders, "Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth Reprint 2007 (Units III, IV & V).

References:

1. Cesar A.Caceres and Albert Zara, "The Practice of Clinical Engineering, Academic Press, New York, 1977.
2. Norman Metzger, "Handbook of Health Care Human Resources Management", 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.
3. Peter Berman "Health Sector Reform in Developing Countries" - Harvard University Press, 1995.
4. William A. Reinke "Health Planning For Effective Management" - Oxford University Press.1988
5. Blane, David, Brunner, "Health and SOCIAL Organization: Towards a Health Policy for the 21st Century" Eric Calrendon Press 2002.
6. Arnold D. Kalcizony & Stephen M. Shortell, "Health Care Management", 6th Edition Cengage Learning, 2011.

Solapur University, Solapur

T.E. (Bio-medical Engineering) Semester-II

SELF-LEARNING COURSE II : TECHNICAL - II

BM326 ROBOTICS AND AUTOMATION IN MEDICINE

Teaching Scheme
2 Credits

Examination Scheme
ESE – 50 Marks

This course introduces the basic abstractions, mechanisms, and their selection of a robotic system. The core of the course contains introduction to various actuators, grippers, manipulators and sensors their usage and applications in a robotic system and perhaps the most compelling reason for a robotics curriculum is that it introduces students to knowledge, concepts, and skills that are needed for understanding the Robotics in Medicine.

Course Prerequisite:
Student shall have knowledge of novice level hardware and software aspects of an embedded system, basic mechanical concepts and some basics of geometry.

Course Objectives:
1. To study about the basic concepts of robots and types of robots.
2. To study about manipulators, actuators and grippers.
3. To study about various types of sensors and power sources
4. To study the various applications of robot in the medical field.

Course Outcome

1. To provide the basic knowledge on design, analysis, control and working principle of robotics in surgery, rehabilitation and drug delivery (Nano robot).

Unit I: Introduction Of Robotics
Introduction to Robotics and its history, Overview of robot subsystems, Degrees of freedom, configurations and concept of workspace, Automation, Mechanisms and movements, Dynamic stabilization- Applications of robotics in medicine

Unit II: Actuators And Grippers
Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, Design consideration in vacuum and other methods of gripping, PD and PID feedback actuator models

Unit III: Manipulators & Basic Kinematics
Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

Unit IV: Power Sources And Sensors
Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors, laser range finder, variable speed arrangements, Path determination - Machinery vision, Ranging - Laser- Acoustic, Magnetic fiber optic and Tactile sensor

Unit V: Robotics In Medicine

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric-, and General-Surgery, Gynecologic Surgery, General Surgery and Nano robotics.

Textbooks

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, First edition, 2003.
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008.
3. Fu.K.S, Gonzalez.R.C., Lee, C.S.G, "Robotics, control", sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008.

References

1. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, *"Principles of Robot Motion: Theory, Algorithms, and Implementations"*, Prentice Hall of India, First edition, 2005.
2. Philippe Coiffet, Michel Chirouze, *"An Introduction to Robot Technology"*, Tata McGraw-Hill, First Edition, 1983.
3. Jacob Rosen, Blake Hannaford & Richard M Satava, *"Surgical Robotics: System Applications & Visions"*, Springer 2011.
4. http://www.lapsurg.com.br/arquivos/books/medical_robotics12402am020100000000.pdf
5. Barbara Webb and Thomas Consi. R, *"BioRobotics: Methods & Applications"*, Barbara Webb and Thomas Consi. R, AAAI Press/MIT Press, First Edition, 2001.
6. Constantinos Mavroidis, Antoine Ferreira, "Nanorobotics: Current approaches and Techniques" , Springer 2011.

Solapur University, Solapur

T.E. (Bio-medical Engineering) Semester-II

SELF-LEARNING COURSE II : TECHNICAL - III

BM326 NUCLEAR MEDICINE

Teaching Scheme
2 Credits

Examination Scheme
ESE – 50 Marks

The purpose of course is to create interest in the student, who would provide high quality health care and advance the cause of science through research & training. This course contains Nuclear medicine instruments, diagnostic and radiation safety.

Course Prerequisite:
Student shall have knowledge of Basic Science aspects of Radiation Physics.

Course Objectives:
To understand the fundamentals of Nuclear Medicine and learn about the instruments involved in production techniques and therapeutic uses of Nuclear Medicine.

Course Outcome

1. To learn the basics of nuclear medicine
2. To study the construction and principle of operation of various nuclear medicine instruments
3. To study the diagnostics and therapeutic applications of nuclear medicine.
5. To get the idea about the radiation safety procedures and regulations.

Unit I - Basics Of Nuclear Medicine
Radioactivity and interaction of radiation; Alpha, Beta and gamma emission, Laws of radioactive decay, Mechanisms of radioactive delay, Radiation intensity and exposure, Decay schemes and energy levels, Compton scattering, Pair productions, Particle interactions

Unit II – Radio pharmaceuticals
Radionuclide production, ^{99}Mo/^{99}mTc generator, Mechanism of localization, Types of radio pharmaceuticals, characteristics of radio pharmaceuticals, Radiopharmaceuticals for diagnosis and treatments in human, Dispensing of radio pharmaceuticals, RIA radiopharmaceuticals and kits production.

Unit III - Nuclear Medicine Instrumentation
Construction and principle operation of Gamma camera, Rectilinear scanner, Basic principles of pulse height analyser, Radiation detectors-Ionization chamber, Geiger Muller counter, Semiconductor detectors, Scintillation detectors, Electronic Instrumentation for radiation detection system

Unit IV - Diagnostic And Therapeutic Applications Of Radionuclide
PET-CT, Single photon emission computed tomography (SPECT), Radio iodine therapy for Thyrotoxicosis , Differentiated thyroid cancers, Palliative treatment for bone metastasis - 32 P and 89 Strontium Dosage, Intravascular particulate radio nuclide Therapy, Receptor targeted therapy, 131 I- MIBG Therapy, Targeted internal radiation in HCC: 90 Y, Radio-synovectomy using Yttrium

Unit V - Radiation Safety

Radiation protection indifferent nuclear isotope therapy procedures, Management of radiation accidents, Radiation effect on pregnancy and fertility, Diagnosis, evaluation and treatment of radiation overexposure, Instruments used in radiation survey & monitoring, Handling of radioactive patients, Role of national and international bodies in radiation safety, ICRP recommendations, BARC regulations regarding limits of radiation exposure

Textbooks/ References

1. Simon Cherry, James Sorenson, Michael Phelps. ―Physics in Nuclear Medicine‖, Elsevier Saunders , 4 th Edition ,2012.
2. Jennifer Prekeges, ―Nuclear Medicine Instrumentation‖, Jones and Barlett publishers, 1st
3. edition, 2011.
4. Max.H.Lombardi, ―Radiation safety in Nuclear Medicine‖, CRC Press, Florida, USA, 2 nd edition 1999.