UNIVERSITY OF MUMBAI

Bachelor of Engineering

Biomedical Engineering (Second Year - Sem III- IV)

Revised course (Rev- 2012)

From Academic Year 2012 -13

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

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Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

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Preamble

The overall technical education in our country is changing rapidly in manifolds. Now it is very much challenging to maintain the quality of education with its rate of expansion. To meet present requirement a systematic approach is necessary to build the strong technical base with the quality. Accreditation will provide the quality assurance in higher education and also to achieve recognition of the institution or program meeting certain specified standards. The main focus of an accreditation process is to measure the program outcomes, essentially a range of skills and knowledge that a student will have at the time of graduation from the program that is being accredited. Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as Chairman, Board of Studies in Electrical Engineering of University of Mumbai, happy to state here that, Program Educational Objectives (PEOs) were finalized for undergraduate program in Electrical Engineering, more than twenty senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for undergraduate program in Electrical Engineering are listed below;

- To provide the overall strong technical foundation to formulate, solve and analyse engineering problems during undergraduate program.
- To prepare students to demonstrate an ability to identify, formulate and solve electrical based issues.
- To prepare students to demonstrate an ability in the area of design, control, analyse and interpret the electrical and electronics systems.
- To prepare students for successful career in industry, research and development.
- To develop the ability among students for supervisory control and data acquisition for power system application.
- To provide opportunity for students to handle the multidisciplinary projects.
- To create the awareness of the life-long learning and to introduce them to professional ethics and codes of professional practice.

The affiliated institutes may include their own PEOs in addition to the above list

To support the philosophy of outcome based education, in addition to stated PEOs, objectives and expected outcomes are also included in the curriculum. I know, this is a small step taken to enhance and provide the quality education to the stake holders.

Dr. M. V. Bhatkar
Chairman,
Board of Studies in Electrical Engineering,
University of Mumbai

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Syllabus Scheme for S.E. Semester III Biomedical Engineering

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM301	Applied Mathematics-III$	4	-	1	4	-	1	5
SEBM302	Electronic Circuits and Design – I	4	2	-	4	1	-	5
SEBM303	Electrical Network Analysis and Synthesis	4	-	1	4	-	1	5
SEBM304	Human Anatomy and Physiology	4	2	-	4	1	-	5
SEBM305	Biomaterials	4	-	1	4	-	1	5
SEBM306	Object Oriented Programming & Methodology $	-	4#	-	-	2	-	2
	TOTAL	20	8	3	20	4	3	27

Out of 4 hours, 2 hours theory shall be taught to the entire class followed by 2 hrs. practical in batches.

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM301	Applied Mathematics-III $	20	20	20	80	25	-	-	125
SEBM302	Electronic Circuits and Design – I	20	20	20	80	25	25	-	150
SEBM303	Electrical Network Analysis and Synthesis	20	20	20	80	25	-	-	125
SEBM304	Human Anatomy and Physiology	20	20	20	80	25	-	25	150
SEBM305	Biomaterials	20	20	20	80	25	-	25	150
SEBM306	Object Oriented Programming & Methodology $	-	-	-	-	50	50*	-	100
TOTAL				100	400	175	75	50	800

*Both Practical and Oral examination

$ Subject common for Electronics and Telecommunication Engineering, Electronics Engineering, Biomedical Engineering, Electrical Engineering and Instrumentation Engineering.

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Syllabus Scheme for S.E. Semester IV Biomedical Engineering

Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM401	Applied Mathematics-IV $	4	-	1	4	-	1	5
SEBM402	Electronic Circuits and Design – II	4	2	-	4	1	-	5
SEBM403	Transducers and Sensors for Medical Applications	4	2	-	4	1	-	5
SEBM404	Logic Circuits	4	2	-	4	1	-	5
SEBM405	Signals and Systems	4	-	1	4	-	1	5
SEBM406	Electronic Instruments and Control System	4	2	-	4	1	-	5
	TOTAL	24	8	2	24	4	2	30

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM401	Applied Mathematics-IV $	20	20	20	80	25	-	-	125
SEBM402	Electronic Circuits and Design – II	20	20	20	80	25	25	-	150
SEBM403	Transducers and Sensors for Medical Applications	20	20	20	80	25	-	25	150
SEBM404	Logic Circuits	20	20	20	80	25	25	-	150
SEBM405	Signals and Systems	20	20	20	80	25	-	25	150
SEBM406	Electronic Instruments and Control System	20	20	20	80	25	-	25	150
TOTAL				120	480	150	50	75	875

$ Subject common for Electronics and Telecommunication Engineering, Electronics Engineering, Biomedical Engineering, Electrical Engineering and Instrumentation Engineering.

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM301	Applied Mathematics-III	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM301	Applied Mathematics-III	20	20	20	80	25	-	-	125

Course Objectives	To provide students with a sound foundation in Mathematics and prepare them for graduate studies. To provide students with mathematics fundamental necessary to formulate, solve and analyze engg. problems. To provide opportunity for students to work as part of teams on multi disciplinary projects.
Course Outcomes	Students will demonstrate basic knowledge of Laplace Transform. Fourier series, Bessel Functions, Vector Algebra and Complex Variable. Students will demonstrate an ability to identify formulate and solve electronics and telecommunication Engg. problem using Applied Mathematics. Students will show the understanding of impact of Engg. Mathematics on Telecom Engg. Students who can participate and succeed in competitive exams like GATE, GRE.

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Module	Contents	Time
1.	**Laplace Transform (LT) of Standard Functions:** Definition. unilateral and bilateral Laplace Transform, LT of *sin(at), cos(at),* e^{at} ,t^n , *sinh(at), cosh(at), erf(t),* Heavi-side unit step, dirac-delta function, LT of periodic function **Properties of Laplace Transform:** Linearity, first shifting theorem, second shifting theorem, multiplication by t^n , division by t , Laplace Transform of derivatives and integrals, change of scale, convolution theorem, initial and final value theorem, Parsavel's identity **Inverse Laplace Transform:** Partial fraction method, long division method, residue method **Applications of Laplace Transform:** Solution of ordinary differential equations	12 hrs.
2.	**Introduction:** Definition, Dirichlet's conditions, Euler's formulae **Fourier Series of Functions:** Exponential, trigonometric functions, even and odd functions, half range sine and cosine series Complex form of Fourier series, orthogonal and orthonormal set of functions, Fourier integral representation.	10 hrs.
3.	**Solution of Bessel Differential Equation:** Series method, recurrence relation, properties of Bessel function of order +1/2 and -1/2 Generating function, orthogonality property Bessel Fourier series of functions	08 hrs.
4.	**Scalar and Vector Product**: Scalar and vector product of three and four vectors and their properties **Vector Differentiation:** Gradient of scalar point function, divergence and curl of vector point function **Properties:** Solenoidal and irrotational vector fields, conservative vector field **Vector Integral:** Line integral, Green's theorem in a plane, Gauss' divergence theorem, Stokes' theorem	12 hrs.
5.	**Complex Variable** Analytic Function: Necessary and sufficient conditions, Cauchy Reiman equation in polar form Harmonic function, orthogonal trajectories **Mapping:** Conformal mapping, bilinear transformations, cross ratio, fixed points, bilinear transformation of straight lines and circles	10 hrs.

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Text books:

1. P. N. Wartikar and J. N. Wartikar, *"A Text Book of Applied Mathematic"*, Vol. I & II, Vidyarthi Griha Prakashan
2. A. Datta, *"Mathematical Methods in Science and Engineering"*, 2012
3. B.S. Grewal, *"Higher Engineering Mathematics"*, Khanna Publication

Reference Books:

1. B. S. Tyagi, *"Functions of a Complex Variable,"* Kedarnath Ram Nath Publication
2. B. V. Ramana, *"Higher Engineering Mathematics"*, Tata Mc-Graw Hill Publication
3. Wylie and Barret, *"Advanced Engineering Mathematics",* Tata Mc-Graw Hill 6th Edition
4. Erwin Kreysizg, *"Advanced Engineering Mathematics"*, John Wiley & Sons, Inc
5. Murry R. Spieget, *"Vector Analysis"*, Schaum's outline series, Mc-Graw Hill Publication

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the tests will be considered for final Internal Assessment.

End Semester Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3. Question No.1 will be compulsory and based on entire syllabus.
4. Remaining question (Q.2 to Q.6) will be selected from all the modules.

Term Work:

At least 08 assignments covering entire syllabus must be given during the **'class wise tutorial'**. The assignments should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.

Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per **'credit and grading system'** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM302	Electronic Circuits and Design – I (abbreviated as ECAD-I)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM302	Electronic Circuits and Design – I	20	20	20	80	25	25	-	150

Course Objectives	This course provides basic platform to understand various electronic components and concepts used in electronic systems. Working, analysis, advantages, shortcomings and application of various electronic systems such as diodes, various transistors, multistage amplifiers etc. is covered in detail. Designing and implementing these electronic systems in laboratory is the key component of the course.
Course Outcomes	Student will be able to design and implement amplifiers as per the specifications given. It will be possible to analyze given electronic system at the circuit level.

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Module	Contents	Time
1.	**Diode Circuits:** Basics of PN junction diode - Equation, characteristics. Clipper and Clamper Circuits, Zener Diode –working, Characteristics.	05 hrs.
2.	**Bipolar Junction Transistor**: Working of PNP and NPN Transistor. Configurations (CB, CC, CE), comparison, Q-Point, DC load line. BJT Biasing - DC analysis, Stability. (Fixed, Self, Voltage divider, Collector to base, Collector to base self). BJT as a switch.	10 hrs.
3.	**A.C. Equivalent Model** – $\mathbf{r_e}$ model, h-parameter model (Exact and Approximate). A.C. Analysis: A.C. load line, A.C. analysis of amplifiers using CE, CB and CC configurations considering effect of Rs and RL, Comparison between various amplifiers. Low frequency and High frequency model, Frequency response of Single stage amplifier. Design of single stage amplifier using BJT.	10 hrs.
4.	**Junction Field Effect Transistor:** Working and basic terminology related to JFET. Configurations (CS, CG, CD), comparison, Q-Point, DC load line. JFET Biasing – Fixed, Self, Voltage divider, Concept of stability against device parameters and temperature, zero temperature drift. A.C. Equivalent model of JFET. A.C. Analysis of amplifiers using CS, CG and CD configurations. considering effect of Rs and RL, Comparison between various amplifiers. Low frequency and High frequency model, Frequency response of Single stage amplifier. Design of single stage amplifier using JFET.	12 hrs.
5.	**MOSFET:** Working of Depletion and Enhancement MOSFET. Characteristics and equations. Basic MOSFET Applications: Switch, Digital Logic Gate and Amplifier.	03 hrs.
6.	**Multistage Amplifiers:** Cascade: BJT-BJT, FET-BJT. Cascode – DC and AC analysis, characteristics and applications. Darlington - DC and AC analysis, characteristics and applications.	08 hrs.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:

Term work consists of minimum eight experiments and a written test. The distribution of the term work shall be as follows,

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Laboratory work (Experiments and Journal) :15 marks
Attendance (Practical and Theory) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Experiments:

1. Clippers and Clampers
2. BJT characteristics in CE configurations
3. Biasing of BJT
4. BJT as a switch
5. BJT as CE Amplifier
6. Frequency response of BJT
7. FET Characteristics
8. FET as a CS Amplifier
9. Frequency response of JFET
10. Simulations of transistorized circuits

Books Recommended:

Text Books:

1. Neamen Donald A., *Electronics Ckt. Analyzer & Design*, 2nd ed., Tata McGraw Hill.
2. Boylestad Robert L., Nashelsky Louis, *Electronics Devices & Circuits*, Pearson Education.
3. *Semiconductor Data Manual*, BPB Publications.

Reference Books:

1. Malvino—Electronic Principles , 6/e ,TMH
2. Millman & Halkias: Basic Electronic Principles; TMH.
3. Martin roden, Gordon carpenter, William wieseman, Electronic design, Fourth edtion, sroff publishers.
4. Donald Schilling & charles belove, electronic circuits discrete and integrated, third edition, Mcgraw Hill.

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM303	Electrical Network Analysis and Synthesis (abbreviated as ENAS)	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM303	Electrical Network Analysis and Synthesis	20	20	20	80	25	-	-	125

Course Objectives	To provide a methodical approach to problem solving. To learn a number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, theorems, source transformation and several methods of simplifying networks. To understand the concept of graphical solution to electrical network To understand frequency response in electrical circuits.
Course Outcomes	Students will develop expertise in designing and analyzing basic electronic circuits that are used as basic building blocks in various communication systems. The knowledge gained will develop ability in them for understanding industry requirement and to design/offer customized solutions as needed. The student will be able to obtain solution to problems in electrical network using different techniques, obtain graphical solution to electrical network, solve problems on frequency response, and synthesize transfer functions in different forms.

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Module	Contents	Time
1.	**Introduction:** Review of D.C. & A.C. circuits, DC Circuits: Current & Voltage Source Transformation, Source Shifting **Mesh & Node Analysis:** Mesh & Node Analysis of D.C. & A.C. circuits with independent & dependent sources. (Introduction to coupled circuits).	07 hrs.
2.	**Network Theorems (** D.C. & A.C. circuits**):** Superposition, Thevenin's & Norton's Theorem (with independent and dependent sources), Maximum power transfer theorem.	06 hrs.
3.	**Circuit Analysis:** Introduction to Graph Theory. Tree, link currents, branch voltages, cut set & tie set, Mesh & Node Analysis, Duality.	06 hrs.
4.	**Time and Frequency Response of Circuits:** First & second order Differential equations, initial conditions. Evaluation & Analysis of Transient Steady state responses using Classical Technique as well as by Laplace Transform (for simple circuits only). Transfer function, Concept of poles and zeros.	09 hrs.
5.	**Two-Port Networks:** Concept of two-port network. Driving point and Transfer Functions, Open Circuit impedance (Z) parameters, Short Circuit admittance (Y) parameters, Transmission (ABCD) parameters. Inverse Transmission (A'B'C'D') parameters. Hybrid (h) parameters. Inter Relationship of different parameters. Interconnections of two-port networks. Terminated two-port networks.	10 hrs.
6.	**Fundamentals of Network Synthesis:** Positive real functions, Driving Point functions, Properties of positive real functions. Testing Positive real functions. Testing driving point functions, Maximum modulus theorem, Properties of Hurwitz polynomials, Residue computations, Even & odd functions, Driving Point Synthesis with L-C, R-C, R-L and R-L-C networks.	10 hrs.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Term work:

Term work consists of minimum eight assignments. The distribution of the term work shall be as follows,

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Laboratory work (Assignments, Journal & visit) :15 marks
Attendance (Practical and Theory) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Experiments:

Minimum Three experiments from the below mentioned list should be performed

1. a) To study Z parameters of a two port network.
   b) To study Y parameters of a two port network.
2. To study the cascade network of two port network
3. To study and verify Maximum power theorem
4. To study the second order frequency response of an RLC circuit

To study Time Response of first order system

List of Tutorials:

Minimum seven tutorials from the below mentioned list should be conducted

1. Mesh & Node Analysis and Network Theorems
2. Circuit Analysis
3. Time and Frequency Response of Circuits (Transient Analysis)
4. Time and Frequency Response of Circuits (Laplace Transform Analysis)
5. Two-Port Networks (Two-Port Parameters)
6. Two-Port Networks (Inter Relationship of different parameters. Interconnections of two-port networks)
7. Fundamentals of Network Synthesis (Hurwitz polynomials and Positive real functions)
8. Fundamentals of Network Synthesis (Driving Point Synthesis with L-C, R-C, R-L and R-L-C networks)

Books Recommended:

Text Books:

1. Sudhakar & S.P. Shyammohan, Circuits and Networks, Tata McGraw Hill, thirteenth reprint, 2000.
2. William H. Hayt, Jack e. Kemmerly & Steven M. Durbin, Engineering Circuit Analysis, McGraw Hill International, sixth edition, 2202.
3. Raymond A. DeCarlo & Pen-Min Lin, Linear Circuit Analysis, Oxford University Press, second edition, 2001.
4. M. E. Van Valkenburg, Introduction to Modern Network Synthesis, Wiley Eastern Ltd.

Reference Books:

1. Artice M. Davis, Linear Circuit Analysis, Thomson Asia Pte. Ltd, Singapore, first edition, 2001.
2. M.E. Van Valkenburg, Network Analysis, Prentice Hall of India, third edition
3. C.L.Wadhwa, Network Analysis and Synthesis, New Age International Publisher, Third Edition.

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM304	Human Anatomy and Physiology (abbreviated as HAP)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM304	Human Anatomy and Physiology	20	20	20	80	25	-	25	150

Course Objectives	To understand the human anatomy and functions of various body structures. To understand different physiological processes taking place inside human body.
Course Outcomes	Students will be well versed with the anatomy and physiology of human body. By this they will be able to correlate the knowledge of medicine and engineering for development of various instrumentation.

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Module	Contents	Time
Anatomy		
1.	**Cell:** Structure and functions of cell. Polarization and depolarization of cell. **Body Structure:** Basic tissues and their functions in brief. Outline of structures of the following system. Cardiovascular System, Respiratory System, Alimentary System, Central Nervous System. Reproductive System, Urinary System, Skeletal System, Muscular System, Endocrine System**,** Special Organs – Eye and Ear, Integumentary system (Skin Study)	10 hrs.
Physiology		
2.	**Cardiovascular System**: Heart, Conductive tissues of heart, Cardiac cycle, Heart Valves, System and Pulmonary Circulation, Transmission of Cardiac Impulse, Blood Pressure, ECG (Einthoven's Triangle, Various leads and Waveforms). **Respiratory System:** Respiration external (Ventilation) Exchange in gases in the alveoli, Artificial respiration. Spiro meter (Forced expiratory volumes) peak flow meter.	10 hrs.
3.	**Blood:** Composition of Blood – Blood cells and their functions. Cell counting, Hemoglobin, Blood groups, Coagulation, Blood transfusion. **Muscle Physiology:** Muscle physiology and aspects of skin resistance	06 hrs.
4.	**Alimentary System:** All organs of the digestive system, other secretions and main Functions. Deglutition and defecation. **Excretory System:** Structure of Nephron, formation of urine and function of Kidney, Urinary Bladder, urethra, internal / external sphincters.	08 hrs.
5.	**Nervous System:** Different parts, their functions. Reflex actions and reflex are, Function of Sympathetic and Parasympathetic nervous system. Never conduction and action potentials. **Eyes and Ears:** Eyes-Structure, Refractive Medias of the eye, formation of image on the Retina, Ophthalmoscope. Ear – Structure of Cochlea, Hearing mechanism, type of Deafness. Hearing aid.	08 hrs.
6.	**Reproductive System:** (Male and Female) Different organs and their functions. Main actions of Androgens, Oestrogens and Progesterone. **Endocrine System:** All glands, their secretions and functions. Control of secretions.	06 hrs.

Assessment:

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Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:
Oral exam will be based on entire subject and the tutorials conducted.

Term work:
Term work consists of minimum eight assignments. The distribution of the term work shall be as follows,

Laboratory work (Assignments, Journal & visit) :15 marks
Attendance (Practical and Theory) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Experiments:
1. To measure Blood Pressure using sphygmomanometer using occlusive cuff method.
2 To determine hemoglobin count in the blood by Shali‘s method.
3. In-vitro recognition of A, B, O blood groups by slide test.
4. To find the total Red Blood Cell count using Neubauer‘s haemocytometer.
5. To find the total White Blood Cell count using Neubauer‘s haemocytometer.
6. To study the Defibrillator
7. To study external Pacemaker
8. To study ECG Machine

Books Recommended:

Text Books:

1. Anatomy and Physiology in Health and Illness: Ross and Wilson. (ELBS Pub)
2. Essentials of Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

Reference Books:

1. Physiology of Human Body. : Guyton. (Prism Book)
2. Review of Medical Physiology: William Ganong. (Prentice Hall Int)
3. Principles of Anatomy and Physiology: Tortora and Grabowski. (Harper collin Pub)
4. Anatomy and Physiology: Elaine N Marieb. (Pearson Education)

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM305	Biomaterials	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM305	Biomaterials	20	20	20	80	25	-	25	150

Course Objectives	To understand the fundamentals of materials used for manufacturing implants, prosthesis and orthoses that has wide application in healthcare industry. To understand the optimal performance of the biomaterials biologically and its biocompatibility with the human system. Students should know the basis of manufacturing processes, effective implementation of biomaterials after surface testing and final implantation. They should be aware of the properties of different biomaterials used and several biological substitutes. They should be aware of the quality testing and the approval by ASTM (American Society of Testing and Materials).
Course Outcomes	This course assigned lectures, tutorials, assignments and industrial visit which enables the students to: Understand the definition of biomaterials, its classification and its surface analysis techniques. The various metallic and ceramic material used for manufacturing of the implants. Several biodegradable polymers and ceramics are utilized for the comfort of the patients, which hydrolizes in situ. Bioglass like 45S5 which has certain amounts of elements in specified proportion, used for biomedical applications in optical areas. The students get awareness about the testing of the biomaterials done biologically before implantation in the human body.

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Module	Contents	Time
1.	**Introduction**: Introduction of Biomaterials, Classification of Biomaterials, General Applications. **Properties and Applications of Metallic Biomaterials and its Biocompatibility:** Stainless steel, Titanium, Titanium based alloys, Cobalt – Chromium alloys in fabrication of bio-devices and implants.	10 hrs.
2.	**Properties and Applications of Polymeric Biomaterials:** Classification, polyurethanes, PTFE, Polyethylene, Polypropylene, Polyacrylates, PMMA, PHEMA, Hydrogel, Silicone rubber, Biopolymer in fabrication of biodevices and implants, Thermoplastic and thermosetting plastics. **Composite Biomaterials:** Properties and Applications of Composite Biomaterials in fabrication of biodevices and implants, Different fabrication processes.	10 hrs.
3.	**Properties and Applications of Ceramic Biomaterials:** Classification, Alumina, Zirconia and types, Bioglass, Calcium Phosphate, Tricalcium phosphate in fabrication of biodevices and implants. **Properties and Applications of Degradable Biomaterials:** Polymers & Ceramics in fabrication of biodevices and implants.	08 hrs.
4.	**Biomaterials for Soft Tissue Replacements:** Properties and Applications of biomaterials for Soft Tissue Replacements, Bulk Space Fillers, Maxillofacial implants, Fluid transfer Implants, Functional Load carrying and supporting implants, Percutaneous devices, Biomaterials in urological practice, Drug delivery systems, Heart valves, Artificial kidney (dialyzer membrane)	08 hrs.
5.	**Techniques for characterization of Surface properties of Biomaterials:** Electron Spectroscopy for Chemical Analysis(ESCA), Secondary Ion Mass Spectrometry(SIMS), Infrared Spectroscopy, Contact Angle Method, Scanning Electron Microscope(SEM).	06 hrs.
6.	**Biological Testing of Biomaterials:** Physiochemical Test, Mechanical Test, Invitro and Invivo types, Different forms of corrosion, Wear, Electrochemical Corrosion Testing.	06 hrs.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:

Oral exam will be based on entire subject and the tutorials conducted.

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Term work:

Term work consists of minimum eight assignments. The distribution of the term work shall be as follows,

Laboratory work (Assignments, Journal & visit) :15 marks

Attendance (Practical and Theory) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Tutorials:

1) Introduction of Biomaterials.
2) Techniques for characterization of Surface properties of Biomaterials.
3) Biological Testing of Biomaterials.
4) Properties and Applications of Metallic Biomaterials and its Biocompatibility.
5) Properties and Applications of Polymeric Biomaterials.
6) Properties and Applications of Ceramic Biomaterials.
7) Biomaterials for Soft Tissue Replacements.
8) Report based on visit or demonstration within the institution.

Visit to Biomaterial manufacturing industry to study the manufacturing of the Biomaterial from raw material to finished product. During the visit the students are required to study.

i. The manufacturing/fabrication steps of Biomaterials. (Related to specific application).
ii. Design considerations/ selection criteria of Biomaterials.(Related to specific application).

The student should submit the detailed report depending on the observations made. The concerned teachers of subject Biomaterial will co-ordinate the visit.

Books Recommended:

Text Books:

1. Biomaterial Science and Engineering: J.V. Park (Plenum Press- New York)
2. Fundaments of Biomedical Engineering: G S. Sawhney (New Age International Publication)
3. Biomaterial Science: An Introduction to Materials in Medicine, Ratner & Hoffmann

Reference Books:

1. Encyclopedia of Medical Devices and Instrumentation: John G. Webster. Vol. I, II, III, IV (Marcel Dekkar Pub).
2. Encyclopedia – Handbook of Biomaterials and Bioengineering: Part-A: Materials Vol I, II (Marcel Dekkar Pub) Part – B: Applications Vol. I, II.
3. Design Engineering on Biomaterials for medical devices: David Hill, John Willey Publication
4. Biological Performance of Materials, 2nd Edition – Jonathan Black, Marcel Dekker Inc. New York. Basel. Hong Kong

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM306	Object Oriented Programming & Methodology	-	4 #	-	-	2	-	2

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM306	Object Oriented Programming & Methodology	-	-	-	-	50	50*	-	100

Course Objectives	To understand the concept of Object Oriented Programming To help student to understand use of programming language such as JAVA to resolve problems. To impart problems understanding, analyzing skills in order to formulate Algorithms. To provide knowledge about JAVA fundamentals: data types, variables, keywords and control structures. To understand methods, arrays, inheritance, Interface, package and multithreading and concept of Applet.
Course Outcomes	Students will be able to code a program using JAVA constructs. Given an algorithm a student will be able to formulate a program that correctly implements the algorithm. Students will be able to generate different patterns and flows using control structures and use recursion in their programs. Students will be able to use thread methods, thread exceptions and thread priority. Students will implement method overloading in their code. Students will be able to demonstrate reusability with the help of inheritance. Students will be able to make more efficient programs.

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Module	Topic	Time
1.	**Fundamental concepts of object oriented programming** Overview of programming: Introduction to the principles of object-oriented programming: Classes, objects, messages, abstraction, encapsulation, inheritance, polymorphism, exception handling, and object-oriented containers Differences and similarity between C++ and JAVA	4 hrs.
2.	**Fundamental of Java programming** Features of Java , JDK Environment & tools ,Structure of Java program ,Keywords , data types, variables, operators, expressions. Decision making, looping, type casting, Input output using scanner class	4 hrs.
3.	**Classes and objects** Creating classes and objects, Memory allocation for objects Passing parameters to Methods ,Returning parameters Method overloading ,Constructor and finalize ( ) Arrays: Creating an array Types of array : One dimensional arrays ,Two Dimensional array, string	6 hrs.
4	**Inheritance, interface and package** Types of inheritance: Single, multilevel, hierarchical Method overriding, super keyword, final keyword, abstract class Interface, Packages	4 hrs.
5.	**Multithreading** Life cycle of thread, Methods, Priority in multithreading	6 hrs.
6.	**Applet** Applet life cycle ,Creating applet, Applet tag	2 hrs.

Note: Out of four hours of practical two hours to be conducted as theory

Text Books:

1. Rajkumar Buyya, **–***Object-oriented programming with JAVA"*, Mcgraw Hill
2. E Balgurusamy, *"Programming with JAVA",* Tata McGraw Hill

Reference Books:

1. Herbert Schildt, *"The Complete Reference JAVA"*, Tata McGraw Hill
2. Barry Holmes and Daniel T. Joyce, *"Object Oriented Programming with Java"*, Jones &

Term Work:

At least **10** experiments covering entire syllabus should be set to have well predefined inference

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and conclusion. The experiments should be students‘ centric and attempt should be made to make experiments more meaningful, interesting and innovative.
Term work assessment must be based on the overall performance of the student with every experiment graded from time to time. The grades will be converted to marks as per **Credit and Grading** System manual and should be added and averaged. Based on the above scheme grading and term work assessment should be done.

The Practical / Oral examination will be based on entire syllabus.

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM401	Applied Mathematics-IV	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM401	Applied Mathematics-IV	20	20	20	80	25	-	-	125

Course Objectives	This course will present the method of calculus of variations (CoV), basic concepts of vector spaces,matrix theory, concept of ROC and residue theory with applications. To provide students with a sound foundation in mathematics and prepare them for graduate studies in Electronics and Telecommunication Engineering To provide students with mathematics fundamental necessary to formulate, solve and analyse engineering problems. To provide opportunity for students to work as part of teams on multi disciplinary projects
Course Outcomes	Students will able to apply method of calculus of variations to specific systems, demonstrate ability to manipulate matrices and compute eigenvalues and eigenvectors, Identify and classify zeros, singular points, residues and their applications. Students will demonstrate an ability to identify formulate and solve Telecommunication Engineering problem using applied mathematics. Students who can participate and succeed in competitive exams like GATE, GRE

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Module	Content	Time
1.	**Calculus of variation** Euler Langrange equation, solution of Euler's Langrange equation (only results for different cases for function) independent of a variable, independent of another variable, independent of differentiation of a variable and independent of both variables Isoperimetric problems, several dependent variables **Functions involving higher order derivatives:** Rayleigh-Ritz method	10 hrs.
2.	**Linear algebra: vector spaces** **Vectors in n-dimensional vector space**: Properties, dot product, cross product, norm and distance properties in n-dimensional vector space. Metric spaces, vector spaces over real field, properties of vector spaces over real field, subspaces. Norms and normed vector spaces Inner products and inner product spaces The Cauchy-Schwarz inequality, orthogonal Subspaces, Gram-Schmidt Process	12 hrs.
3.	**Linear Algebra: Matrix Theory** Characteristic equation, Eigenvalues and Eigenvectors, properties of Eigenvalues and Eigenvectors Cayley-Hamilton theorem, examples based on verification of Cayley-Hamilton theorem Similarity of matrices, Diagonalisation of matrix Functions of square matrix, derogatory and non-derogatory matrices Quadratic forms over real field, reduction of quadratic form to a diagonal canonical form, rank, index, signature of quadratic form, Sylvester's law of inertia, value-class of a quadratic form of definite, semidefinite and indefinite Singular Value Decomposition	15 hrs.
4.	**Complex Integration:** Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula Taylor's and Laurent's series. **Complex Variables:** Zeros, singularities, poles of f(z), residues, Cauchy's Residue theorem Applications of Residue theorem to evaluate real Integrals of different types	15 hrs.

Text books:

1) A Text Book of Applied Mathematics Vol. I & II by P.N.Wartilar & J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune
2) Mathematical Methods in science and Engineering, A Datta (2012)
3) Higher Engg. Mathematics by Dr. B.S. Grewal, Khanna Publication

Reference Books:

1) Todd K.Moon and Wynn C. Stirling, Mathematical Methods and algorithms for Signal Processing, Pearson Education.

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2) Kreyszig E., Advanced Engineering Mathematics, 9th edition, John Wiley, 2006.
3) Linear Algebra- Hoffman & Kunze (Indian editions) 2002
4) Linear Algebra- Anton & Torres (2012) 9th Indian Edition.
5) Complex Analysis – Schaum Series.

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

End Semester Examination:
1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. The students need to solve total 4 questions.
3: Question No.1 will be compulsory and based on entire syllabus.
4: Remaining question (Q.2 to Q.6) will be selected from all the modules.

Term Work:
At least 08 assignments covering entire syllabus must be given during the **Class Wise Tutorial**. The assignments should be students' centric and an attempt should be made to make assignments more meaningful, interesting and innovative.
Term work assessment must be based on the overall performance of the student with every assignment graded from time to time. The grades will be converted to marks as per **Credit and Grading System** manual and should be added and averaged. Based on above scheme grading and term work assessment should be done.

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM402	Electronic Circuits and Design – II (abbreviated as ECAD-II)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM402	Electronic Circuits and Design – II	20	20	20	80	25	25	-	150

Course Objectives	The course covers the basic principles of Linear Integrated Circuit and Operational Amplifiers in particular their analysis, design and applications. Few practical and specific IC chips are studied.
Course Outcomes	To acquire the ability to design practical circuits by selecting proper IC chips needed for a particular application.

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Module	Contents	Time
1.	**Feedback and Stability:** • Introduction to Feedback, Basic Feedback Concepts. • Ideal Close-Loop Gain, Gain Sensitivity Bandwidth Extension, Noise Sensitivity, Reduction of Non-Linear Distortion. • Ideal Feedback Topologies, Series-Shunt, Shunt-Series, Series-Series, Shunt-Shunt Configurations, Voltage (Series-Shunt) Amplifiers, Current (Shunt-Series) Amplifiers, Trans-Conductance (Series-Series) Amplifiers, Trans-Resistance (Shunt-Shunt) Amplifiers, Stability of Feedback Circuit.	10 hrs.
2.	**Output Stage and Power Amplifiers :** • Classes of Power amplifiers, Class-A Operation, Class-B operation, Class AB Operation, Class C Operation, • Analysis of: Class-A Power Amplifiers (Direct coupled and Transformer coupled), Class-B Power Amplifiers, Class-AB Push Pull and Complementary Symmetry Power amplifier. • Power amplifier design. • Heat Sinks, design of Heat Sinks.	05 hrs.
3.	**Differential Amplifiers:** • Basic Concept, characteristics. • Types: Dual Input Balanced Output, Dual Input Unbalanced Output, Single Input Balanced Output And Single Input Unbalanced Output. • Common mode and Differential mode analysis - DC and AC analysis. • Differential amplifiers with Swamping Resistor. • Constant current source, current mirror circuits and active loads.	05 hrs.
4.	**Operational Amplifier Circuit Design :** • Introduction to an Ideal Operational Amplifier , Operational Amplifier internal circuit, Block Diagram, DC Characteristics, AC Characteristics and equivalent circuit of Op-amp, • Op-amp IC 741 characteristics and its features (Ideal and Practical), Open loop, closed loop concept, frequency response and concept of virtual ground. • Modes of operation: Inverting, Non-inverting, Differential mode.	05 hrs.
5.	**Operational Amplifiers Applications :** • **Applications without using any Feedback:** Voltage comparators (Inverting and Non- inverting) and Window detectors, zero detector. • **Applications using Negative Feedback:** Adder, Subtractor/differential Amplifier, Voltage follower, Integrator (practical and Ideal), Differentiator (practical and Ideal), Instrumentation amplifier, Voltage to Current and Current to Voltage converters, Precision diodes, Active Half wave rectifiers, Active Full wave rectifier, Clipper, Clampers, Log and Antilog amplifiers, Sample & hold circuits, Peak detector, Gyrator, Negative Impedance convertor, Multipliers and Dividers,	15 hrs.

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	Isolation Amplifier, Operational Transconductance Amplifiers. • **Applications using Positive Feedback (Waveform generators): -** Schmitt Trigger (Regenerative comparator), Square wave generator (Astable Multivibrator), Monostable Multivibrator, Triangular wave generator, Saw tooth wave generator, Sine wave Generator (Oscillators)	
6.	**Oscillators using Op-Amp:** • Concepts of Oscillation. Barkhausen's criteria for an oscillator. • Types of oscillators: RC Phase shift Oscillator, Wien Bridge oscillator, Colpitt's Oscillator, Hartley Oscillator, Crystal Oscillator, Clapp Oscillator, Twin T oscillator, Tuned collector oscillator. (Phase shift, Frequency of oscillation, condition of sustained oscillation, circuit operation and Amplitude stability in the above oscillators).	08 hrs.

Assessment:

Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Practical & Oral Examination:

Practical examination will be based on one experiment performed from the list of experiments given in the syllabus and the oral will be based on entire subject.

Term work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows,

Laboratory work (Experiments and Journal) :15 marks
Attendance (Practical and Theory) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Experiments:

1. Differential Amplifier
2. Negative Feedback.
3. Op-Amp Parameters
4. Op-Amp as integrator.
5. Op-Amp as differentiator
6. Opamp as adder and substractor
7. RC Phase shift oscillator using opamps
8. Wein Bridge Oscillator using opamps
9. Instrumentation Amplifier
10. Schmitt triggers
11. Comparator

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12. Class A design
13. Simulations of various circuits

Books Recommended:

Text Books:

3. Electronic Circuit Analysis and Design- Donald A Neamen,
4. Electronic Devices and circuits – R Bolystead.
5. Op-Amps and linear integrated circuits – R. Gayakwad
6. Linear Integrated Circuits: Roy Chaudhary

Reference Books:

1. Integrated Electronics –Millman & Halkias
2. Opamps and linear integrated circuits, Theory and Applications- James Fiore

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM403	Transducers and Sensors for Medical Applications (abbreviated as TSMA)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM403	Transducers and Sensors for Medical Applications	20	20	20	80	25	-	25	150

Course Objectives	To provide the knowledge of basic concepts such as generalized instrumentation system, general properties of input transducers, static and dynamic characteristics of transducers and sensors. To provide a thorough understanding of principle and working of transducers and sensors used for displacement, motion, pressure and temperature measurement, biopotential electrodes, chemical sensors, biosensors, fiber optic sensors, and radiation sensors. To study the biomedical applications of the above transducers and sensors. To perform experiments based on some of the above transducers and sensors.
Course Outcomes	After completion of the above course the students shall be competent in the following ways: 1) They have a clear understanding of generalized medical instrumentation system, general properties of input transducers, static and dynamic characteristics of transducers and sensors. 2) They have a thorough understanding of various transducers and sensors taught in the course. 3) They are able to apply the transducers and sensors learnt in the course in suitable medical contexts. 4) They have a working knowledge of some the transduces and sensors that they have learnt in the course.

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Module	Contents	Time
1.	**Introduction:** Generalized Instrumentation System, General Properties of Input Transducer. Static Characteristics: Accuracy, Precision, Resolution, Reproducibility, Sensitivity, Drift, Hysteresis, Linearity, Input Impedance and Output Impedance. Dynamic Characteristics: First Order and Second Order Characteristics, Time Delay, Error Free Instrument, Transfer Functions. Design Criteria, Generalized Instrument Specifications.	06 hrs.
2.	**Displacement, motion and Pressure Measurement**: (with applications) Resistive: Potentiometers, Strain Gauges and Bridge Circuits. Inductive: Variable Inductance and LVDT Capacitive type, Piezoelectric Transducers. Types of Diaphragms, Bellows, Bourdon Tubes.	08 hrs.
3.	**Temperature Measurement:** Thermistor, Thermocouple, Resistive Temperature Detector, IC based Temperature Measurement Radiation Sensors and Applications	08 hrs.
4.	**Biopotential Electrodes:** Electrodes Electrolyte Interface, Half-Cell Potential, Polarization, Polarizable and Non Polarizable, Electrodes, Calomel Electrode, Electrode Circuit Model, Electrode Skin-Interface and Motion Artifact. Body Surface Electrodes. Internal Electrodes: Needle and Wire Electrodes (Different Types). Microelectrodes: Metal, Supported Metal Micropipette (Metal Filled Glass And Glass Micropipette Electrodes)	08 hrs.
5.	**Chemical Sensors:** Blood gas and Acid- Base Physiology Potentiometric Sensors, Ion Selective Electrodes, ISFETS. Amperometric Sensors, Clark Electrode with examples - pH, pO2, pCO2 Electrodes, Transcutaneous Arterial Oxygen Tension, Carbon Dioxide measurements: capnostat. **Fiber Optic Sensors:** Design Principles in Fabrication of Fiber Optic Sensors - Temperature, Chemical, Pressure.	10 hrs.
6.	**Biosensor:** Classifications: Biological phenomenon, Transduction Phenomenon i.e. Enzyme Sensor and Electrode based: Affinity Sensors (Catalytic Biosensors), Two examples of each Biosensors and Immunosensors. Fiber optic sensor:	08 hrs.

Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:
Oral exam will be based on entire subject and the tutorials conducted.

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Term work:

Term work consists of minimum eight experiments. The distribution of the term work shall be as follows,

Laboratory work (Assignments and Journal) :15 marks

Attendance (Practical and Theory) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Experiments

1. To study the dynamic behavior of thermometer system.
2. To study the characteristics of a thermistor.
3. To study thermistor linearization.
4. To study the characteristics of a light dependent resister.
5. To study the principle and working of a thermocouple.
6. To study principle and working of LVDT.
7. To study principle and working of a capacitive Transducer.
8. To study principle and working of a strain gage sensor.
9. To study principle and working of a pressure sensor.
10. To study biopotential electrodes.
11. To study electrode skin interface (Contact Impedance).
12. To study pH electrode.

Books Recommended:

Text Books:

1. Medical Instrumentation-Application and Design by John G. Webster.
2. Transducers for Biomedical Measurements: Principles and Applications, Richard S.C. Cobbold, John Wiley & Sons, 1974.
3. Instrument Transducer – An Intro to their performance and design, Hermann K P. Neubert.
4. Biomedical sensors – fundamentals and application by Harry N, Norton.
5. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiyo Tamma and P. Ake Öberg.
6. Electronics in Medicine and Biomedical Instrumentation by Nandini K. Jog PHI Second Edition 2013.

Reference Books:

1. Principles of applied Biomedical Instrumentation by La Geddes and L.E. Baker.
2. Biomedical instrumentation and measurement by Leslie Cromwell, Fred. J. Weibell and Pfeiffer.
3. Principles of Biomedical Instrumentation and Measurement, Richard Aston, Merril Publishing Co., Columbus, 1990.
4. Measurement Systems, Application and Design, Ernest O. Doeblin, McGraw-Hill, 1985.
5. Handbook of Modern Sensors – Physics, Design and Application, Jacob Fraden, AIP press.

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM404	Logic Circuits (abbreviated as LC)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM404	Logic Circuits	20	20	20	80	25	25	-	150

Course Objectives	To make students aware of basics of Digital circuits, Logic design various Logic Families, Flip-flops, Design of various counters, registers and their applications.
Course Outcomes	Students will gain expertise on developing analog and digital circuits for various applications in the field of Electronics and Instrumentation.

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Module	Contents	Time
1.	**Introduction:** Number system, Binary, Octal, Hexadecimal and other. Conversion from One system to another, Binary, BCD and Hexadecimal. Binary Arithmetic (addition, subtraction, multiplication, division) Hexadecimal and octal arithmetic, first and second complement methods. **Binary Codes:** Weighted Reflective, Sequential, Gray, Error detecting codes, Odd, Even parity, Hamming Codes, Alphanumeric, Morse, Teletypewriter ASCII, EBCDIC codes, Converting Binary to Gray & Gray to Binary, Conversion from BCD to XS3. Application of gray code, shaft position encoding. **Boolean Algebra Logic Gates:** AND, OR, NOT, XOR, XNOR, operation NAND, NOR used of the universal gate for Performing different operation. Laws of Boolean algebra. De- Morgan's theorems. Relating a Truth Table to a Boolean Expression. Multi level circuits.	08 hrs.
2.	**Combinational Circuits:** K-MAPS and their use in specifying Boolenan Expressions, Minterm, Maxterm SOP and POS Implementation. Implementation a logic function using universal gates. Variable entered maps For five and six variable functions Quine Mc Clusky tabular techniques.	6 hrs.
3.	**Combinational Logic Circuit Design:** Designing code converter circuits e.g. Binary to Gray, BCD to Seven Segments, Parity Generator. Binary Arithmetic circuits:- Adders, Subtractors (Half and full) BCD adder- Subtractor, carry Lookaheard adder, Serial adder, Multiplier Magnitude Comparators, 7485 comparator, Arithmetic Logic units. **Use of Multiplexers in Logic Design:** Multiplexer (ULM) Shannon's theorem. ULM trees. De- Multiplexers, Line decoders, Designing using ROMs and ULMs. Hazards in combinational circuits.	10 hrs.
4.	**Sequential Logic Circuits:** Comparison of Combinational & Sequential Circuits, Multi-vibrators (Astable, Monostable And Bistable) Flip-Flops, SR, T, D, JK, Master Slave JK, Converting one Flip-Flop to another, Use of Denounce switch. Counter Modulus of a counter, Ripple counter, Up/Down Counter, Designing sequential counters using gate IC and counter IC by drawing state transition Diagram & state transition table. Ring counter Johnson counter, twisted ring counter, Pseudo Random number generator, Unused states and locked conditions.	10 hrs.
5.	**Registers:** Serial input serial output, serial input parallel output, Left Right shift register, Use of register ICs for sequence generator and counter. Bidirectional shift register. **Memories:** RAM, ROM the basic cell IC bipolar, CMOS, RAM dynamic RAM cell. Magnetic core NVRAM, bubble memory, CCD, PAL, PLA.	08 hrs.
6.	**Logic Families:** RTL, DTL, TTL, schotkey clamped TTL, Tristate gate ECL, IIL, MOS device CMOS Comparison of logic families, interfacing different families. TTL with CMOS, NMOS, TTL, ECL, & TTL, IIL, & TTL.	06 hrs..

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Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:
Oral exam will be based on entire subject and the practicals conducted.

Term work:
Term work consists of minimum eight experiments. The distribution of the term work shall be as follows,
Laboratory work (Assignments and Journal) :15 marks
Attendance (Practical and Theory) :10 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List of Experiments
1. To study the various Logic gates.
2. To design various gates using Universal gates.
3. To design binary to gray code converter and gray to binary converter.
4. To design BCD to Excess3 converter.
5. To design parity generator and parity checker circuits.
6. To design adder and subtractor circuits.
7. To design various circuits using multiplexers.
8. To design various circuits using de-multiplexer.
9. To study S-R , J-K, T and D Flip flops.
10. To design Asynchronous counter.
11. To design Synchronous counter.

Books Recommended:
Text Books:

1. R.P.Jain, ―Modern Digital Electronics,‖ Tata McGraw Hill, 1984
2. M Morris Mono, –Digital Design,‖ Prentice Hall International-1984.
3. Malvino & Leach, –Digital Principal and Applications‖ , Tata McGraw Hill, 1991.
4. Malvino, –Digital Electronics‖ , Tata McGraw Hill, 1997.

Reference Books:

1. James Bignell & Robert Donovan, –Digital Electronics‖ , Delmar, Thomas Learning,
2. Jog N.K, –Logic Circuits‖ , 2nd edition, Nandu Publisher & Printer Pvt .Ltd. 1998.
3. Alan b. Marcovitz, –Introduction to Logic Design –, McGraw Hill International 2002.

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM405	Signals and Systems (abbreviated as SS)	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM405	Signals and Systems	20	20	20	80	25	-	25	150

Course Objectives	To introduce the concepts and techniques associated with the understanding of signals and systems such as the basic parameters, properties and interaction of signals and system. To familiarise with techniques suitable for analysing and synthesising signals and systems both in continuous as well as discrete time domain.
Course Outcomes	Upon the completion of this course, the students should demonstrate the ability to: Represent signals and system mathematically, determine basic parameters ,transformation signal independent variable, describing continuous and discrete systems in terms of differential and difference equations respectively. Derive and calculate convolution sum and integral of LTI systems, properties of system in terms of impulse response. Determine Fourier series representation of CT &DT signals, properties of Fourier series, determine CT and DT Fourier transform of both periodic and non periodic signals, Properties, and convergence issues. Derive and determine Laplace transform, region of convergence, application of Laplace transform .inverse Laplace transform. Derive and determine z-transform, ROC and the properties .inverse z-transform, application of z-transform. Block diagram representation of the system function. Pole zero plots .

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Module	Contents	Time
1.	**Introduction to Signals and Systems:** Definition of signals and systems, communication and control systems as examples, Classification of signals: Continuous time and discrete time, 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 folding, precedence rule. Elementary signals: exponential, sine, step, impulse and its properties, ramp, rectangular, triangular, signum, sinc functions. Systems: Definition, Classification: linear and non linear, time variant and invariant, causal and non-causal, static and dynamic, stable and unstable, invertible.	10 hrs.
2.	**System Analysis:** System modeling: Input output relation, impulse response, block diagram, integro-differential equation. Definition of impulse response, convolution integral, convolution sum, computation of convolution integral using graphical method and analytical method. Properties of convolution, system interconnection, system properties in terms of impulse response, step response in terms of impulse response.	08 hrs.
3.	**Fourier Analysis of Continuous Time Signals** Orthogonal functions, Representation of signals in terms of weighted orthogonal basis functions, Coefficient calculation on the basis of minimum square error. Fourier series: Representation of Fourier series in terms of sine, cosine, exponential functions. The complex Fourier spectrum, Properties of Fourier series, Power Density Spectrum. convergence of Fourier series, Gibbs phenomenon, Fourier transform and its properties. Fourier transform of singular functions. Energy density spectrum.	08 hrs.
4.	**Fourier series of discrete time signal** Harmonically related complex exponential, Determination of discrete time Fourier series – Properties, Discrete time Fourier transform – Properties, Fourier Transform of periodic signals	06 hrs.
5.	**Laplace Transform:** Double sided Laplace transforms, Region of Convergence, properties, Unilateral Laplace Transform, properties, applications of Laplace transform to the solution of differential equations. Relationship between Laplace and Fourier transform.	08 hrs.
6.	**Z-Transformation:** Definition, Region of Convergence, properties and inverse of z transform. Long division method, partial fraction expansion method, residue method – one-sided Z-transform –properties – initial value & final value theorem - solution of LCCDE with initial conditions – zero input response and zero state response - system function – poles and zeros – basic concept of BIBO stability. Analysis of discrete time systems using Z−transform. Relationship between Laplace and Z transform.	08 hrs.

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Assessment:
Internal Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.
End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:
Oral exam will be based on entire subject and the tutorials conducted.

Term work:
Term work consists of minimum eight assignments.(Tutorials) The distribution of the term work shall be as follows,
Laboratory work (Assignments, Journal & visit) :15 marks
Attendance (Practical and Theory) :10 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Books Recommended:
Text Books:

1. Oppenheim A. V. & Alan S.Wllisky, Signals and Systems, Pearson Education
2. Simon Haykin & Barry Van Veen, Signals and Systems, Wiley-India

Reference Books:

1. ProakisJ. G. & Manolakis D. G., Digital Signal Processing, Principles, algorithms & applications, Pearson Education
2. Ramesh Babu P., Signals and Systems, Scitech Publications(India) Pvt. Ltd.
3. Charles L. Phillips,John M. Parr & EveARiskin, Signals, Systems and Transforms, Pearson Education

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Sub Code	Subjects	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
SEBM406	Electronic Instruments and Control System (abbreviated as EICS)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
SEBM406	Electronic Instruments and Control System	20	20	20	80	25	-	25	150

Course Objectives	To make students learn basic principle of working and applications of various Electronic Instruments. Time domain and Frequency domain analysis of dynamic systems with concepts of stability.
Course Outcomes	Students will be able to effectively use Electronic Instruments in the laboratory for various experiments. They will be able to analyze given systems and suggest modifications.

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Module	Contents	Time
Electronic Instruments		
1.	**Electronic and Digital Voltmeter:** Principle of Operation: Ammeter, Voltmeter and Ohmmeter, Advantages of EVM over Conventional type Analog Voltmeter. Factors involved in selection of Voltmeter. FET Voltmeter, Peak and Average Responding voltmeter, True RMS responding voltmeter. Digital to Analog Converter: Binary weighted and R-2R ladder. Analog to digital converter: Ramp type, Dual Slope type, Successive Approximation type ADC, ADC 0808. DVM: Ramp type, Dual Slope type, Successive Approximation type, Flash type DVM. Resolution & Sensitivity. Multimeter: Working, Specifications	06 hrs.
2.	**Frequency meter, Phase meter and Function generator:** Digital frequency meter with various applications. Digital Phase meter: Block diagram and working. Signal Generator: Block diagram, Specifications. Function Generator: Block diagram and working, Specifications.	06 hrs.
3.	**Oscilloscopes:** Block Diagram of C.R.O (in details). Requirements of Time base, Delayed Time Base, Post deflection acceleration, triggering. Description of Panel Layout and working of controls. Specifications of CRO. Applications: Measurement of voltage, current. Measurement of phase and frequency - Lissajous Patterns, Intensity modulation, Velocity modulation. Component testing. Types: Dual trace, Dual beam, Sampling, Analog Storage, Digital Storage, Digital readout oscilloscope – Block diagram, working, applications and comparison.	08 hrs.
Control Systems		
4.	**Introduction to Control Systems:** Basic concepts of control systems, open loop and closed loop systems, difference between open loop and closed loop systems, classifications. Mathematical model of physical systems, transfer function, block diagram algebra, signal flow graph (SFG), Masoin's gain formula, application of SFG to control systems.	08 hrs.
5.	**Time domain analysis :** Standard test signals: Step, ramp, parabolic and impulse signals. Time response of 1st order systems to unit step and unit ramp inputs. Time response of 2nd order to unit step input. Time response specifications. Steady state errors and error constants of different types of control systems Generalized error series method Transient Response	07 hrs.
6.	**Concepts of stability :** Necessary conditions of stability, Hurwitz stability criterion, routh stability criterion, application of routh stability criterion to linear feed back systems, relative stability. Root locus techniques : Root locus concepts, rules for construction of root loci, determination of root locus, root contours. Frequency domain analysis: Introduction, bode plots, determination of stability from Bode plots, Nyquist stability criterion.	13 hrs.

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Assessment:
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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students. Minimum 80% syllabus should be covered in question papers of end semester examination.

Oral Examination:
Oral exam will be based on entire subject and the tutorials conducted.

Term work:
Term work consists of minimum eight experiments and assignments. The distribution of the term work shall be as follows,
Laboratory work (Assignments, Journal & visit) :15 marks
Attendance (Practical and Theory) :10 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

List Of Experiments:
1. FET, Peak Reading and Average reading Voltmeter
2. D to A converter
3. A to D converter
4. Digital Phase meter
5. Study of Front panel of CRO
6. Lissajous Patterns and component testing using CRO

Books Recommended:
Text Books:

1. Cooper W. D. & Helfrick A.D.- Electronic Instrumentation & Measurement Techniques
2. Kalasi H.S.- Electronic Instrumentation
3. Rangan, Sharma and Mani- Instrumentation devices and system
4. A.K. Sawhney- Electrical & Electronic Measurement & Instrumentation.
5. Modern Control Engineering : D.Roy Choudhury, PHI
6. Modem Control Engineering : K. Ogata , PHI
7. Control Systems Engineering : L.J. Nagrath, M. Gopal, Third Edition, New Age International Publishers.

Reference Books:

1. Control System, Theory & Applications : Samarjit Ghosh, Pearson Education
2. System Dynamic and Control : Eroni Umez Erani., PWS Publishing, International Thompson Publishing Company

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