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

Scheme for Semester IV

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
BMC401	Applied Mathematics IV	04	----	01	04	----	01	05
BMC402	Biomedical Transducers and Measuring Instruments	04	----	----	04	----	----	04
BMC403	Linear Integrated Circuits	04	----	----	04	----	----	04
BMC404	Digital Electronics	04	----	----	04	----	----	04
BMC405	Signals and Control Systems	04	----	----	04	----	----	04
BML401	Introduction to Simulations Tools	----	02	----	----	01	----	01
BML402	Biomedical Transducers and Measuring Instruments	----	02	----	----	01	----	01
BML403	Linear Integrated Circuits	----	02	----	----	01	----	01
BML404	Digital Electronics	----	02	----	----	01	----	01
BML405	Signals and Control Systems	----	02	----	----	01	----	01
Total		**20**	**10**	**01**	**20**	**05**	**01**	**26**

Examination Scheme for Semester IV

Course Code	Course Name	Examination Scheme												Total Marks
		Theory				Term work		Practical		Oral		Pract./Oral		
		External (UA)		Internal (CA)										
		Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
BMC401	Applied Mathematics - IV	80	32	20	8	25	10	---	---	---	---	---	---	125
BMC402	Biomedical Transducers and Measuring Instruments	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC403	Linear Integrated Circuits	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC404	Digital Electronics	80	32	20	8	---	---	---	---	---	---	---	---	100
BMC405	Signals and Control Systems	80	32	20	8	---	---	---	---	---	---	---	---	100
BML401	Introduction to Simulations Tools	---	---	---	---	25	10	25	10	---	---	---	---	50
BML402	Biomedical Transducers and Measuring Instruments	---	---	---	---	25	10	---	---	25	10	---	---	50
BML403	Linear Integrated Circuits	---	----	---	---	25	10	---	---	---	---	25	10	50
BML404	Digital Electronics	---	---	---	---	25	10	---	---	---	---	25	10	50
BML405	Signals and Control Systems	---	---	---	---	25	10	---	---	25	10	---	---	50
Total		**400**	**160**	**100**	**40**	**150**	**60**	**25**	**10**	**50**	**20**	**50**	**20**	**775**

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BMC401	Applied Mathematics IV (Abbreviated as AM - IV)	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.							
BMC401	Applied Mathematics IV (AM - IV)	20	20	20	80	03	25	--	--	--	125

Course Code	Course Name	Credits
BMC401	Applied Mathematics IV	05
Course Objectives	• To develop analytical insight of the student to prepare them for graduates studies in Electronic and Telecommunication • To enhance their ability to solve and analyse telecommunication engineering problem. • To provide learner with a strong mathematical foundation to acquire the professional competence knowledge and skills.	
Course Outcomes	• It is expected that learner will develop the proactive approach towards the selection of methods to a solution of telecommunication problems. • Learner will be able identify different probability distribution , learn sampling technique, compute Eigen values and Eigen vectors and evaluate complex integrals and use their application in Electronic and Telecommunication problems. • Learner will be able to know new subjects that are required to solve in industry.	

Module No.	Unit No.	Topics	Hrs.
1		**Linear Algebra: Vector Spaces**	**06**
	1.1	Vectors in n-dimensional vector space: properties, dot product, cross product, norm and distance properties in n-dimensional vector space.	
	1.2	Vector spaces over real field, properties of vector spaces over real field, subspaces.	
	1.3	The Cauchy-Schwarz inequality, Orthogonal Subspaces, Gram-Schmidt process.	
2		**Linear Algebra: Vector Matrix Theory**	**10**
	2.1	Characteristic equation, Eigen values and Eigen vectors, properties of Eigen values and Eigen vectors	
	2.2	Cayley-Hamilton theorem, examples based on verification of Cayley-Hamilton theorem.	
	2.3	Similarity of matrices, Diagonalisation of matrices.	
	2.4	Functions of square matrix, derogatory and non-derogatory matrices.	
3		**Random Variables**	**10**
	3.1	Discrete & continuous random variables, expectation, Variance, Probability mass function and Density Function, Probability distribution for random variables	
	3.2	Moments, Moment Generating Function.	
	3.3	Functions of one random variable and their distribution and density functions	
4		**Probability distribution and Correlation**	**10**
	4.1	Probability distribution: Binomial distribution, Poisson & normal distribution (For detailed study)	
	4.2	Karl Pearson's coefficient of correlation, covariance, Spearman's Rank correlation.	
	4.3	Lines of Regression.	
5		**Complex integration**	**12**
	5.1	Complex Integration: Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula.	
	5.2	Taylor's and Laurent's Series	
	5.3	Zeros, singularities, poles of f(z), residues, Cauchy's Residue theorem.	
	5.4	Applications of Residue theorem to evaluate real Integrals of different types.	

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. Higher Engineering Mathematics by Dr. B. S. Grewal 42th edition, Khanna Pub.
2. Advanced Engineering Mathematics by Kreyszig E. 9th edition, John Wiley.
3. A Text Book of Applied Mathematics Vol. II by P.N.Wartilar & J.N.Wartikar, Pune, Vidyarthi Griha Prakashan., Pune.

Reference Books:

1. Advanced Engg. Mathematics by C. Ray Wylie & Louis Barrett.TMH International Ed.
2. Mathematical Methods of Science and Engineering by Kanti B. Datta, Cengage.
3. Theory And Problems of Statistics by Murry R. Spieget, Schaun's out line series- McGraw Hill Publication.

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
BMC402	Biomedical Transducers and Measuring Instruments (Abbreviated as BTMI)	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.							
BMC402	Biomedical Transducers and Measuring Instruments (BTMI)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC402	Biomedical Transducers and Measuring Instruments	04
Course Objectives	• To provide the knowledge of basic concepts such as measuring instruments and 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, bio-potential 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	• To clearly understand generalized medical instrumentation system, general properties of transducers, static and dynamic characteristics of transducers and sensors. • Understand the fundamental principles and applications of various types of sensors including motion, displacement and pressure sensors. • Present different transduction methods for measuring temperature.	

	• To understand principle of various biopotential electrodes • Understand principle and working of chemical sensor • To understand principle of various biosensors, and differentiate various amperometric and potentiometric sensors.

Module	Contents	Hours
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.	04
2	**Medical Instruments:** **Electronic and Digital Voltmeter** Types: 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, DVM: Ramp type, Dual Slope type, Successive Approximation type, Flash type DVM. Resolution & Sensitivity. Multimeter: Working, Specifications. **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. Types: Dual trace, Dual beam, Digital Storage – Block diagram, working, application, comparison.	14
3	**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.	10
4	**Temperature Measurement:** Thermistor, Thermocouple, Resistive Temperature Detector, IC based Temperature Measurement Radiation Sensors	06
5	**Bio potential 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)	06

6	**Chemical Sensors:** Blood gas and Acid- Base Physiology, Potentiometric Sensors (pH, pCO_2 Electrodes, Amperometric Sensors (pO_2), ISFETS, Transcutaneous Arterial O_2 and CO_2 Tension Monitoring. **Fiber Optic Sensors:** Principle of Fiber Optics, Fiber Optic Sensors - Temperature, Chemical, Pressure. **Biosensor:** Classifications and types with examples.	**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. Kalasi H.S.- Electronic Instrumentation
2. A.K. Sawhney- Electrical & Electronic Measurement & Instrumentation.
3. Medical Instrumentation-Application and Design by John G. Webster.
4. Instrument Transducer – An Intro to their performance and design, Hermann K P. Neubert.
5. Biomedical sensors – fundamentals and application by Harry N, Norton.
6. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiyo Tamma and P. Ake Öberg.
7. 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.
6. Transducers for Biomedical Measurements: Principles and Applications, Richard S.C. Cobbold, John Wiley & Sons, 1974.

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
BMC403	Linear Integrated Circuits (Abbreviated as LIC)	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.							
BMC403	Linear Integrated Circuits (LIC)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC403	Linear Integrated Circuits	04
Course Objectives	• To provide concepts of differential, operational and power amplifiers with their applications and design methodology • To cover analysis of circuits with negative feedback	
Course Outcomes	Learner will be able to: • Analyse different types of differential amplifiers • Demonstrate basics of operational amplifiers • Analyse and design operational amplifier to perform mathematical operations • Analyse and design operational amplifier as oscillators • Illustrate basics of negative feedback and perform analysis on different types of circuits with negative feedback • Exhibit working of power amplifiers, its types and DC and AC analysis and designing	

Module	Contents	Hours
1.	**Differential Amplifiers:** • Basic Concept • 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	**05**
2.	**Introduction to operational Amplifier :** • Introduction to an Ideal Operational Amplifier, Block Diagram, DC and AC Characteristics, Equivalent circuit of Op-amp • Op-amp IC 741 characteristics, frequency response and concept of virtual ground.	**05**
3.	**Applications of operational Amplifier :** • Adder, Subtractor /differential Amplifier, Voltage follower, Integrator (practical and Ideal), Differentiator (practical and Ideal), Instrumentation amplifier • Voltage to Current and Current to Voltage converters, Active Half wave rectifiers, Active Full wave rectifier, Clipper, Clampers, Log and Antilog amplifiers, Sample & hold circuits, Peak detector, Multipliers and Dividers, • Schmitt Trigger (Regenerative comparator), Voltage comparators, zero crossing detector.	**15**
4.	**Oscillators using Operational Amplifier:** • 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, (Phase shift, Frequency of oscillation, condition of sustained oscillation, circuit operation and Amplitude stability in the above oscillators).	**08**
5.	**Negative Feedback:** • Introduction to Feedback • Negative feedback characteristics: Gain Sensitivity, Bandwidth Extension, Noise Sensitivity, Reduction of Non-Linear Distortion. • Feedback Topologies, Series-Shunt, Shunt-Series, Series-Series, Shunt-Shunt Configurations • Negative feedback amplifiers: Voltage Amplifiers, Current Amplifiers, Trans-Conductance Amplifiers, Trans-Resistance Amplifiers (DC and AC analysis.	**10**
6.	**Power Amplifiers :** • Classes of Power amplifiers, Class-A, Class-B, Class AB, Class C • Analysis: 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 and its design	**05**

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

Reference Books:

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

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
BMC404	Digital Electronics (Abbreviated as DE)	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.							
BMC404	Digital Electronics (DE)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC404	Digital Electronics	04
Course Objectives	• To make learner aware of basics of Digital circuits, logic design, various Logic Families and Flip-flops. • Learner should be able to design of various counters, registers and their applications.	
Course Outcomes	Learner will be able to: • Understand various number systems and its arithmetic (BCD, Binary, Octal, Hexadecimal etc.) • Solve sums on K-maps, Boolean algebra and SOP-POS implementations. • Design code converter circuits, parity generator-checker circuits and magnitude comparator circuits. • Design circuits using multiplexers, demultiplexers, and decoders. • Design synchronous and asynchronous counters and registers using flip flops. • Design various gates using various logic families.	

Module	Contents	Hours
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.	**05**
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.	**05**
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.	**15**
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, State transition diagrams, 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.	**08**
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, Universal shift register	**10**
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.	**05**

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. 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.

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
BMC405	Signals and Control System (Abbreviated as SCS)	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme									
		Theory									
		Internal Assessment			End sem	Duration (hrs)	Term work	Pract	Oral	Pract. / Oral	Total
		Test 1	Test 2	Avg.							
BMC405	Signals and Control System (Abbreviated as SCS)	20	20	20	80	03	--	--	--	--	100

Course Code	Course Name	Credits
BMC405	Signals and Control Systems	04
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 familiarize with techniques suitable for analysing and synthesizing signals and systems in continuous domain.	
Course Outcomes	• Represent signals and system mathematically • Represent integral of LTI systems, properties of system in terms of impulse response • Determine Fourier series representation of CT, properties of Fourier series • Derive and determine Laplace transform, region of convergence, application of Laplace transform, Inverse Laplace transform. • Analyse given systems and suggest modifications.	

Module	Contents	Hours
1	**Introduction to Signals:** Basic of continuous time signals like unit step, ramp, exponential, operation on signals like flipping, shifting, scaling, and multiplication. Classification of signals: Periodic /Aperiodic, Power and Energy, Even and Odd.	07

2	**Introduction to Systems:** System representation in the continuous and discrete time domain. Classification of systems on the basis of Causal/non-Causal, Time variance/Time invariance, Linear/Non-Linear, Stable/Unstable. Continuous convolution	**07**
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, convergence of Fourier series, Gibbs phenomenon. Fourier transform and its properties. Fourier transform of singular functions. Energy density spectrum	**07**
4	**Laplace Transform:** Double sided Laplace transforms, Region of Convergence, properties, Unilateral Laplace Transform, properties, applications of Laplace transform to the solution of differential equations. Inverse Laplace Transform.	**08**
5	**Introduction to Control Systems**: Basic concepts of control systems, open loop and closed loop systems, difference between open loop and closed loop systems, signal flow graph.	**07**
6	**Time domain and Frequency domain behaviour of Systems** Time domain analysis of first order and second order systems. Condition of BIBO stability in time domain. Frequency response of linear systems. Stability and Routh array, Bode plots, Root Locus	**12**

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. Oppenheim A. V. & Alan S.Wllisky, Signals and Systems, Pearson Education
2. Simon Haykin & Barry Van Veen, Signals and Systems, Wiley-India
3. Modern Control Engineering : D.Roy Choudhury, PHI
4. Modem Control Engineering : K. Ogata , PHI
5. Control Systems Engineering: L.J. Nagrath, M. Gopal, Third Edition, New Age International Publishers.

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 & Eve A Riskin, Signals, Systems and Transforms, Pearson Education
4. Control System, Theory & Applications : Samarjit Ghosh, Pearson Education

5. System Dynamic and Control : Eroni Umez Erani., PWS Publishing, International Thompson Publishing Company

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
BML401	Introduction to Simulations Tools (IST)	--	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.						
BML401	Introduction to Simulations Tools (IST)	--	--	--	--	25	25	--	--	50

Course Code	Course Name	Credits
BML401	Introduction to Simulations Tools	01
Course objective	• To study Matlab/Scilab • Study Proteus	
Course Outcome	Learner will be able to: • Understand various tools of Matlab/Scilab • Write Programme in Matlab/Scilab • Simulate Digital and analog circuits • Understand use of Proteus software • Simulate differential equations	

List of Laboratory Experiments: (Any seven)

1. Study of Various Matlab/Scilab Commands
2. Plotting variable using Matlab/Scilab
3. Study of various Proteus commands.
4. Simulating Inverting and Non inverting Amplifier in Proteus
5. Implementing logic gates using Proteus
6. Decade Counter using flip-flop in Proteus
7. Simulating differential Equations
8. Simulate basic electrical circuit using pspice

Any other experiment using these simulation tools which will help learner to understand the application of these tools during their B.E project work

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.

Practical examination will be based on suggested practical list.

Course Code	Course Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
BML402	Biomedical Transducers and Measuring Instruments (BTMI)	--	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.						
BML402	Biomedical Transducers and Measuring Instruments (BTMI)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML402	Biomedical Transducers and Measuring Instruments	01
Course objective	• To display and record signals using CRO. • To implement digital to analog converter. • To analyse step response of a thermometer and measure temperature using various temperature transducers. • To measure displacement using various displacement transducers. • To measure pressure using a pressure transducer. • To measure pH of a solution using pH electrodes.	
Course Outcome	Learner will be able to: • Record and display signals using CRO. • Convert analog data into digital form. • Analyse step response of a thermometer and measure temperature using various temperature transducers. • Measure displacement using various displacement transducers. • Measure pressure using a pressure transducer. • Measure pH of a solution using pH electrodes.	

Syllabus: Same as that of BMC402 Biomedical Transducers and Measuring Instruments

List of Laboratory Experiments: (Any seven)

1. Study of Front panel of CRO
2. A to D converter

3. To study the dynamic behaviour of thermometer system.
4. To study the characteristics of a thermistor.
5. To study thermistor linearization.
6. To study the characteristics of a light dependent resister.
7. To study the principle and working of a thermocouple.
8. To study principle and working of LVDT.
9. To study principle and working of a capacitive Transducer.
10. To study principle and working of a strain gage sensor.
11. To study principle and working of a pressure sensor.
12. To study pH electrode.

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. Kalasi H.S.- Electronic Instrumentation
2. A.K. Sawhney- Electrical & Electronic Measurement & Instrumentation.
3. Medical Instrumentation-Application and Design by John G. Webster.
4. Instrument Transducer – An Intro to their performance and design, Hermann K P. Neubert.
5. Biomedical sensors – fundamentals and application by Harry N, Norton.
6. Biomedical Transducers and Instruments, Tatsuo Togawa, Toshiyo Tamma and P. Ake Öberg.
7. 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.
6. Transducers for Biomedical Measurements: Principles and Applications, Richard S.C. Cobbold, John Wiley & Sons, 1974.

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
BML403	Linear Integrated Circuits (LIC)	--	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.						
BML403	Linear Integrated Circuits (LIC)	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML403	Linear Integrated Circuits	01
Course Objective	• To provide designing methodology and implementation technique for differential, operational and power amplifiers.	
Course Outcome	• To design and implement various mathematical operations using operational amplifier • To implement waveform generation using operational amplifier • To implement circuits of differential amplifiers, power amplifiers and negative feedback.	

Syllabus: Same as that of BMC403 Linear Integrated Circuits

List of Laboratory Experiments: (Any seven)

1. Differential amplifier
2. Inverting amplifier
3. Non-inverting amplifier
4. Designing circuit using operational amplifier for given mathematical equation
5. Integrator
6. Differentiator
7. Half wave rectifier

8. RC-phase shift oscillator
9. Wein bridge oscillator
10. Instrumentation amplifier
11. Negative feedback
12. Schmitt trigger
13. Comparator
14. Zero crossing detector
15. Class B push pull power 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.. Electronic Circuit Analysis and Design- Donald A Neamen,
2. Electronic Devices and circuits – R Bolystead.
3. Op-Amps and linear integrated circuits – R. Gayakwad
4. Linear Integrated Circuits: Roy Chaudhary

Reference Books:

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

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
BML404	Digital Electronics	--	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.						
BML404	Digital Electronics	--	--	--	--	25	--	--	25	50

Course Code	Course Name	Credits
BML404	Digital Electronics	01
Course Objective	• To make learner aware of basics of digital circuits, logic design and Flip-flops. • Learner should be able to design of various counters, registers and their applications.	
Course Outcome	Learners will be able to: 1. Understand various ICs used for basic gates,EX-OR and EX-NOR gates 2. Design code converter circuits. 3. Design parity generator-checker circuits, adder-subtractor circuits and magnitude comparator circuits 4. Design circuits using multiplexers, demultiplexers, and decoders. 5. Design synchronous and asynchronous counters using flipflops. 6. Design various registers using flip flops.	

Syllabus: Same as that of BMC404 Digital Electronics

List of Laboratory Experiments: (Any seven)

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 decade counter
12. To design Synchronous counter.

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. 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.

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
BML405	Signals and Control Systems (SCS)	--	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.						
BML405	Signals and Control Systems (SCS)	--	--	--	--	25	--	25	--	50

Course Code	Course Name	Credits
BML405	Signals and Control Systems	01
Course objective	• 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 familiarize with techniques suitable for analyzing and synthesizing signals and systems in continuous domain.	
Course Outcome	• Represent signals and system mathematically • Represent integral of LTI systems, properties of system in terms of impulse response • Determine Fourier series representation of CT, properties of Fourier series • Derive and determine Laplace transform, region of convergence, application of Laplace transform, Inverse Laplace transform. • Analyze given systems and suggest modifications.	

Syllabus: Same as that of BMC405 Signals and Control Systems

List of Laboratory Experiments: (Any Five)

1. Introduction to signals and plotting of signals
2. Operations on Signal
3. Classification of Signals
4. Open Loop and Closed loop
5. Stability
6. Bode Plot
7. Root Locus
8. Convolution
9. Pole Zero plot

List of suggested Tutorials: (Any Six)

1. Introduction to signals and systems
2. Fourier Series
3. Laplace Transform
4. Inverse Laplace Transform
5. Application of Laplace Transform
6. Open Loop and Closed loop
7. Signal Flow graph
8. Stability
9. Bode Plot
10. Root Locus
11. Time domain analysis

Any other practical and tutorial 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 (Tutorial) : 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.

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