UNIVERSITY OF MUMBAI

Bachelor of Engineering
Electronics Engineering

Final Year Engineering
(Sem. VIII), Revised course
(REV- 2012) effective from Academic Year 2015 -16

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC801	CMOS VLSI Design	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
EXC801	CMOS VLSI Design	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXC302: Electronic Devices
- EXC303: Digital Circuits and Design
- EXC402: Discrete Electronic Circuits
- EXC502: Design With Linear Integrated Circuits
- EXC601: VLSI Design
- EXC702: IC Technology

Course Objectives:

1. To teach analysis and design of building blocks of CMOS Analog VLSI Circuits.
2. To highlight the issues associated with the CMOS analog VLSI circuit design.

Course Outcomes:

After successful completion of the course student will be able to

1. discuss tradeoffs involved in analog VLSI Circuits.
2. analyze building blocks of CMOS analog VLSI circuits.
3. design building blocks of CMOS analog VLSI circuits
4. carry out verifications of issues involved in analog circuits via simulations

Module No.	Unit No.	Topics	Hrs.
1. 0		**CMOS analog building blocks**	8
	1.1	**MOS Models:** Necessity of CMOS analog design, Review of characteristics of MOS device, MOS small signal model, MOS spice models	
	1.2	**Passive and Active Current Mirrors:** Basic current mirrors, Cascode current mirrors and Active current mirrors	
	1.3	**Band Gap References:** General Considerations, Supply-independent biasing, Temperature independent references, PTAT current generation and Constant Gm biasing	
2.0		**Single Stage Amplifiers**	10
	2.1	**Configurations:** Basic concepts, Common source stage, Source follower, Common gate stage, Cascode stage	
	2.2	**Frequency Response and Noise:** General considerations, Common-source stage, Source followers, Common-gate stage, Cascode stage and Noise in single stage amplifiers	
3.0		**Differential Amplifiers**	10
	3.1	**Configurations:** Single ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS loads, Gilbert cell	
	3.2	Frequency response and noise in differential pair	
4.0		**MOS Operational Amplifiers**	10
	4.1	**Op-amp Design:** General Considerations, performance parameters, One-stage op-amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations, Slew Rate, Power supply rejection, Noise in op-amps	
	4.2	**Stability and Frequency Compensation:** General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op-amps	
5.0		**Mixed Signal Circuits**	10
	5.1	**Switch Capacitor Circuits:** MOSFETs as switches, Speed considerations, Precision Considerations, Charge injection cancellation, Unity gain buffer, Non-inverting amplifier and integrator	
	5.2	**Oscillators:** General considerations, Ring oscillators, LC oscillators, VCO	
	5.3	**Phase-Locked Loop:** Simple PLL, Charge pump PLL, Nonideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits	
6.0		**Analog Layout and other concepts**	04
	6.1	**Analog Layout Techniques:** Antenna effect, Resistor matching, capacitor matching, current mirror matching, floorplanning, shielding and guard rings	
	6.2	AMS design flow, ASIC, Full custom design, Semi custom design, System on Chip, System in package, Hardware software co-design	
		Total	**52**

Recommended Books:

1. B Razavi, "*Design of Analog CMOS Integrated Circuits*", Tata McGraw Hill, 1st Edition.
2. R. Jacaob Baker, Harry W. Li, David E. Boyce, "*CMOS Circuit Design, Layout,and Stimulation*", Wiley, Student Edition
3. P. E. Allen and D. R. Holberg, "*CMOS Analog Circuit Design*", Oxford University Press, 3rd Edition.
4. Gray, Meyer, Lewis, Hurst, "*Analysis and design of Analog Integrated Circuits*", Willey, 5th Edition

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC 802	Advanced Networking Technologies	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC 802	Advanced Networking Technologies	20	20	20	80	-	-	-	100

Course Pre-requisite:

- EXE704: Computer Communication Networks

Course Objectives:

1. To make students familiar with data communication technologies and how to use them to: Design, Implement, Operate, Manage enterprise networks.
2. To introduce the concept of wireless WAN,WAP and different IEEE standards.

Course Outcomes:

Upon completion of the course, students should be able to:

1. Analyze the performance of networks.
2. Determine the network performance using monitor tools..
3. Set up WLAN,PAN
4. Explain optical networking technology

Module No.	Unit No.	Topics	Hrs.
1		**Emerging Wireless Technologies**	10
	1.1	**Wireless Personal Area Network** – Bluetooth Bluetooth (IEEE 802.15.1),Definitions of the Terms Used in Bluetooth, Bluetooth Protocol Stack, Bluetooth Link Types, Bluetooth Security, Network Connection Establishment in Bluetooth, Network Topology in Bluetooth, Bluetooth Usage Models	
	1.2	Bluetooth Applications, WAP and Bluetooth Wireless Personal Area Networks (WPAN):Low Rate (LR) and High Rate (HR)Wireless Sensor Network, Usage of Wireless Sensor Networks, Wireless Sensor Network	
	1.3	Model, Sensor Network Protocol Stack, ZigBee Technology, IEEE 802.15.4 LR-WPAN Device Architecture, IEEE 802.15.3a Ultra WideBand, Radio Frequency Identification.	
2		**Optical Networking**	06
	2.1	ONET/SDH Standards, devices, DWDM, frame format, DWDM, Performance and design considerations.	
3		**WAN Technologies**	12
	3.1	**Frame:** FR concept, FR specifications, FR design and VoFR and Performance and design considerations	
	3.2	**ATM:** The WAN Protocol: Faces of ATM, ATM Protocol operations. (ATM cell and Transmission) ATM Networking basics, Theory of Operations, B-ISDN reference model, PHY layer, ATM Layer (Protocol model), ATM layer and cell	
	3.3	Traffic Descriptor and parameters, Traffic Congestion control defined, AAL Protocol model, Traffic contract and QoS, User Plane overview, Control Plane AAL, Management Plane, Sub S3 ATM,ATM public services	
4		**Network Design**	08
	4.1	Network layer design, access layer design, access network capacity, network topology and Hardware and completing the access network design.	
5		**Network Security**	08
	5.1	Security threats, safeguards and design for network security	
	5.2	**Enterprise Network Security:** DMZ, NAT, SNAT, DNAT, Port Forwarding, Proxy, Transparent Proxy, Packet Filtering and Layer 7 Filtering	
6		**Network Management and Control**	
	6.1	Network management definitions, functional areas (FCAPS), SNMP, RMON,	08
	6.2	Designing a network management solutions, Monitoring and control of network activity and network project management	
		Total	52

Recommended Books:

1. Data Network Design by Darren Spohn, 3e McGraw Hill publications
2. Data Communication and Network Security by Carr and Snyder, McGraw Hill Publications.
3. Communication Networks by Leon-Garcia and Indra Widjaja, 2e, Tata McGraw-Hill Publications.
4. Information Security by Mark Stamp and Deven Shah by Wiley Publications.
5. Behrouz A Forouzan, Data communications and Networking 4th Edition,
6. McGraw-Hill Publication.
7. William Stallings, Data Computer Communications, Pearson Education
8. Wireless communication and Networking-Vijay Garg, ELSEVIER Inc
9. Eldad Perahita ,Next Generation wireless LANS, Cambridge Publication
10. Computer Networking by J. F. Kurose and K. W. Ross, Pearson Education
11. Local Area Networks by Gerd Keiser, McGraw-Hill Publication.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Course Name	Teaching Scheme	Credits Assigned					
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
EXC803	MEMS Technology	04	--	--	04		--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC803	MEMS Technology	20	20	20	80	-	-	-	100

Course Pre –requisite:

- EXC 404: Basic VLSI Design
- EXC 604: IC Technology

Course Objective:

- To provide a basic knowledge of MEMS processing steps and processing modules.
- To demonstrate the use of semiconductor based processing modules used in the fabrication of variety of sensors and actuators (e.g. pressure sensors, accelerometers, etc.) at the micro-scale.
- To provide an understanding of basic design and operation of MEMS sensors and transducers.

Course Outcome:

On Completion of this course Student will be able to

- Understand the underlying fundamental principles of MEMS devices including physical operation, mathematical modeling and fabrication.
- Design and simulate MEMS devices and system using standard simulation tools.
- Develop different concepts of micro system sensors and actuators for real-world applications.

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to MEMS**	04
	1.1	Introduction to MEMS & Real world Sensor/Actuator examples (DMD, Air-bag, pressure sensors). MEMS Sensors in Internet of Things (IoT), BioMedical Applications	
2		**MEMS Materials and Their Properties**	10
	2.1	Materials (eg. Si, SiO2, SiN, Cr, Au, Ti, SU8, PMMA, Pt); Important properties: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure. Understanding Selection of materials based on applications.	
3		**MEMS Fab Processes – 1**	11
	3.1	Understanding MEMS Processes & Process parameters for: Cleaning, Growth & Deposition, Ion Implantation & Diffusion, Annealing, Lithography. Understanding selection of Fab processes based on Applications	
4		**MEMS Fab Processes – 2**	10
	4.1	Understanding MEMS Processes & Process parameters for: Wet & Dry etching, Bulk & Surface Micromachining, Die, Wire & Wafer Bonding, Dicing, Packaging. Understanding selection of Fab processes based on Applications	
5		**MEMS Devices**	11
	5.1	Architecture, working and basic quantitative behaviour of Cantilevers, Microheaters, Accelerometers, Pressure Sensors, Micromirrors in DMD, Inkjet printer-head. Understanding steps involved in Fabricating above devices	
6		**MEMS Device Characterization**	06
	6.1	Piezoresistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behavior, MEMS Reliability	
		Total	52

Recommended Books:

1. An Introduction to Microelectromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc
2. Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing
3. Microsystem Design - by S. Senturia; Publisher: Springer
4. Analysis and Design Principles of MEMS Devices - Minhang Bao; Publisher: Elsevier Science
5. Fundamentals of Microfabrication - by M. Madou; Publisher: CRC Press; 2 edition
6. Micro Electro Mechanical System Design - by J. Allen; Publisher: CRC Press
7. Micromachined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC8041	Robotics	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
EXC8041	Robotics	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXS 301 : Applied Mathematics III
- EXS 401 : Applied Mathematics IV
- EXC 404 : Principles of Control Systems

Course Objectives:

1. To prepare students with basics of robotics
2. To familiarize students with kinematics & dynamics of robots
3. To familiarize students with path & Trajectory planning of robots
4. To familiarize students with robot vision

Course Outcomes:

After successful completion of the course student will be able to

1. Describe kinematics and dynamics of stationary and mobile robots
2. Describe trajectory planning for robots
3. Implement trajectory generation and path planning various algorithms
4. Work in interdisciplinary projects

Module No.	Unit No.	Topics	Hrs.
1		**Fundamentals of Robotics**	03
	1.1	Robot Classification, Robot Components, Degrees of freedom, Joints, Coordinates, Coordinate frames, workspace, applications	
2		**Forward & Inverse Kinematics of Robots**	09
	2.1	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation	
	2.2	Denavit-Hatenberg representation of forward kinematics, Inverse kinematic solutions, Case studies	
3		**Velocity Kinematics & Dynamics**	14
	3.1	**Differential motions and velocities :** Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian,Singularities.	
	3.2	**Dynamic Analysis of Forces :** Lagrangian mechanics, Newton Euler formulation, Dynamic equations of robots, Transformation of forces and moment between coordinate frames	
4		**Robot Motion Planning**	04
	4.1	Concept of motion planning, Bug Algorithms – Bug1, Bug2, Tangent Bug	
5		**Potential Functions and Visibility Graphs**	08
	5.1	Attractive/Repulsive potential, Gradient descent, wave-front planner, navigation potential functions, Visibility map, Generalized Voronoi diagrams and graphs, Silhouette methods	
6		**Trajectory planning**	08
	6.1	Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	
7		**Robot Vision**	06
	7.1	Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform.	
		Total	52

Recommended Books:

1. Robert Shilling, Fundamentals of Robotics - Analysis and control, Prentice Hall of India
2. Saeed Benjamin Niku, “Introduction to Robotics – Analysis, Control, Applications”, Wiley India Pvt. Ltd., Second Edition, 2011
3. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia E. Kavraki and Sebastian Thrun, “Principles of Robot Motion – Theory, Algorithms and Implementations”, Prentice-Hall of India, 2005.
4. Mark W. Spong , Seth Hutchinson, M. Vidyasagar, “Robot Modeling & Control ”, Wiley India Pvt. Ltd., 2006
5. John J. Craig, “Introduction to Robotics – Mechanics & Control”, Third Edition, Pearson Education, India, 2009
6. Aaron Martinez & Enrique Fernandez, “Learning ROS for Robotics Programming”, Shroff Publishers, First Edition, 2013.
7. Mikell P. Groover et.al, ”Industrial Robots-Technology, Programming & applications” ,McGraw Hill , New York, 2008

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC 8042	Mobile Communication	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC 8042	Mobile Communication	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXC 704: Computer Communication Networks
- EXC: Digital Communication

Course Objectives:

To enable the student to study, understand and appreciate the concepts of mobile communication technology.

Course Outcomes:

After successful completion of the course student will be able to

1. Understand the fundamentals of mobile communications
2. Differentiate between GSM and CDMA
3. Understand the evolving wireless communication technologies.
4. Understand the requirement of 4 G technology

Module No.	Unit No.	Topics	Hrs.
1		**Cellular Communication System**	10
	1.1	**I**ntroduction to Cellular Communications, Frequency reuse, Multiple Access Technologies	
	1.2	**Cellular Processes:** Channel assignment, Call Setup, Handoff strategies, interferences and system capacity	
	1.3	**Traffic Theory:** Trunking and grade of service, improving system capacity	
2		**GSM**	8
	2.1	GSM Network architecture, signaling protocol architecture, identifiers, channels, Frame structure, speech coding, authentication and security, call procedure, handoff procedure, services and features	
3		**CDMA digital cellular standard (1S-95)**.	8
	3.1	Frequency and channel specifications of IS-95, forward and reverse CDMA channel, packet and frame formats, mobility and radio resource management	
4		**3 G Mobile Communication System**	10
	4.1	2.5 G TDMA Evolution Path, GPRS, EDGE , 2.5G CDMA one cellular N/W, Need of 3G Cellular N/w, IMT 2000 Global Standard, UMTS Technology, W-CDMA Air interface, TD-SCDMA Technology, CDMA 2000 Cellular Technology	
5		**4G Wireless Standards**	8
	5.1	Need for 4G network, difference between 3G and 4G, LTE, WiMAX	
6		**Emerging Technologies**	8
	6.1	Mobile Adhoc Network, Mobile IP and Mobility Management, Mobile TCP, Wireless Sensor Networks, RFID Technology	
		Total	**52**

Recommended Books:

1. Wireless Communications - Theodore S. Rappaport, Prentice Hall of India, PTR publication
2. Mobile & Personal Communication system & Services by Raj Pandya , Prentice –Hall of India (PHI) Private Limited
3. Principles of Wireless Networks-KavehPahlavan, Prashant Krishnamurthy, PHI
4. Wireless communication and Networking-Vijay Garg, ELSEVIER Inc
5. Wireless communication- Singhal_TMH
6. Fundamentals of Wireless Communications, "David Tse and Pramod Viswanath, Publisher, Cambridge University Press.
7. Wireless Communications: Andrea Goldsmith, Cambridge University Press.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Subject Code	Subject Name	Teaching Scheme (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC 8043	Digital Control System	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC 8043	Digital Control System	20	20	20	80	--	--	--	100

Course Prerequisites:

- EXC404: Principles of Control System
- EXC504: Signals and Systems

Course Objective:

1. To study the importance of digital control
2. To study stability analysis of digital control systems
3. To study the design of digital control systems

Course Outcomes:

1. Students will be able to differentiate between analog and digital control and importance of digital control
2. Student will be able to analyze the digital control systems
3. Students will be able to design digital controllers

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction**	
	1.1	Why digital control system? Advantages and limitations, comparison of continuous and discrete data control, block diagram of digital control system	**12**
	1.2	Data conversion and quantization, sampling and reconstruction of analog signal, zero and first order hold	
	1.3	Impulse invariance, bilinear transformation, finite difference approximation of derivatives	
2.0		**Modeling of Digital Control System**	**04**
	2.1	Linear difference equation, pulse transfer function, input output model	
	2.2	Examples of first order continuous and discrete time systems	
	2.3	Signal flow graph applied to digital control system	
3.0		**Time Domain Analysis and Stability of Digital Control System**	**08**
	3.1	Mapping between s plane and Z plane, Jury's method, R. H. criteria	
	3.2	Comparison of time response of continuous and digital control system	
	3.3	Steady state analysis of digital control system, effect of sampling on transient response	
4.0		**State Space Analysis**	**08**
	4.1	Discrete time state equation in standard canonical form, similarity transformation	
	4.2	State transition matrix, solution of discrete time state equation	
	4.3	Discretization of continuous state space model and its solution.	
5.0		**Pole Placement and Observer Design**	**10**
	5.1	Concept of reachability, controllability, constructability and observability	
	5.2	Design of controller using pole placement method, dead beat controller design	
	5.3	Concept of duality, state observer design, concept of multi rate output feedback based state estimation	
6.0		**Transfer Function Approach to Controller Design**	**10**
	6.1	Control structures, internal stability,	
	6.2	Internal model principle and system type, well behaved signals	
	6.3	Discretization of PID controllers, pole placement controllers with performance specifications	
		Total	**52**

Recommended Books:

1. M. Gopal, "Digital Control and State Variable Methods", McGraw Hill companies, 3rd edition, 2009.
2. K. Ogata, "Discrete-Time Control Systems", PHI, 2nd edition, 2009.
3. B. C. Kuo, "Digital Control Systems", Oxford University press, 2nd edition, 2007.
4. K. M. Moudgalya, "Digital Control", Wiley India, 2012.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules

Course code	Course Name	Teaching Scheme (Hrs)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut.	Total
EXC8044	**Biomedical Electronics**	4						**4**

Course code	Course Name	Examination Scheme							
		Theory (out of 100)				Term Work	Practical and oral	Oral	Total
		Internal Assessment (out of 20)			End Sem. Exam				
		Test 1	Test 2	Avg.					
EXC8044	**Biomedical Electronics**	20	20	20	80	--	--	--	**150**

Course Pre-requisites:

- EXC305:Electronic Instruments and Measurements
- FEC102,202: Applied Physics I and II

Course Objective:

1. To make students understand the Identification, classification, and working principle of various Biomedical Instruments used for Bio-potential measurement
2. Application of these instruments in diagnosis, therapeutic treatment and imaging fields

Course Outcome:

The Students will be able to

1. Identify various Bio-potential and their specifications in terms of amplitude and frequency.
2. Understand principle and working of various Biomedical Instruments for diagnosis applications.
3. Decide the applications of therapeutic instruments for treatment purpose.
4. Understand applications of imaging instruments and the modalities involved in each technique.

Module No.	Unit No.	Topics	Hrs.
1		**Bio-Potential and Measurement**	08
	1.1	Structure of Cell, Origin of Bio-potential, electrical activity of cell their characteristic and specifications.	
	1.2	Measurement of RMP and AP. Electrode-Electrolyte interface and types of bio-potential electrodes.	
2		**Physiological Systems and Related Measurement**	14
	2.1	Respiratory system- Physiology of respiration and measurements of respiratory related parameters	
	2.2	Cardiovascular system- Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias	
	2.3	Nervous system- Nerve cell, neuronal communication, nerve-muscle physiology, CNS, PNS. Generation of EEG and its measurement. Normal and abnormal EEG, evoked potential and epilepsy	
	2.4	Muscular system- Generation of EMG signal, specification and measurement.	
		Design of ECG amplifier	
3		**Cardiovascular Measurement**	08
	3.1	Blood Pressure- Direct and Indirect types. Blood Flow- Electromagnetic and Ultrasonic types. Blood Volume- Types of Plethysmography. (Impedance, Capacitive and Photoelectric) Cardiac Output- Flicks method, Dye-dilution and Thermo-dilution type. Heart sound measurement	
4		**Life support Instruments**	08
	4.1	Pacemaker- Types of Pacemaker, mode of pacing and its application. Defibrillator- AC and DC Defibrillators and their application. Heart Lung machine and its application during surgery. Haemodialysis system and the precautions to be taken during dialysis. Baby Incubator and its application	
5		**Imaging Techniques**	10
	5.1	X-Ray- Generation, X-ray tube and its control, X-ray machine and its application	
	5.2	CT Scan- CT Number, Block Diagram, scanning system and application. Ultrasound Imaging- Modes of scanning and their application	
	5.3	MRI- Concepts and image generation, block diagram and its application	
6		**Significance of Electrical Safety**	04
	6.1	Physiological effects of electrical current, Shock Hazards from electrical equipments and methods of accident prevention.	
		Total	52

Recommended Books:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education, 1980.
2. John G. Webster, "Medical Instrumentation", John Wiley and Sons, 4th edition, 2010.
3. R. S. Khandpur, "Biomedical Instrumentation", TMH, 2004
4. Richard Aston, "Principles of Biomedical Instrumentation and Instruments", PH, 1991.
5. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", PHI/Pearson Education, 4th edition, 2001.
6. John E Hall, Gyton's Medical Physiology, 12th edition, 2011

Internal Assessment (IA):
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End Semester Examination:
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules