UNIVERSITY OF MUMBAI

Bachelor of Biomedical Engineering

Third Year and Final Year Engineering

Sem. V, VI, VII & VIII

Revised course (Rev- 2012)

From Academic Year 2012 -13

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

Preamble

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

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

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

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

Preamble

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

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

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

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

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

Chairman,
Board of Studies in Electrical Engineering,
University of Mumbai

Syllabus Scheme for T.E. Semester V Biomedical Engineering

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM501	Biomedical Instrumentation-I	4	2	-	4	1	-	5
TEBM502	Microprocessors	4	2	-	4	1	-	5
TEBM503	Analog and Digital Circuits Design	4	2	-	4	1	-	5
TEBM504	Biomedical Digital Signal Processing	4	2	-	4	1	-	5
TEBM505	Principles of Communication Engineering	4	2	-	4	1	-	5
TEBM506	Business Communication and Ethics	-	2*+2	-	-	2	-	2
	TOTAL	**20**	**14**	**-**	**20**	**7**	**-**	**27**

* Theory for entire class to be conducted

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM501	Biomedical Instrumentation-I	20	20	20	80	25	-	25	150
TEBM502	Microprocessors	20	20	20	80	25	25	-	150
TEBM503	Analog and Digital Circuits Design	20	20	20	80	25	25	-	150
TEBM504	Biomedical Digital Signal Processing	20	20	20	80	25	-	25	150
TEBM505	Principles of Communication Engineering	20	20	20	80	25	-	25	150
TEBM506	Business Communication and Ethics	-	-	-	-	50	-	-	50
TOTAL				**100**	**400**	**175**	**50**	**75**	**800**

Syllabus Scheme for T.E. Semester VI Biomedical Engineering

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM601	Biomedical Instrumentation –II	4	2	-	4	1	-	5
TEBM602	Biostatistics	4	-	1	4	-	1	5
TEBM603	Biological Modeling and Simulation	3	2	-	3	1	-	4
TEBM604	Microcontrollers and Embedded Systems	4	2	-	4	1	-	5
TEBM605	Medical Imaging –I	4	2	-	4	1	-	5
TEBM606	Digital Image Processing	4	2	-	4	1	-	5
	TOTAL	**23**	**10**	**1**	**23**	**5**	**1**	**29**

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM601	Biomedical Instrumentation –II	20	20	20	80	25	25	-	150
TEBM602	Biostatistics	20	20	20	80	25	-	-	125
TEBM603	Biological Modeling and Simulation	20	20	20	80	25	-	25	150
TEBM604	Microcontrollers and Embedded Systems	20	20	20	80	25	-	25	150
TEBM605	Medical Imaging –I	20	20	20	80	25	-	25	150
TEBM606	Digital Image Processing	20	20	20	80	25	50*	-	175
TOTAL				**120**	**480**	**150**	**75**	**75**	**900**

*Both Practical and Oral examination

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM501	Biomedical Instrumentation-I (abbreviated as BMI-I	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM501	Biomedical Instrumentation-I	20	20	20	80	25	-	25	150

Course Objectives	With an invent of various new diseases and anomalies the correct diagnosis of the patient has become a real challenge. The medical awareness among patients and various litigations point to a need of newer diagnostics equipment. Advancement of technology in biomedical engineering has resulted in various state of art diagnostics equipment. To enable students to understand the basic principal, working and design of various automated diagnostic equipment.
Course Outcomes	Students will demonstrate the principles of electronics used in designing various diagnostic equipment. Students will be able to understand the working principle and applications of various diagnostic equipment. Students who can participate and succeed in competitive exams.

Module	Contents	Time
1.	**Basic principle, technical specification, working and applications of Laboratory Instruments.** 1. Spectrophotometer 2. Colorimeter 3. Electrolyte Analyser 4. Blood cell counter 5. Auto-analyser 6. Blood gas analyser	10
2.	**Basic principle, technical specification, working and applications of Laboratory Instruments.** Electrophoresis and types Chromatography ELISA concepts (direct and indirect), reader & washer Microscopes and its types: optical compound, electron microscope, fluorescence	10

	microscope.	
3.	**Blood Flow Measurement:** Electromagnetic, Ultrasonic, NMR and Laser Doppler flowmetry, cardiac output measurement, impedance plethysmography.	08
4.	**Pulmonary Function Analyser and Ventilator:** Respiration measurement technique: Lung volume and capacities. Spirometry, Pulmonary function measurement and analyser, Oximetry, Ventilators and Anesthesia Equipment	12
5.	**Heart Lung machine and types of artificial oxygenator**	03
6.	**Audiometers:** Basic audiometer, Pure tone and Speech audiometer, evoked response Audiometry.	05

Text books:

1. Handbook of Biomedical Enginerring By R.S. Khandpur (TMH Pub).
2. Handbook of Analytical Instruments By R.S. Khandpur (TMH Pub).
3. Medical Instrumentation, Application and Design By J.G. Webster.
4. Medical Electronics – A.G. Patil ,R K Jha, R Hariharan(Excel Books, New Delhi)

Reference Books:

1. Encyclopedia of medical devices and instrumentation - J.G. Webster Vol I, II, III, IV (John Willey).
2. Introduction to Biomedical Equipment Technology By Carr.-Brown (Pearson Education Pub)
3. Introduction to Biomedical Engineering – Joseph Bronzino (CRC Press)
4. Various Instruments Manuals
5. Various internet resources

Internal Assessment (IA):

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

End Semester Examination:

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

Term Work:

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

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

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM502	Microprocessors (abbreviated as MP)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM502	Microprocessors	20	20	20	80	25	25	-	150

Course Objectives	To develop background knowledge and core expertise in microprocessor. To study the concepts and basic architecture of 8086 Pentium processor and Co-processor 8087. To know the importance of different peripheral devices and their interfacing to 8086. To know the design aspects of basic microprocessor based system. To write assembly language programs in microprocessor for various applications.
Course Outcomes	Students will learn The architecture and software aspects of microprocessor 8086 Assembly language program in 8086 for various applications. Co-processor configurations. Various interfacing techniques with 8086 for various applications. Basic concepts of 8087 Co-processor.

Module	Contents	Time
1.	**Introduction to Microprocessor** Introduction to Microprocessor and Microcontroller, Microcomputer based system elements ,Generalized block diagram of Microprocessor, RISC & CISC CPU Architectures, Harvard & Von-Neumann CPU architecture, Microprocessor Programming languages, Microcomputer System software, Evolution of Microprocessor	04
2.	**Architecture of Intel 8086 Microprocessor** 8086 Architecture and organization, Pin configuration, Pin Functions, Memory segmentation concept, Minimum and Maximum modes of 8086, 8288 Bus Controller, Read and Write bus cycle of 8086, 8086 Memory organization	08
3.	**Instruction set and Programming of 8086** 8086 Addressing modes,8086 Instruction encoding formats and instruction set, Assembler directives, 8086 programming and debugging of assembly language program	10
4.	**Memory Interfacing with 8086:**	04

	Introduction, Address Decoding, Interfacing 8086 with RAM and ROM, Comparison between Memory Mapped I/O and I/O Mapped I/O	
5.	**Peripherals interfacing with 8086** 8086Interrupt structure, Programmable interrupt controller 8259,8259 interfacing with 8086,Programmable Peripheral Interface 8255, , 8086 interfacing with ADC, keyboard and seven segment display using 8255, DMA controller 8237,8086 interfacing with 8237	10
6.	**8087 Math coprocessor** Introduction, 8087 Architecture, Interfacing of 8086 with 8087, 8087 Instruction set, Assembly language Programming based on 8086-8087 system	12

List of Experiments:

1. 16 bit Arithmetic operations - Addition, Subtraction, Multiplication, Division using 8086
2. Logical operations – AND, OR, NOT using 8086
3. Searching Largest and smallest number using 8086
4. Sorting –the numbers in Ascending and Descending order using 8086
5. Code Conversion using 8086 (BCD to Hex, BCD to binary, Hex-BCD etc.)
6. String Manipulation using 8086
7. Interfacing ADC with 8086
8. Interfacing DAC with 8086
9. Parallel Communication between two microprocessor kits using Mode 1 and Mode 2 of 8255.
10. Interfacing 8259 using 8086
11. Computation of area of circle using 8087.
12. Computation of Hypotenuse using 8087.
13. Computation of Roots of Quadratic equation using 8087.

Text books:

1. "8086/8088 family: "Design, Programming an Interfacing", John Uffenbeck: Prentice Hall, 2nd Edition
2. Microcomputer systems 8086/8088 family, Architecture, Programming and Design - Yu-Cheng Liu & Glenn A Gibson, 2nd Edition- July 2003, Prentice Hall of India.
3. "Advanced Microprocessor and Peripherals – Architecture, Programming and Interfacing", A.K.Ray & K.M Bhurchandi, Tata Mc Graw Hill , 2006.

Reference Books:

1. "Microprocessors and Interfacing : Programming and Hardware", Douglas V.Hall, second edition , Tata Mc Graw Hill ,2006.
2. " IBM PC Assembly language and programming"Peter Abel, , fifth edition
3. "Pentium Processor System Architecture", Don Anderson, Tom Shanley: MindShare Inc., 2nd Edition

Internal Assessment (IA):

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

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

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

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

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM503	Analog and Digital Circuits Design (abbreviated as ADCD)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM503	Analog and Digital Circuits Design	20	20	20	80	25	25*	-	150

*Both practical and oral examination

Course Objectives	To understand and provide knowledge of various Analog And Digital Circuits Such as Timer IC 555, PLL IC, VCO, 723 voltage regulator . To understand different types of filters and design them for the given specifications
Course Outcomes	To acquire the ability to design practical circuits by selecting proper IC chips needed for a particular application

Module	Contents	Time
1.	**Waveform Generation IC's:** • IC 555 Functional Block diagram, Circuit diagram. • IC 555 in Astable Multivibrator(AMV) functional diagram, circuit diagram with application • IC 555 in Monostable Multivibrator (MMV) functional diagram, circuit diagram with application • PLL (IC 565 or equivalent) circuit diagram, and its applications • VCO(IC 566) Circuit diagram and its applications. Function Generator (IC 8038 or equivalent) Circuit diagram and its applications	12
2.	**Special Function IC's:** • F-V convertors and V-F convertors: Circuit diagram and its applications • Instrumentation Amplifier (AD 624 /AD 620) Circuit diagram and its applications, • Monolithic Isolation Amplifier module • Opto-couplers and Opto-isolators PWM (SG 3525 or equivalent) Circuit diagram and its applications	06
3.	**Active Filters:** • Frequency response, design of first order (LP, HP, BP) filter and applications. • Frequency response, design of 2nd order (Chebyshev, Butterworth, Elliptical	12

	filters) LP, HP, BP, All pass, Notch, band reject • KRC filter. • Capacitor filter, switched capacitor filter. Generalized Impedance Convertor (GIC)	
4.	**Power Devices and Circuits:** • SCR's: Basic structure, characteristics, Two transistor and Operations. series and parallel connections of SCRs. • DIAC and TRIAC: Basic Structure and characteristics, applications • UJT: Operation, characteristics, parameters and UJT as a relaxation oscillator Power MOSFET : Device structure, equivalent circuit and characteristics	06
5.	**Voltage Controllers and Regulators :** • Analog switches, Relays : Basic Types • Functional block diagram of Voltage Regulators • Types of voltage regulators: Fixed voltage regulators (78XX and 79XX), Adjustable voltage regulators, linear voltage regulator IC 723, Design of low voltage regulator and high voltage regulator using 723. Switching Mode Power Supply (SMPS)	06
6.	**Motors And Drivers :** Stepper, Servo, DC/AC Motors drivers and geared motors (Basic operation and application)	06

List of Experiments:

1. Design AMV for Duty cycle >=50%
2. Design MMV given duty cycle
3. Application of AMV square wave generator /
4. Application of MMV as a missing pulse detector / frequency divider
5. PLL
6. VCO
7. Function Generator IC
8. Design for Band pass Filter /Band reject
9. Design of Notch filer / Twin T filter
10. Design of Low Pass Filter/ High pas Filter
11. Instrumentation Amplifier
12. IC 723 Voltage regulator

Text books:

1. Op-Amps and linear integrated circuits – R. Gayakwad
2. Linear Integrated Circuits: Roy Chaudhary
3. Design with operational amplifiers and analog integrated circuits. Sergio Franco,
4. Integrated Circuits K.R.Botkar.
5. Power Electronics, Ned Mohan.
6. Power Electronics, M.H.Rashid.
7. Power Electronics, M.D.Singh and K.B.Khanchandani,

Reference Books:

1.Integrated Electronics –Millman & Halkias
2. Opamps and linear integrated circuits, Theory and Applications- James Fiore.
3. Power Electronics, P.C.Sen.
4. Power Electronics, Dr.P.S.Bimbhra,

Internal Assessment (IA):

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

End Semester Examination:

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

Practical and Oral Examination:

Practical and oral examination will be based on experiments performed during the term and the course - project.

Term Work:

Term work consists of minimum six experiments and a mini – project based on the syllabus. The distribution of the term work shall be as follows:
Laboratory work (Experiments, mini - project and Journal) :15 marks
Attendance (Practical and Theory) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM504	Biomedical Digital Signal Processing (abbreviated as BDSP)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM504	Biomedical Digital Signal Processing	20	20	20	80	25	-	25	150

Course Objectives	After active participation in this course students will be able to: Understand the fundamental techniques and applications of digital signal processing with emphasis on biomedical signals. Students should be able to do the following upon completion of this course Understand the basics of discrete time signals Understand Circular and linear convolution and their implementation using DFT Analyse signals using discrete Fourier transform Understand efficient computation techniques such as DIT and DIF FFT algorithms Design of FIR filters using window method Design of digital IIR filters by designing prototype analog filters and then applying analog to digital conversion
Course Outcomes	This course will enable the students to: Understand discrete time signals and systems and their classification. It will also equip them to design and implement various Digital filters and filter discrete time signals.

Module	Contents	Time
1.	Basic Elements of DSP concepts of frequency in analog and digital signals –sampling theorems –Discrete time signals and systems- Properties –Z-transform- linear & circular convolution- Correlation –DTFT	08
2.	Introduction to DFT-Properties of DFT,	06
3.	Introduction DIT and DIF FFT algorithms. Use of FFT in linear filtering, Discrete Cosine transforms	06
4.	Review of Design of analog Butterworth and Chebyshev Filters, Frequency transformation in analog domain, Design of IIR Digital Filters using Impulse invariance method-Design of digital Filters using Bilinear transformation	12
5.	Structure of FIR filters-Linear phase filters –Filter design using window technique-Frequency sampling techniques –Finite Word length effects in digital filters. Realisation of FIR &IIR filters Direct ,cascade and parallel forms	10

6.	Introduction to Digital signal Processors–Architecture –Features-addressing formats –functional mode-introduction to commercial Processors. Application of DSP in Biomedical Applications	06

List of Experiments:

1. Basics of Programming
2. Simulations of standard signals
3. Concept of Aliasing
4. Linear convolution circular convolution
5. Discrete Fourier Transform(DFT)
6. Design and simulation of FIR filter
7. IIR filters using Butterworth approximation
8. IIR filter using Chebyshev approximation

Text books:

1. Digital signal processing Principles Algorithms and Application –Proakis &Manolakis – Third edition PHI
2. Digital Signal Processing –Sanjit K. Mithra Tata Mc-graw Hill
3. Digital Signal Processing – S. Salivahanan, C.Gnanapriya, 2/ed Tata McGraw Hill

Reference Books:

1. Digital signal processing – A.V. Oppenheim and R.W.Schafer- PHI
2. Understanding Digital Signal Processing –Richard G. Lyons-3/ed Pearson Publication

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

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

Term Work:
Term work consists of minimum eight experiments. The distribution of the term work shall be as follows:
Laboratory work (Experiments and Journal) :15 marks
Attendance (Practical and Theory) :10 marks
The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM505	Principles of Communication Engineering (abbreviated as PCE)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM505	Principles of Communication Engineering	20	20	20	80	25	-	25	150

Course Objectives	This subject provides introduction to the basic principles and techniques used in analog and digital communications. The subject then focuses on developing an understanding of the principles and techniques of analog modulation as well as digital modulation. Communication transmitters and receivers techniques are discussed for different transmission conditions. The subject then covers a range of digital modulation techniques which are frequently used in modern communication systems. Subject Name also include the advantages, disadvantages and application of all communication techniques.
Course Outcomes	Students will be familiar with all the communication techniques. And they are able to use in biomedical application

Module	Contents	Time
1.	**Introduction to communication system :** Elements of communication system, types of communication system, Noise, Signal to Noise ratio, Noise factor, Noise figure, Noise Temperature	04
2.	**Amplitude Modulation :** Mathematical analysis of Am wave, Different types of AM Spectrum, Bandwidth, waveform, DSBFC(Grid Modulated, Plate Modulated, Collector Modulated),DSBSC(FET Balanced Modulator, Ring Diode modulator),SSB(Phase shift method, Filter method, Third method) and Introduction of ISB and VSB, Low level and high level modulator transmitter **AM Receiver:** Receiver Parameters sensitivity, selectivity, fidelity, double spotting, Image frequency and its rejection, dynamic range TRF receiver, superetrodyne receiver, double conversion receiver AM detectors –Simple and Practical Diode detector, Principles and types of tracking,	13

	Principles and types of AGC, Demodulation of DSBSC and SSB waves	
3.	**FM Modulation :** Principles of FM waveform, spectrum, Bandwidth ,FM generation – Direct and Indirect FM, Principles of AFC, Pre-emphasis and Deemphasise in FM, Effect of noise in FM, Noise Triangle FM demodulation – Simple Slope detector, Balanced slope detector, Foster Seeley discriminator, Ratio detector, Quadrature detector, Block diagram of FM receivers, Capture effect in FM receivers, Difference between AM and FM system	09
4.	**Analog Pulse Modulation Techniques :** Sampling Theorem for low pass signals and band pass signals, Proof of Sampling theorem, Concept of Aliasing, PAM, PWM,PPM – Generation, Detection, Advantages, Disadvantages, comparison	06
5.	**Digital Pulse Modulation And Transmission Techniques :** Advantages and Disadvantages of digital transmission, PCMTrasmitter, Receiver, Quantization, Companding, DPCM,DM,ADM – Transmitter, Receiver, Advantages and Disadvantages Digital Transmission – Types of digital transmission (ASK,FSK,PSK) Generation, Detection, Advantages Disadvantages	11
6.	**Multiplexing techniques :** Concept of multiplexing and multiple access, FDM, TDM Transmitter and Receiver, Hierarchy, Application, Advantages Disadvantages, PCM-TDM system, FDMA, TDMA, CDMA	05

List of Experiment:

1. DSB-SC, DSB-FC, SSB AM generation and detection
2. FM generation and detection
3. Pre-emphasis and De-emphasis
4. Sampling and reconstruction
5. PAM generation and detection
6. PWM generation and detection
7. PPM generation and detection
8. PCM generation and detection
9. DM generation and detection
10. Time division multiplexing
11. Frequency division multiplexing

Text books:

1. Electronic communication system – Wayne Tomasi,Pearson Education
2. Electronic communication system – Roy Blake, Thomson Learning
3. Electronic communication system - Kennedy and Devis,TMH

Reference Books:

1. Digital and Analog communication system – Leon W Couch, Pearson Education
2. Principles of communication system – Taub and Schilling ,TMH

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

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

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

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

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM506	Business Communication and Ethics (abbreviated as BCE)	-	2*+2	-	-	2	-	2

* Theory for entire class to be conducted

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM506	Business Communication and Ethics	-	-	-	-	50	-	-	50

Course Objectives	
Course Outcomes	

Module	Contents	Time

Syllabus Scheme for T.E. Semester VI Biomedical Engineering

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM601	Biomedical Instrumentation –II	4	2	-	4	1	-	5
TEBM602	Biostatistics	4	-	1	4	-	1	5
TEBM603	Biological Modeling and Simulation	3	2	-	3	1	-	4
TEBM604	Microcontrollers and Embedded Systems	4	2	-	4	1	-	5
TEBM605	Medical Imaging –I	4	2	-	4	1	-	5
TEBM606	Digital Image Processing	4	2	-	4	1	-	5
	TOTAL	**23**	**10**	**1**	**23**	**5**	**1**	**29**

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM601	Biomedical Instrumentation –II	20	20	20	80	25	25	-	150
TEBM602	Biostatistics	20	20	20	80	25	-	-	125
TEBM603	Biological Modeling and Simulation	20	20	20	80	25	-	25	150
TEBM604	Microcontrollers and Embedded Systems	20	20	20	80	25	-	25	150
TEBM605	Medical Imaging –I	20	20	20	80	25	-	25	150
TEBM606	Digital Image Processing	20	20	20	80	25	50*	-	175
TOTAL				**120**	**480**	**150**	**75**	**75**	**900**

*Both Practical and Oral examination

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM601	Biomedical Instrumentation-II (abbreviated as BMI-II)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM601	Biomedical Instrumentation-II	20	20	20	80	25	25	-	150

Course Objectives	The day by day rising cost of medical diagnosis has created a thrust for point of care diagnostic tools. There is well laid network of various communication channels. Students will be able to understand the basic principle of generation of various bioelectric signals, their non-invasive capture, recording, transmission and various issues involved. Further with some examples it builds the design perspective for low cost point of care devices which is the need of an hour
Course Outcomes	Students will demonstrate the principles of electronics used in designing various diagnostic equipments. Students will be able to understand the working principle and applications of various diagnostic equipments. Students who can participate and succeed in competitive exams.

Module	Contents	Time
1.	**Generation of Bioelectric Potentials:** Basic cell physiology, Nerve, Muscle, Pacemaker and Cardiac muscle	05
2.	**Biophysical signal capture, processing and recording systems (with technical specifications):** Typical medical recording system and general design consideration. Sources of noise in low level recording circuits and their removal techniques. ECG, EMG, EEG, Electrode placement and Measuring techniques for EOG, ERG and Phonocardiography. Measurement of skin resistance. **Biofeedback Technique:** EEG, EMG	13
3.	**Patient Monitoring System:** Measurement of Heart Rate, Pulse rate, Blood pressure, Temperature and Respiration rate, Apnea Detector. Electrical Safety in Biophysical Measurements. Heart rate variability measurement and applications.	10
4.	**Arrhythmia and Ambulatory Monitoring Instruments:** Cardiac Arrhythmias, waveforms and interpretation from them. Stress test measurement.	08

	Ambulatory monitoring instruments-Holter monitor **Point of care devices and their design considerations for homecare devices:** glucometer (kidney function), disposable lung function test.	
5.	**Foetal and Neonatal Monitoring System:** Cardiotocograph, Methods of monitoring of Foetal Heart rate , Incubator and Infant warmer. Non stress test monitoring.	06
6.	**Biotelemetry, Telemedicine concepts and its application**	06

Text books:

1. Handbook of Biomedical Engineering by R.S. Khandpur, PHI
2. Medical Instrumentation, Application and Design by J.G. Webster, TMH.
3. Introduction to Biomedical Equipment Technology by Carr.-Brown (Pearson Education Pub)
4. Introduction to Biomedical Engineering by J Bronzino

Reference Books:

1. Encyclopaedia of medical devices and instrumentation - J.G. Webster Vol I, II, III, IV (John Willey).
2. Principles of applied Biomedical Instrumentation by Geddes and Becker, Wiley interscience publication.
3. Principles of Biomedical Instrumentation and Measurement by Richard Aston
4. Various Instruments Manuals.
5. Various internet resources.

Internal Assessment (IA):

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

End Semester Examination:

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

Term Work:

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

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

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM602	Biostatistics (abbreviated as BST)	4	-	1	4	-	1	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM602	Biostatistics	20	20	20	80	25	-	-	125

Course Objectives	To cover basic concepts and theory related to statistics
Course Outcomes	Students will be able to apply statistical methods to biomedical data

Module	Contents	Time
1.	Descriptive statistics and probability Frequency distribution, Measures of central tendency, Measures of dispersion Basic probability and Bayes theorem.	04
2.	Probability and Sampling Distributions Discrete probability distributions Continuous probability distributions - Binomial, poisson and normal distributions Sampling distributions – sample mean, difference between two sample means, sample proportions, difference between two sample proportions	10
3.	Estimation t- distribution Confidence intervals for - population mean, difference between two population means, population proportion, difference between two population proportions, variance of normally distributed population, ratio of variances of two normally distributed populations Determination of sample size for estimating mean and proportions	07
4.	Hypothesis testing Hypothesis testing for – Population mean, difference between two population means, population proportions, difference between two population proportions, population variance, ratio of two population variances Type – I and II error and power of test	07
5.	Analysis of variance Completely randomized design, Randomized complete block design, repeated measures design, factorial experiment. Regression and Correlation Simple linear regression, correlation model, correlation coefficient, multiple	13

	regression, multiple correlation	
6.	Chi square distribution and analysis of frequency Chi-square distribution – properties Test of goodness of fit, independence and homogeneity	07

List of Tutorials:

1. Descriptive statistics and probability
2. Discrete probability distributions
3. Continuous probability distributions
4. Sampling distributions
5. Estimation
6. Hypothesis testing
7. Analysis of variance
8. Regression and Correlation
9. Chi square distribution and analysis of frequency

Text books:

1. Biostatistics – A foundation for analysis in health sciences by Wayne W. Daniel, Seventh edition, Wiley India
2. Fundamentals of mathematical statistics by S. C. Gupta and V. K. Kapoor, second edition, Sultan Chand Publisher
3. Probability and statistics for engineers by J. Ravichandran, Wiley /india
4. Biostatistics – How it works by Steve selvin, Pearson education
5. An Introduction to Biostatistics by Sunder Rao and J. Richard, Third Edition, Prentice Hall of India
6. Probability and Statistics by Schaum's series

Internal Assessment (IA):

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

End Semester Examination:

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

Term Work:

At least 08 tutorials covering entire syllabus must be given during the '**class wise tutorial'**. The tutorials should be students' centric and meaningful, interesting and innovative.

The distribution of the term work shall be as follows,
Tutorials :15 marks
Attendance (Tutorial and Theory) :10 marks
The final certification and acceptance of term-work ensures the satisfactory performance in tutorial. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM603	Biological Modeling and Simulation (abbreviated as BMS)	3	2	-	3	1	-	4

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM603	Biological Modeling and Simulation	20	20	20	80	25	-	25	150

Course Objectives	To make students understand basic concepts of modeling which will help them develop biological model and simulate physiological processes for better understanding.
Course Outcomes	The students will be able to design hardware and develop software for various biomedical systems. Students will learn to use various simulation software for modeling biological systems.

Module	Contents	Time
1.	**Physiological Modeling**: Steps in Modeling, Purpose of Modeling, lumped parameter models, distributed parameter models, compartmental modeling, modeling of circulatory system, regulation of cardiac output and respiratory system.	04
2.	**Model of Neurons:** Biophysics tools, Nernst Equation, Donnan Equilibrium, Active Transport (Pump) GHK equation, Action Potential, Voltage Clamp, Channel Characteristics, Hodgkin- Huxley Conductance Equations, Simulation of action potential, Electrical Equivalent model of a biological membrane, impulse propagation- core conductor model , cable equations.	11
3.	**Neuromuscular System:** modeling of skeletal muscle, mono and polysynaptic reflexes, stretch reflex, reciprocal innervations, two control mechanism, Golgi tendon, experimental validation, Parkinson's syndrome.	06
4.	**Eye Movement Model:** Four eye movements, quantitative eye movement models, validity criteria.	06
5.	**Thermo regulatory systems:** Thermoregulatory mechanisms, model of thermoregulatory system, controller model, validation and application.	03
6.	**Modelling of other physiological systems.** **Modelling the Immune response:** Behavior of the immune system, linearized model of the immune response.	06

	Modelling of Drug delivery systems. **Modelling of Insulin Glucose feedback system** and Pulsatile Insulin secretion	

List of Experiments/Assignments:

Experiments can be carried out using any of these softwares.

1. Simulations using MATLAB
2. Simulations using HHSim
3. Simulations using Neurons in Action
4. Developing a model of neuron using NEURON

Text books:

1. Bioengineering, Biomedical, Medical and Clinical Engg.: A.Teri Bahil.
2. Signals and systems in Biomedical Engg.: Suresh R Devasahayam.
3. Bio-Electricity A quantitative approach by Barr and Ploncey

Reference Books:

1. Biomedical Engineering Handbook by Bronzino (CRC Press)

Internal Assessment (IA):

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

End Semester Examination:

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

Term Work:

Term work consists of minimum six experiments and two assignments. The distribution of the term work shall be as follows:

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

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM604	Microcontrollers and Embedded Systems (abbreviated as MES)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM604	Microcontrollers and Embedded Systems	20	20	20	80	25	-	25	150

Course Objectives	Students will learn the basics of Microcontroller designing and interfacing. Students will understand and improve programming concepts.
Course Outcomes	Students will develop understanding of hardware design and will be able to design controller based real time applications. Students will develop programming skills for designing and developing automated and user friendly systems.

Module	Contents	Time
1.	**Embedded Systems** Definition of embedded systems, overview of embedded systems and its classification, design challenges, processor technology, IC technology, design technology and tradeoffs, examples of embedded systems	04
2.	**MCS-51 Microcontroller** 8051 architecture ; its variants and comparision, comparision of microprocessor and microcontrollers, CPU timing and machine cycle, memory organisation, SFR's, integrated prepherials such as timers/counters, serial ports, parallel I/O ports, interrupt structure, memory interfacing power saving and power down modes.	10
3.	**8051programming** Assembly language programming process, programming tools, Instruction set in detail and addressing modes, Programming practice using assembly and C compilers	12
4.	**Microcontroller design and interfacing case studies** Interfacing with external memories, Interfacing with 8255, Interfacing with 7 segment display, Interfacing with keyboard, interfacing with LCD, Interfacing with ADC,DAC and Sensors, Interfacing with stepper motor Interfacing with PC using RS232	12
5.	**Serial Communication Protocols** Operation of serial port, programming for asynchronous serial communication, Serial Communication using the 'I2C', SPI, Introduction to USB & CAN bus.	05
6.	**Real time operating system**	05

	Introduction to RTOS concept, RTOS scheduling models interrupt latency and response times of the tasks as performance metric. Example of any small RTOS system	

Text books:

1.The 8051 microcontrollers-Kenneth J Ayala
2.Embedded systems-architecture, programming and design, Rajkamal, Tata McGraw Hill
3.Embedded System Design: A unified Hardware/Software Introduction Frank Vahid,Toney Givargis- John Wiley publication
3.An Embedded Software Primer David E. Simon - Pearson Education
4.The 8051 Microcontroller and Embedded Systems Muhammad A Mazidi, , Pearson Education
5.Using MCS-51 Microcontroller Han-Way Huang,.
6. 8051 microcontroller hardware, software applications.V U dayashankara, M S Mallikarjunaswamy,

Reference Books:

1. Sriram Iyer and Pankaj Gupta, Embedded Realtime systems programming, Tata McGraw Hill

2. Embedded Microcomputer Systems- Real time Interfacing -Valvano

Internal Assessment (IA):

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

End Semester Examination:

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

Oral Examination:

Oral examination will be based entire syllabus and on the course-project.

Term Work:

Term work consists of minimum five experiments and a course - project based on the syllabus. The distribution of the term work shall be as follows:
Laboratory work (Experiments, course - project and Journal) :15 marks
Attendance (Practical and Theory) :10 marks

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM605	Medical Imaging-I (abbreviated as MI-I)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM605	Medical Imaging-I	20	20	20	80	25	-	25	150

Course Objectives	To familiarize the students with the various Imaging techniques in medicine operating principles and quality control aspects of various imaging modalities. To keep the students abreast with the technological developments in the field of Medical Imaging
Course Outcomes	The students will able to understand essential physics, concepts of Medical Imaging and how they are employed in diagnosis and therapy. The students will also get familiar with the current techniques of medical Imaging along with their clinical applications. The students will also be able to apprehend the importance of radiation constructive utilization and safety.

Module	Contents	Time
1.	**Ultrasound in Medicine:** Introduction , Production and Characteristics of Ultrasound Display System : A mode ,B mode and M mode display and applications. Ultrasound transducers and Instrumentation. Real time Ultrasound ,Continuous wave and Pulsed wave Doppler Ultrasound systems, color flow imaging,applications.	12
2.	**X- ray Imaging:** Properties of X rays,production of X rays, X ray interaction with matter . Total radiographic System : X –ray tubes, Rating of X ray tubes. X –ray generators, X ray Image and beam Limiting Deices, Controls, X ray Film Development Technique.	12
3.	**Flouroscopic Imaging and x ray Image Intensifier Digital subtraction Angiography**	06
4.	**Computed Radiography and Digital Radiography ,Mammography**	10
5.	**Medical Thermography: Physics of thermgraphy, Thermographic equipment, applications.**	04
6.	**Endoscopy : Equipment , Imaging and its applications**	04

Text books:

1. Christensen's Physics of Diagnostic Radiology
2. Medical Imaging Physics William .R.Hendee

Reference Books:

1. Biomedical Technology and Devices by James Moore .
2. Biomedical Engineering Handbook by Bronzino
3. Physics of Diagnostic images –Dowsett

Internal Assessment (IA):

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

End Semester Examination:

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

Term Work:

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

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

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.

Sub Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut	Total
TEBM606	Digital Image Processing (abbreviated as DIP)	4	2	-	4	1	-	5

Sub Code	Subject Name	Examination scheme							
		Theory Marks				Term work	Pract.	Oral	Total
		Internal Assessment			End Sem exam				
		Test 1	Test 2	Avg.					
TEBM606	Digital Image Processing	20	20	20	80	25	50*	-	150

*Both Practical and Oral examination

Course Objectives	Introduce to the students the basic theory of digital image processing. Expose students to various available techniques and possibilities of this field. Learn basic image enhancement, transforms, segmentation, compression, morphology, representation, description techniques & algorithms. Prepare students to formulate solutions to general image processing problems. Develop hands-on experience in using computers to process images. Familiarize with MATLAB / C/ Labview/ similar software for processing digital images.
Course Outcomes	Students shall demonstrate the ability: To acquire the fundamental concepts of a digital image processing system such as image acquisition, enhancement, segmentation, transforms, compression, morphology, representation and description. To analyze images in the spatial domain. To analyze images in the frequency domain through the Fourier transform. To design and implement with MATLAB/C/Labview algorithms for digital image processing operations such as point processing, histogram processing, spatial and frequency domain filtering, denoising, transforms, compression, and morphological processing.

Module	Contents	Time
1.	**Basics of Image Processing**: Image acquisition, Processing, Communication, Display; Electromagnetic spectrum; Elements of visual perception - Structure of the human eye, Image formation in the eye, Brightness adaptation and discrimination, Image formation model, Uniform and non-uniform sampling, Quantization, Image formats.	05
2.	**Image Enhancement**: Spatial domain - Point processing techniques, Histogram processing, Neighbourhood processing, Frequency domain techniques - 2D-DFT, Properties of 2D-DFT, Low pass, High pass, Noise removal, Homomorphic filters,	12

	Basics of colour image processing.	
3.	**Image Segmentation**: Basic relationships between pixels - Neighbours, Adjacency, Connectivity, Regions, Boundaries, Distance measures; Detection of discontinuities, Point, Line, Edge detection, Edge linking, Hough transform, Thresholding-based segmentation, Region-based segmentation.	08
4.	**Image Transforms**: DFT, FFT, DCT, DST, Hadamard, Walsh, Haar, Slant, K-L Transforms, Basis functions and basis images, Introduction to wavelet transform.	08
5.	**Image Compression**: Fundamentals of image compression models, Lossless compression - RLE, Huffman, LZW, Arithmetic coding techniques. Lossy compression - IGS coding, Predictive coding, Transform coding, JPEG, JPEG 2000.	08
6.	**Morphology, Representation and Description**: Dilation, Erosion, Open, Close, Hit-or-miss, Boundary extraction, Region filling, Thinning and thickening; Chain Codes, Polygonal approximations, Signatures; Fourier descriptors, Moments.	07

List of Experiments (using Matlab / C/ Labview/ similar software)

1. Point Processing techniques (At least 4 experiments).
2. Spatial domain Filtering.
3. Histogram Processing (Histogram Stretching and Equalisation).
4. Frequency Domain Filtering (Plotting 2D-DFT, Low pass and High Pass- Ideal, Butterworth and Gaussian Filters).
5. Segmentation-Gradient operators.
6. Transforms-DCT.
7. Morphology-Dilation Erosion.

Text books:

1. Digital Image Processing, Gonzalez and Woods- Pearson Education.
2. Fundamentals of Digital Image Processing, A.K. Jain –P.H.I.
3. Digital Image Processing and Analysis, Chanda Majumder-Printice Hall India.

Reference Books:

1. Digital Image Processing and Computer Vision, Sonka, Hlavac, Boyle-Cengage learning.
2. Digital Image Processing, William Pratt- John Wiley.

Internal Assessment (IA):

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

End Semester Examination:

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

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

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

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and completion of journal. Term work assessment must be based on the overall performance of the student.