# 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)

# 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.

| 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.<br>To provide students with mathematics fundamental necessary to formulate, solve and analyze engg. problems.<br>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.<br>Students will demonstrate an ability to identify formulate and solve electronics and telecommunication Engg. problem using Applied Mathematics.<br>Students will show the understanding of impact of Engg. Mathematics on Telecom Engg.<br>Students who can participate and succeed in competitive exams like GATE, GRE. |

| 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<br>**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<br>**Inverse Laplace Transform:** Partial fraction method, long division method, residue method<br>**Applications of Laplace Transform:** Solution of ordinary differential equations | 12 hrs. |
| 2. | **Introduction:** Definition, Dirichlet's conditions, Euler's formulae<br>**Fourier Series of Functions:** Exponential, trigonometric functions, even and odd functions, half range sine and cosine series<br>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<br>Bessel Fourier series of functions | 08 hrs. |
| 4. | **Scalar and Vector Product**: Scalar and vector product of three and four vectors and their properties<br>**Vector Differentiation:** Gradient of scalar point function, divergence and curl of vector point function<br>**Properties:** Solenoidal and irrotational vector fields, conservative vector field<br>**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<br>Reiman equation in polar form<br>Harmonic function, orthogonal trajectories<br>**Mapping:** Conformal mapping, bilinear transformations, cross ratio, fixed points, bilinear transformation of straight lines and circles | 10 hrs. |

**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.

| 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. |

| Module | Contents | Time |
|---|---|---|
| 1. | **Diode Circuits:**<br>Basics of PN junction diode - Equation, characteristics.<br>Clipper and Clamper Circuits, Zener Diode –working, Characteristics. | 05 hrs. |
| 2. | **Bipolar Junction Transistor**:<br>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:**<br>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.<br>A.C. Analysis of amplifiers using CS, CG and CD configurations. considering effect of Rs and RL, Comparison between various amplifiers.<br>Low frequency and High frequency model, Frequency response of Single stage amplifier. Design of single stage amplifier using JFET. | 12 hrs. |
| 5. | **MOSFET:**<br>Working of Depletion and Enhancement MOSFET. Characteristics and equations.<br>Basic MOSFET Applications: Switch, Digital Logic Gate and Amplifier. | 03 hrs. |
| 6. | **Multistage Amplifiers:**<br>Cascade: BJT-BJT, FET-BJT.<br>Cascode – DC and AC analysis, characteristics and applications.<br>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,

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.

| 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 |

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|---|---|
| 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. |

| Module | Contents | Time |
|---|---|---|
| 1. | **Introduction:**<br>Review of D.C. & A.C. circuits,<br>DC Circuits: Current & Voltage Source Transformation, Source Shifting<br>**Mesh & Node Analysis:**<br>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)**:**<br>Superposition, Thevenin's & Norton's Theorem (with independent and dependent sources), Maximum power transfer theorem. | 06 hrs. |
| 3. | **Circuit Analysis:**<br>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:**<br>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:**<br>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:**<br>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,

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.

| 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. |

| Module | Contents | Time |
|---|---|---|
| **Anatomy** | | |
| 1. | **Cell:** Structure and functions of cell. Polarization and depolarization of cell.<br>**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 ).<br>**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.<br>**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.<br>**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.<br>**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.<br>**Endocrine System:** All glands, their secretions and functions. Control of secretions. | 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.

**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)

| 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. |

| Module | Contents | Time |
|---|---|---|
| 1. | **Introduction**: Introduction of Biomaterials, Classification of Biomaterials, General Applications.<br>**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.<br>**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.<br>**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.

**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

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

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

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.**