AC

Item No.

UNIVERSITY OF MUMBAI

Revised Syllabus for the

SE Biomedical Engineering

(Second Year - Semester III and IV)

(As per Choice Based Credit and Grading System with effect from the academic year 2017–2018)

From Co-ordinator's Desk:

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, **Choice Based Credit and Grading System** is also introduced to ensure quality of engineering education.

Choice 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 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 Faculty of Technology has devised a transparent credit assignment policy adopted ten points scale to grade learner's performance. Choice Based Credit and Grading System were implemented for First Year Bachelor of Engineering from the academic year 2016-2017. Subsequently this system will be carried forward for Second Year Bachelor of Engineering in the academic year 2017-2018.

Dr. Suresh K. Ukarande
Co-ordinator,
Faculty of Technology,
Member - Academic Council
University of Mumbai, Mumbai

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 to achieve recognition of the institution or program meeting certain specified standards. The 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 the graduate program in Biomedical Engineering, more than ten senior faculty members from the different institutes affiliated to University of Mumbai were actively participated in this process. Few PEOs were finalized for graduate program in Biomedical Engineering are listed below:

Program Educational Objectives (PEOs)

1. To provide sound knowledge of basic sciences, human anatomy, human physiology, electrical and electronic systems, building a strong foundation for career advancement.

2. To develop a logical approach, analytical thinking and problem solving capabilities in order to make the learner competent to face and address the global challenges in their chosen field.

3. To impart technical knowledge and competency skills to perform in various areas like sales & marketing, product engineering, research-development, hospital administration, regulatory affairs and also to venture into entrepreneurship.

4. To develop proficiency in various soft skills and bring awareness about social obligations and professional ethics to pursue professional career in a healthcare industry.

5. Motivate to pursue research and specialization in a plethora of domains in the field of Biomedical Engineering covering disciplines such as, Medical Instrumentation, Neuroscience, Computational Engineering, Robotics Engineering, Medical Signal and Image processing, Rehabilitation Engineering, VLSI, Nanotechnology and Biosensors, etc.

Program Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

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

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations,

and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Dr. S. R. Deore,
Chairman,
Board of Studies in Electrical Engineering,
Member - Academic Council
University of Mumbai

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC301	Applied Mathematics III (Abbreviated as AM – III)	04	--	01	04	--	01	05

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC301	Applied Mathem-atics III (AM – III)	20	20	20	80	03	25	--	--	--	125

Course Code	Course Name	Credits
BMC301	Applied Mathematics III	05
Course Objectives	• To build the strong foundation in Mathematics of learner needed for the field of Biomedical Engineering. • To provide learner with mathematics fundamentals necessary to formulate, solve and analyses complex engineering problems. • To prepare student to apply reasoning informed by the contextual knowledge to engineering practice. • To prepare learner to work as part of teams on multi-disciplinary projects.	
Course Outcomes	• Learner will demonstrate basic knowledge of Laplace Transform. Fourier series, Bessel Functions, Vector Algebra and Complex Variable. • Learner will demonstrate an ability to identify and Model the problems of the field of Biomedical Engineering and solve it. • Learner will be able to apply the application of Mathematics in Biomedical Engineering.	

Module No	Unit No.	Topic	Hours
1		**Laplace Transform**	
	1.1	**Laplace Transform (LT) of Standard Functions:** Definition of Laplace transform, Condition of Existence of Laplace transform, Laplace transform of $e^{at}, Sin(at), \cos(at), \sinh(at), \cosh(at), t^n$ Heaviside unit step function, Dirac-delta function, Laplace transform of Periodic function	**7**
	1.2	**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, Evaluation of integrals using Laplace transform.	
2		**Inverse Laplace Transform & its Applications**	
	2.1	Partial fraction method, Method of convolution, Laplace inverse by derivative	**6**
	2.2	**Applications of Laplace Transform:** Solution of ordinary differential equations, Solving RLC circuit differential equation of first order and second order with boundary condition using Laplace transform (framing of differential equation is not included)	
3		**Fourier Series**	
	3.1	**Introduction:** Orthogonal and orthonormal set of functions, Introduction of Dirichlet's conditions, Euler's formulae	**11**
	3.2	**Fourier Series of Functions:** Exponential, trigonometric functions of any period =2L, even and odd functions, half range sine and cosine series	
	3.3	Complex form of Fourier series, Fourier integral representation, Fourier Transform and Inverse Fourier transform of constant and exponential function.	
4		**Vector Algebra & Vector Differentiation**	
	4.1	**Review of Scalar and Vector Product**: Scalar and vector product of three and four vectors, Vector differentiation, Gradient of scalar point function, Divergence and Curl of vector point function	**7**
	4.2	**Properties:** Solenoidal and irrotational vector fields, conservative vector field	
5		**Vector Integral**	
	5.1	Line integral	**6**
	5.2	Green's theorem in a plane, Gauss' divergence theorem and Stokes' theorem	
6		**Complex Variable & Bessel Functions**	

	6.1	**Analytic Function:** Necessary and sufficient conditions (No Proof), Cauchy Reiman equation Cartesian form (No Proof) Cauchy Reiman Equation in polar form (with Proof), Milne Thomson Method and it application, Harmonic function, orthogonal trajectories	**11**
	6.2	**Mapping:** Conformal mapping, Bilinear transformations, cross ratio, fixed points	
	6.3	**Bessel Functions:** Bessel's differential equation, Properties of Bessel function of order +1/2 and -1/2, Generating function, expression of $\cos(x\sin\theta)$, $\sin(x\sin\theta)$ in term of Bessel functions	

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.

Books Recommended:
Text Books:
1. H.K. Das, "*Advanced engineering mathematics*", S . Chand, 2008
2. A. Datta, *"Mathematical Methods in Science and Engineering"*, 2012
3. B.S. Grewal, *"Higher Engineering Mathematics"*, Khanna Publication

Reference Books:
1. B. V. Ramana, *"Higher Engineering Mathematics"*, Tata Mc-Graw Hill Publication
2. Wylie and Barret, *"Advanced Engineering Mathematics"*, Tata Mc-Graw Hill 6th Edition
3. Erwin Kreysizg, *"Advanced Engineering Mathematics"*, John Wiley & Sons, Inc
4. Murry R. Spieget, *"Vector Analysis"*, Schaum's outline series, Mc-Graw Hill Publication

Theory Examination:
1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. Total 04 questions need to be solved.
3. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 5 marks will be asked.
4. Remaining questions will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC302	Basics of Human Physiology (Abbreviated as BHP)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC302	Basics of Human Physiology (BHP)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC302	Basics of Human Physiology	04
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	Learners will be able to: • Understand the structure and function of cell, the action potential and muscle physiology. • Distinguish the different anatomical parts of cardiovascular and respiratory system. Understand the physiology of heart, and other organs of cardiovascular system, concept of Blood pressure and use of ECG. Understand the exchange in gases taking place in body and use of spirometer. • To know the composition of blood, blood cells with their functions, basics of cell counting, blood grouping and coagulation of blood. • Distinguish different organs of digestive and urinary system. Understand the process of digestion, secretions and their functions. Understand the process of urine formation and micturition • Understand the anatomy of nervous system, working of different parts of brain, parasympathetic and sympathetic nervous system, reflex arc and reflex action. Distinguish different parts of eyes and ear, their structure and function. Understand the hearing mechanism and image formation on	

	the retina, understand the use of ophthalmoscope and design of hearing aid • Understand the different parts of male and female reproductive system with their working, action of sex hormones. To know all the endocrine glands with their secretion and function, and control action.

Module	Contents	Hours
1	**Organization of Human Body:** Cell, Tissue, Organ, Organ system, Structure and functions of cell, Polarization and Depolarization of Cell, Types of tissues, Homeostasis, Positive and Negative Feedback Mechanism **Muscle Physiology:** Muscle physiology and aspects of Skin Resistance	05
2	**Cardiovascular System**: Anatomy of Cardiovascular System, Heart, Conductive Tissues of Heart, Cardiac Cycle, Heart Valves, Systemic and Pulmonary Circulation, Transmission of Cardiac Impulse, Blood Pressure, ECG, Einthoven's Triangle, Twelve Lead System and ECG Waveforms **Respiratory System:** Anatomy of Respiratory System, Ventilation, Exchange in gases in the alveoli, Spirometer (Forced Expiratory Volumes)	12
3	**Blood:** Composition of Blood – Blood cells and their functions, Haemoglobin, Blood Grouping, Coagulation, Wound Healing.	05
4	**Alimentary System:** All organs of the Digestive System, other secretions and main Functions, Deglutition and Defecation. **Urinary System:** Structure of Nephron, Function of Kidney, Urinary Bladder, Urethra, Internal/External Sphincters, Formation of Urine, Micturition	08
5	**Nervous System:** Different parts, their functions. Reflex actions and reflex are, Function of Sympathetic and Parasympathetic nervous system. Nerve conduction and action potentials. **Special Senses:** **Eyes**-Structure, Refractive Medias of the Eye, Formation of Image on the Retina. **Ear** – Structure of Cochlea, Hearing mechanism	10
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.	08

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.

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)

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC303	Electrical Network Analysis and Synthesis (Abbreviated as ENAS)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC303	Electrical Network Analysis and Synthesis (ENAS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC303	Electrical Network Analysis and Synthesis	04
Course Objectives	• To learn a number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, source transformation and several methods of simplifying networks. • To apply concept of network theorems to the electrical circuits. • To understand the concept of graphical solution to electrical network. • To understand frequency response in electrical circuits. • To make the learner learn how to synthesize an electrical network from a given impedance/admittance function.	
Course Outcomes	Learner will be able to • Apply number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, source transformation and several methods of simplifying networks. • Apply the concept of circuit analysis to understand network theorems • Apply the concept of graphical solution to electrical network. • Distinguish between different one port and two port network parameters • Analyse time and frequency response of the electrical circuits. • To make the learner learn how to synthesize an electrical network from a given impedance/admittance function.	

Module	Contents	Hours
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**
2	**Network Theorems (** D.C. & A.C. circuits)**:** Superposition, Thevenin's & Norton's Theorem (with independent and dependent sources), Maximum power transfer theorem.	**06**
3	**Circuit Analysis:** Introduction to Graph Theory. Tree, link currents, branch voltages, cut set & tie set, Mesh & Node Analysis, Duality.	**06**
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**
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**
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**

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.

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.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC304	Electronic circuit analysis and design (Abbreviated as ECAD)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC304	Electronic Circuit Analysis and Design (ECAD)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC304	Electronic Circuit Analysis and Design	04
Course Objectives	• To understand basic characteristics of semiconductor devices. • To design small signal amplifiers using BJT and FET	
Course Outcomes	Learner will be able to: • Understand the basic semiconductor components like P-N junction diodes, zener diodes and their various applications. • Understand BJT working and its various configurations and DC operating conditions • Understanding AC operating conditions and Design of single stage small signal CE amplifiers • Design of single stage small signal CS amplifiers • Understand the working of MOSFETs, its characteristics and its various applications • Understanding the concept of multistage amplifiers	

Module	Contents	Hours
1.	**Diodes Circuits:** Basics of PN junction diode - Equation, characteristics. Clipper and Clamper Circuits using diodes, Zener Diode – Characteristics and Working, Study Zener as a voltage regulator	05
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
3.	.**A.C. Equivalent Model – r_e** model, h-parameter model (Exact and Approximate), Hybrid-π model A.C. Analysis-(Using any one model): A.C. load line, A.C. analysis of CE, CB, CC amplifier configurations, Effects of R_S and $R_{L,}$ Comparison between various amplifiers. Low frequency and High frequency analysis, Frequency response of Single stage amplifier. Design of single stage amplifier using BJT.	10
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 amplifier configurations, Effects of R_S and R_L, Comparison between various amplifiers. Low frequency and High frequency analysis, Frequency response of Single stage amplifier. Design of single stage amplifier using JFET.	12
5.	**MOSFET:** Working of Depletion and Enhancement type MOSFET Construction, Characteristics and equations, Basic MOSFET Applications	04
6.	**Multistage Amplifiers:** Cascade: BJT-BJT, FET-BJT. Cascode – DC and AC analysis, characteristics Darlington amplifier- DC and AC analysis, characteristics	07

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.

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.

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3: Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4: Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC305	Biomaterials , Prosthetics and Orthotics (Abbreviated as BPO)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory					Term work	Pract	Oral	Pract. / Oral	Total
		Internal Assessment			End sem	Duration (hrs)					
		Test 1	Test 2	Avg.							
BMC305	Biomaterials Prosthetics and Orthotics (BPO)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC305	Biomaterials, Prosthetics and Orthotics	04
Course Objectives	• To understand the fundamentals of materials used for manufacturing implants that has wide application in healthcare industry. • To understand design principles of prostheses and orthoses.	
Course Outcomes	• Understand the definition, classification and general applications of biomaterials. Study the surface characterization techniques. • Understand properties and applications of polymeric, degradable and composite biomaterials. • Understand properties and applications of metals and ceramic biomaterials. • Selection of materials on the basis of testing of the biomaterials done biologically, mechanically, physio-chemically and thermally before implantation in the human body. • Study anatomical levers, gait cycle and gait parameters • Understand the definition of prostheses and orthoses and its design principles.	

Module	Contents	Hours
1	**Introduction**: Introduction of Biomaterials, Classification of Biomaterials, General Applications. **Techniques for characterization of Surface properties of Biomaterials:** Electron Spectroscopy for Chemical Analysis (ESCA), Secondary Ion Mass Spectrometry(SIMS), Infrared Spectroscopy, Contact Angle Method.	**08**
2	**Properties and Applications of Polymeric and degradable Biomaterials:** Classification, polyurethanes, PTFE, Polyethylene, Polypropylene, Polyacrylates, PMMA, PHEMA, Hydrogel, Silicone rubber, Biopolymer in fabrication of biodevices and implants, Thermoplastic and thermosetting plastics. Degradable biomaterials (PGA and PLA), applications in drug delivery systems. **Composite Biomaterials:** Properties, classification and Applications of Composite Biomaterials in fabrication of biodevices and implants. Applications of biomaterials in Drug delivery systems,	**09**
3	**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. **Properties and Applications of Ceramic Biomaterials:** Classification, Alumina, Zirconia and types, Bioglass, Calcium Phosphate, Tricalcium phosphate in fabrication of biodevices and implants.	**08**
4	**Biological Testing of Biomaterials:** Physiochemical Test, Mechanical Test, Invitro and Invivo types, Different forms of corrosion, Wear, Electrochemical Corrosion Testing.	**08**
5	**Movement biomechanics** Overview of joints and movments, anatomical levers, gait cycle (stance and swing phase with stick diagram), gait parameters	**05**
6	**Prosthetics and Orthotics** Principles of three point pressure, Lower limb prostheses, partial weight bearing-PTB socket, total contact- quadrilateral socket. Upper limb prosthesis (terminal devices) Spinal orthoses.	**10**

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.

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
4. American Atlas of Orthopedics: Prosthetics, C. V. Mosby.
5. American Atlas of Orthopedics: Orthotics, C. V. Mosby
6. Basics of Biomechanics by Ajay Bahl, Jaypee publications.

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

Theory Examination:

1. Question paper will comprise of 6 questions, each carrying 20 marks.
2. Total four questions need to be solved.
3. Q.1 will be compulsory, based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining question will be randomly selected from all the modules.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML301	Object Oriented Programming (Abbreviated as OOPM)	--	04#	--	--	02	--	02

 # Out of four hours, 2 hours theory shall be taught to the entire class and 2 hours practical in batches.

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML301	Object Oriented Programming (OOPM)	--	--	--	--	50	--	--	50	100

Course Code	Course Name	Credits
BML301	Object Oriented Programming	02
Course Objective	• To learn the object oriented programming concepts • To study various java programming constructs like multithreading, exception handling, packages etc. • To explain components of GUI based programming.	
Course Outcome	• To apply fundamental programming constructs. • To illustrate the concept of packages, classes and objects. • To elaborate the concept of strings, arrays and vectors. • To implement the concept of inheritance and interfaces. • To implement the notion of exception handling and multithreading. • To develop GUI based application.	

Prerequisite: Structured Programming Approach

Sr. No.	Module	Detailed Content	Hours
1	**Introduction to Object Oriented Programming**	**1.1OO Concepts:** Object, Class, Encapsulation, Abstraction, Inheritance, Polymorphism. **1.2Features of Java, JVM** **1.3 Basic Constructs/Notions:** Constants, variables and data types, Operators and Expressions,Revision of Branching and looping	02
2	**Classes, Object and Packages**	**2.1**Class,Object, Method. **2.2** Constructor, Static members and methods **2.3** Passing and returning Objects **2.4**Method Overloading **2.5** Packages in java, creating user defined packages, access specifiers.	05
3	**Array, String and Vector**	**3.1** Arrays, Strings, StringBuffer **3.2** Wrapper classes, Vector	04
4	**Inheritance and Interface**	**4.1**Types of Inheritance, super keyword, Method Overriding, abstract class and abstract method, final keyword, **4.2** Implementing interfaces, extending interfaces	03
5	**Exception Handling and Multithreading**	**5.1** Error vs Exception, try, catch, finally, throw, throws, creating own exception **5.2** Thread lifecycle, Thread class methods, creatingthreads, Synchronization	04
6	**GUI programming in JAVA**	**6.1 Applet:** Applet life cycle, Creating applets, Graphics class methods, Font and Color class, parameter passing. **6.2 Event Handling:** Event classes and event listener **6.3 Introduction to AWT:** Working with windows, Using AWT controls- push Buttons, Label, Text Fields, Text Area, Check Box, and Radio Buttons.	06

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

List of Laboratory Experiments: (Any Fifteen experiments and three assignments)

1. Program on various ways to accept data through keyboard and unsigned right shift operator.
2. Program on branching, looping, labelled break and labelled continue.
3. Program to create class with members and methods, accept and display details for single object.
4. Program on constructor and constructor overloading
5. Program on method overloading
6. Program on passing object as argument and returning object
7. Program on creating user defined package

8. Program on 1D array
9. Program on 2D array
10. Program on String
11. Program on StringBuffer
12. Program on Vector
13. Program on single and multilevel inheritance (Use super keyword)
14. Program on abstract class
15. Program on interface demonstrating concept of multiple inheritance
16. Program on dynamic method dispatch using base class and interface reference.
17. Program to demonstrate try, catch, throw, throws and finally.
18. Program to demonstrate user defined exception
19. Program on multithreading
20. Program on concept of synchronization
21. Program on Applet to demonstrate Graphics, Font and Color class.
22. Program on passing parameters to applets
23. Program to create GUI application without event handling using AWT controls
24. Program to create GUI application with event handling using AWT controls

Assessment:

Term Work:

Term work shall consist of minimum 15 experiments and 3 Assignments
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments): 20 Marks
Laboratory work (journal) : 10 Marks
Assignments : 15 Marks
Attendance : 5 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. Herbert Schildt, 'JAVA: The Complete Reference', Ninth Edition, Oracle Press.
2. Sachin Malhotra and Saurabh Chaudhary, "Programming in Java", Oxford University

Reference Books:

1. Ivor Horton, 'Beginning JAVA', Wiley India.
2. DietalandDietal, 'Java: How to Program', 8/e,PHI
3. 'JAVA Programming', Black Book, Dreamtech Press.

Practical and oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML302	Basics of Human Physiology (BHP)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML302	Basics of Human Physiology (BHP)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML302	Basics of Human Physiology	01
Course Objective	• To understand the human anatomy and functions of various body structures. • To understand different physiological processes taking place inside human body	
Course Outcome	• To measure blood pressure using occlusive cuff method • To apply blood cell counting principle for measuring blood composition. • To analyse electrical activity of heart. • To apply the knowledge of instruments used for supporting cardio-vascular system	

Syllabus: Same as that of BMC302 Basics of Human Physiology.

List of Laboratory Experiments: (Any Seven)

1. To measure Blood Pressure using sphygmomanometer using occlusive cuff method.
2. To determine hemoglobin count in the blood by Sahli'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 ECG Machine

7. To study electrical activity of heart
8. To measure heart-beats using PQRST Waveform of ECG.
9. To study Cardiac Pacemaker.
10. To study Defibrillator.
11. Visit to the hospital anatomy department to view specimen.
12. Presentations on the given topic.

Any other experiment based on syllabus which will help learner to understand topic/concept

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (programs / journal) : 10 Marks
Attendance : 5 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. 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)

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML303	Electrical Network Analysis and Synthesis (ENAS)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML303	Electrical Network Analysis and Synthesis (ENAS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML303	Electrical Network Analysis and Synthesis	01
Course Objective	• To implement several methods of simplifying networks. • To verify network theorems for analyzing electrical circuits. • To understand the concept of graphical solution to electrical network • To study frequency response in electrical circuits. • To make the learner learn how to synthesize an electrical network from a given impedance/admittance function.	
Course Outcome	Learner will be able to • Apply number of powerful engineering circuit analysis techniques such as nodal analysis, mesh analysis, source transformation and several methods of simplifying networks. • Implement network theorems to analyze the circuit • Apply the concept of graphical solution to electrical network. • Discriminate between different one port and two port network parameters • Analyze time and frequency response of the electrical circuits • Synthesize an electrical network from a given impedance/admittance function.	

Syllabus: Same as that of BMC303 Electrical Network Analysis and Synthesis.

List of Laboratory Experiments: (Any five)

1. To study superposition theorem
2. To study Norton theorem

3. To study Thevenin's theorem
4. To study and verify Maximum power theorem
5. To study transfer functions
6. a) To study Y parameters of a two-port network.
   b) To study Z parameters of a two-port network.
7. Interconnection of two-port network
8. To study Time Response of first order system
9. To study the second order frequency response of an RLC circuit

Suggested Tutorials: (Any six)

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

Any other experiment based on syllabus which will help learner to understand topic/concept

Assessment:

Term Work:

Term work shall consist of minimum 5 experiments and 6 tutorials
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Tutorials) : 10 Marks
Attendance : 5 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. 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.

Oral examination will be based on suggested practical list and entire syllabus.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML304	Electronic Circuit Analysis and Design (ECAD)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme								
		Theory				Term work	Pract.	Oral	Pract. / Oral	Total
		Internal Assessment			End sem					
		Test 1	Test 2	Avg.						
BML304	Electronic Circuit Analysis and Design (ECAD)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML304	Electronic Circuit Analysis and Design	01
Course Objective	• To apply the theoretical knowledge of semiconductor devices to practical circuits. • To design and implement Clippers, Clampers, Zener regulator and small signal amplifiers	
Course Outcome	Learner will be able to: • Verify the outputs of various electronic circuits such as clipper, clampers etc. • Verify the transfer characteristics of basic semiconductor devices. • Design amplifier circuits and verify their results practically. • Study frequency response of small signal amplifiers.	

Syllabus: Same as that of BMC304 Electronic Circuit Analysis and Design.

List of Laboratory Experiments: (Any seven)

1. To study Clipper circuit
2. To study Clampers circuit
3. Study of zener as a regulator
4. Study of BJT characteristics
5. Study of BJT as switch
6. Implementation of biasing circuit of BJT

7. Study of frequency response of CE amplifier
8. Study of FET characteristics
9. Implementation of biasing circuit of FET
10. Study of Frequency response of CE amplifier

Any other experiment based on syllabus which will help learner to understand topic/concept

Assessment:

Term Work:

Term work shall consist of minimum 7 experiments.
The distribution of marks for term work shall be as follows:
Laboratory work (Experiments) : 10 Marks
Laboratory work (Journal) : 10 Marks
Attendance : 5 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. 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.

Practical and oral examination will be based on suggested practical list and entire syllabus.