

# **1<sup>st</sup> Year Curriculum for B.Tech courses in Engineering & Technology**

*(Applicable from the academic session 2018-2019)*



**Maulana Abul Kalam Azad University of Technology, West Bengal**

*(Formerly West Bengal University of Technology)*

BF- 142, Sector-I, Salt Lake, Kolkata- 700064, India

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**A. Definition of Credit:**

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credits

**B. Range of credits :**

A range of credits from 150 to 160 for a student to be eligible to get B.Tech Degree in Engineering. A student will be eligible to get B.Tech Degree *with Honours*, if he/she completes an additional 20 credits. These could be acquired through Massive Open Online Courses (MOOCs).

**C. MOOCs for B. Tech Honours**

The additional 20 credits (for obtaining B. Tech with Honours) are to be gained through MOOCs. The complete description of the MOOCs relevant for the first year course are given in *Annexure-I*. The courses for subsequent years of study will be posted subsequently.

**D. Guidelines regarding Mandatory Induction Program for the new students**

All concerned are requested to follow the guidelines given in *Annexure-II* (Notice dt.06/12/2017) concerning Mandatory Induction Program. The colleges/ Institute may also refer to the AICTE Model Curriculum for Undergraduate Degree Courses in Engineering & Technology (January 2018) -Volume I (Page No.31-38), if necessary.

**E. Mandatory Additional Requirement for earning B. Tech Degree**

All concerned are requested to follow the guidelines in *Annexure-III* concerning Mandatory Additional Requirements.

**F. Group division:**

***Group-A:***

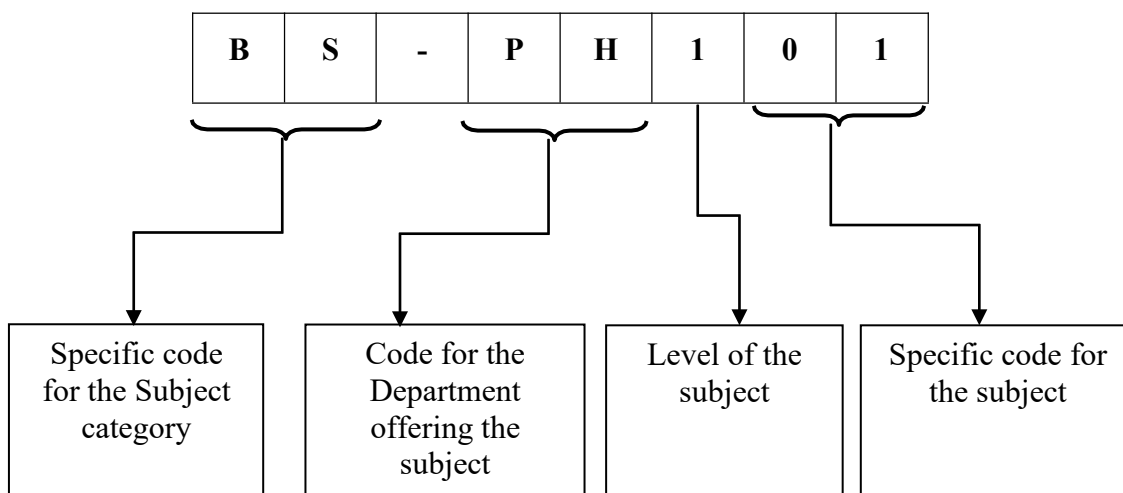
Chemistry based subjects: [Bio-Technology, Food Technology, Leather Technology, Textile Technology, Ceramic Technology, Chemical Engineering and any other Engineering that chooses to be Chemistry based] + Physics based subjects: [Mechanical Engineering, Production Engineering, Civil Engineering, Automobile Engineering, Marine Engineering, Apparel Production Engineering, Computer Science & Engineering, Information Technology.]

***Group-B:***

All Physics based subjects which are also Electrical & Electronics based [Electrical Engineering, Electronics & Communication Engineering, Applied Electronics & Instrumentation Engineering, Power Engineering, Electrical & Electronics Engineering, Bio-Medical Engineering, Instrumentation & Control Engineering]

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**G. Subject Numbering Scheme:**



<b>List of Codes for Subject Category</b>	
<b>Code</b>	<b>Category Name</b>
BS	Basic Science Courses
ES	Engineering Science Courses
HM	Humanities and Social Sciences including Management courses
PC	Professional core courses
PE	Professional Elective courses
OE	Open Elective courses
MC	Mandatory courses
PW	Project

<b>List of Codes for Departments</b>			
<b>Code</b>	<b>Name of the Department</b>	<b>Code</b>	<b>Name of the Department</b>
APM	Apparel Production Engineering	ECE	Electronics & Communication Engineering
AEIE	Applied Electronics & Instrumentation Engineering	FT	Food Technology
AUE	Automobile Engineering	IT	Information Technology
BME	Bio-Medical Engineering	ICE	Instrumentation & Control Engineering
BT	Bio-Technology	LT	Leather Technology
CT	Ceramic Technology	MRE	Marine Engineering
CHE	Chemical Engineering	ME	Mechanical Engineering
CE	Civil Engineering	PWE	Power Engineering
CSE	Computer Science & Engineering	PE	Production Engineering
EEE	Electrical & Electronics Engineering	TT	Textile Technology
EE	Electrical Engineering		

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<b>First Year First Semester</b>							
<b>Mandatory Induction Program- 3 weeks duration</b>							
Sl No.	Category	Subject Code	Subject Name	Total Number of contact hours			Credits
				L	T	P	
<b>Theory</b>							
1	Basic Science course	BS-PH101/ BS-CH101	Physics-I (Gr-A)/ Chemistry-I(Gr-B)	3	1	0	4
2	Basic Science course	BS-M101/ BS-M102	Mathematics –IA*/ Mathematics –IB *	3	1	0	4
3	Engineering Science Courses	ES-EE101	Basic Electrical Engineering	3	1	0	4
<i>Total Theory</i>				<b>9</b>	<b>3</b>	<b>0</b>	<b>12</b>
<b>Practical</b>							
1	Basic Science course	BS-PH191/ BS-CH191	Physics-I Laboratory (Gr-A)/ Chemistry-I Laboratory (Gr-B)	0	0	3	1.5
2	Engineering Science Courses	ES-EE191	Basic Electrical Engineering Laboratory	0	0	2	1
3	Engineering Science Courses	ES-ME191/ ES-ME192	Engineering Graphics & Design(Gr-B)/ Workshop/Manufacturing Practices(Gr-A)	1	0	4	3
<i>Total Practical</i>				<b>1</b>		<b>9</b>	<b>5.5</b>
<b>Total of First Semester</b>				<b>10</b>	<b>3</b>	<b>9</b>	<b>17.5</b>

\* Mathematics –IA (BS-M101) - CSE & IT  
 Mathematics –IB (BS-M102) - All stream except CSE & IT

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<b>First Year Second Semester</b>							
Sl No.	Category	Subject Code	Subject Name	Total Number of contact hours			Credits
				L	T	P	
<b>Theory</b>							
1	Basic Science courses	BS-PH201/ BS-CH201	Physics-I (Gr-B)/ Chemistry-I (Gr-A)	3	1	0	4
2	Basic Science courses	BS-M201/ BS-M202	Mathematics –IIA#/ Mathematics –IIB#	3	1	0	4
3	Engineering Science Courses	ES-CS201	Programming for Problem Solving	3	0	0	3
4	Humanities and Social Sciences including Management courses	HM-HU201	English	2	0	0	2
<i>Total Theory</i>				<b>11</b>	<b>2</b>	<b>0</b>	<b>13</b>
<b>Practical</b>							
1	Basic Science courses	BS-PH291/ BS-CH291	Physics-I Laboratory (Gr-B)/ Chemistry-I Laboratory (Gr-A)	0	0	3	1.5
2	Engineering Science Courses	ES-CS291	Programming for Problem Solving	0	0	4	2
3	Engineering Science Courses	ES-ME291/ ES-ME292	Engineering Graphics & Design(Gr-A)/ Workshop/Manufacturing Practices(Gr-B)	1	0	4	3
4	Humanities and Social Sciences including Management courses	HM-HU291	Language Laboratory	0	0	2	1
<i>Total Practical</i>				<b>1</b>	<b>0</b>	<b>13</b>	<b>7.5</b>
<b>Total of Second Semester</b>				<b>12</b>	<b>2</b>	<b>13</b>	<b>20.5</b>

# Mathematics –II (BS-M201) - CSE & IT  
Mathematics –II (BS-M202) - All stream except CSE & IT

	<b>Group-A</b>	<b>Group-B</b>
1 <sup>st</sup> Year 1 <sup>st</sup> Semester	Physics-I (BS-PH101); Workshop/Manufacturing Practices (ES-ME192)	Chemistry-I (BS-CH101); Engineering Graphics & Design (ES-ME191)
1 <sup>st</sup> Year 2 <sup>nd</sup> Semester	Chemistry-I (BS-CH201); Engineering Graphics & Design (ES-ME291)	Physics-I (BS-PH201); Workshop/Manufacturing Practices (ES-ME292)

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<b>Course Code :</b> BS-PH101/ BS-PH201	<b>Category :</b> Basic Science Courses
<b>Course Title :</b> Physics-I	<b>Semester :</b> First/ Second
<b>L-T-P : 3-1-0</b>	<b>Credit:4</b>
<b>Pre-Requisites:</b>	

**Course objectives :**

Basic concepts of mechanics, optics and its applications, electricity, magnetism and qualitative understanding of concepts of quantum physics and statistical mechanics.

**1. Mechanics ( 7L)**

Problems including constraints & friction. Basic ideas of vector calculus and partial differential equations. Potential energy function  $F = -\text{grad } V$ , equipotential surfaces and meaning of gradient. Conservative and non-conservative forces. Conservation laws of energy & momentum. Non-inertial frames of reference. Harmonic oscillator; Damped harmonic motion forced oscillations and resonance. Motion of a rigid body in a plane and in 3D. Angular velocity vector. Moment of inertia.

**2. Optics (5L)**

- Distinction between interference and diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits ( only the expressions for max;min, & intensity and qualitative discussion of fringes); diffraction grating(resolution formulac only), characteristics of diffraction grating and its applications.
- Polarisation : Introduction, polarisation by reflection, polarisation by double reflection, scattering of light, circular and elliptical polarisation, optical activity.
- Lasers : Principles and working of laser : population inversion, pumping, various modes, threshold population inversion with examples .

**3. Electromagnetism and Dielectric Magnetic Properties of Materials (8L)**

- Maxwell's equations. Polarisation, permeability and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius- Mossotti equation(expression only), applications of dielectrics.
- Magnetisation , permeability and susceptibility, classificationof magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.

**4. Quantum Mechanics (16L)**

- Introduction to quantum physics, black body radiation, explanation using the photon concept, Compton effect, de Broglie hypothesis, wave-particle duality, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom.

**5. Statistical Mechanics (8L)**

- Macrostate, Microstate, Density of states, Qualitative treatment of Maxwell Boltzmann, Fermi-Dirac and Bose-Einstein statistics.

**Course outcomes:**

Students will be familiar with

- Basic concepts of mechanics
- Bragg's Law and introduction to the principles of lasers, types of lasers and applications.
- Various terms related to properties of materials such as, permeability, polarization, etc.
- Some of the basic laws related to quantum mechanics as well as magnetic and dielectric properties of materials.
- Simple quantum mechanics calculations.
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**Learning Resources:**

1. Introduction to Electrodynamics, David J. Griffiths, Pearson Education India Learning Private Limited
2. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker, Wiley
3. Electricity, Magnetism, and Light, Wayne M. Saslow, Academic Press
4. Engineering Mechanics (In SI Units) (SIE), S. Timoshenko, D.H. Young, J.V. Rao, Sukumar Pati, McGraw Hill Education
5. Classical mechanics, Narayan Rana, Pramod Joag, McGraw Hill Education
6. Introduction to Classical Mechanics, R Takwale, P Puranik, McGraw Hill Education
7. Engineering Mechanics, M.K. Harbola, Cengage India
8. An Introduction to Mechanics (SIE), David Kleppner, Robert Kolenkow, McGraw Hill Education
9. Principles of mechanics, John L. Synge and Byron A. Griffith, New York, McGraw-Hill
10. Mechanics (Dover Books on Physics), J. P. Den Hartog, Dover Publications Inc.
11. Engineering Mechanics: Dynamics, L.G. Kraige J.L. Meriam, Wiley
12. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Robert Eisberg, Robert Resnick, Wiley
13. Introduction to Quantum Mechanics, J. Griffiths David, Pearson Education
14. Modern Quantum Mechanics, J. J. Sakurai, Cambridge University Press
15. Optics, Hecht, Pearson Education
16. Optics, Ghatak, McGraw Hill Education India Private Limited
17. Fundamentals of Statistical and Thermal Physics, Reif, Sarat Book Distributors
18. Statistical Mechanics, Pathria, Elsevier
19. Statistical Physics, L.D.Landau, E.M. Lifshitz, Butterworth-Heinemann

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<b>Course Code :</b> BS-CH101/ BS-CH201	<b>Category :</b> Basic Science Courses
<b>Course Title :</b> Chemistry-I	<b>Semester :</b> First/ Second
<b>L-T-P : 3-1-0</b>	<b>Credit:4</b>
<b>Pre-Requisites:</b>	

*Detailed contents*

**i) Atomic and molecular structure (10 lectures)**

Schrodinger equation. Particle in a box solutions and their applications for simple sample. Molecular orbitals of diatomic molecules (e.g.H<sub>2</sub>). Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.

**ii) Spectroscopic techniques and applications (8 lectures)**

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterisation techniques. Diffraction and scattering.

**iii) Intermolecular forces and potential energy surfaces (4 lectures)**

Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena.

**iv) Use of free energy in chemical equilibria (8 lectures)**

First and second laws of thermodynamics and thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.

**v) Periodic properties (4 Lectures)**

Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries

**vi) Stereochemistry (4 lectures)**

Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds

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**vii) Organic reactions and synthesis of a drug molecule (4 lectures)**

Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.

**Course Outcomes**

The concepts developed in this course will aid in quantification of several concepts in chemistry that have been introduced at the 10+2 levels in schools. Technology is being increasingly based on the electronic, atomic and molecular level modifications. Quantum theory is more than 100 years old and to understand phenomena at nanometer levels, one has to base the description of all chemical processes at molecular levels.

The course will enable the student to:

Analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.

Rationalise bulk properties and processes using thermodynamic considerations.

Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques

Rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.

List major chemical reactions that are used in the synthesis of molecules.

**Learning Resources:**

1. Engineering Chemistry, Satyaprakash, Khanna Book Publishing, Delhi
2. University chemistry, by B. H. Mahan
3. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane
4. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
5. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
6. Physical Chemistry, by P. W. Atkins
7. Spectroscopy of Organic Compounds, by P.S.Kalsi, New Age International Pvt Ltd Publishers
8. Physical Chemistry, P. C. Rakshit, Sarat Book House
9. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5<sup>th</sup> Edition  
<http://bcs.whfreeman.com/vollhardtschore5e/default.asp>

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<b>Course Code :</b> BS-M101	<b>Category :</b> Basic Science Course
<b>Course Title :</b> Mathematics – I A	<b>Semester :</b> First (CSE & IT)
<b>L-T-P : 3-1-0</b>	<b>Credit: 4</b>
<b>Pre-Requisites: High School Mathematics</b>	

<b>Module No.</b>	<b>Description of Topic</b>	<b>Lectures Hours</b>
1	<b>Calculus (Integration):</b> Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.	8
2	<b>Calculus (Differentiation):</b> Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.	6
3	<b>Matrices:</b> Matrices, Vectors: addition and scalar multiplication, matrix multiplication; Linear systems of equations, linear Independence, rank of a matrix, determinants, Cramer's Rule, inverse of a matrix, Gauss elimination and Gauss-Jordan elimination.	7
4	<b>Vector Spaces:</b> Vector Space, linear dependence of vectors, Basis, Dimension; Linear transformations (maps), Range and Kernel of a linear map, Rank and Nullity, Inverse of a linear transformation, Rank-Nullity theorem, composition of linear maps, Matrix associated with a linear map.	9
5	<b>Vector Spaces (Continued):</b> Eigenvalues, Eigenvectors, Symmetric, Skew-symmetric, and Orthogonal Matrices, Eigenbases. Diagonalization; Inner product spaces, Gram-Schmidt orthogonalization.	10

**Course Outcomes:**

The students will be able to:

Apply the concept and techniques of differential and integral calculus to determine curvature and evaluation of different types of improper integrals.

Understand the domain of applications of mean value theorems to engineering problems.

Learn different types of matrices, concept of rank, methods of matrix inversion and their applications.

Understand linear spaces, its basis and dimension with corresponding applications in the field of computer science.

Learn and apply the concept of eigen values, eigen vectors, diagonalisation of matrices and orthogonalization in inner product spaces for understanding physical and engineering problems

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**Learning Resources:**

1. Reena Garg, Engineering Mathematics-I, Khanna Publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. Michael Greenberg, Advanced Engineering Mathematics, Pearson.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
5. Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cenage Learning.
6. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.
7. S.K. Mapa, Higher Algebra: Abstract and Linear, Sarat Book House Pvt.Ltd.
8. Hoffman and Kunze: Linear algebra, PHI.

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<b>Course Code :</b> BS-M102	<b>Category :</b> Basic Science Course
<b>Course Title :</b> Mathematics –I B	<b>Semester :</b> First (All stream except CSE & IT)
<b>L-T-P : 3-1-0</b>	<b>Credit: 4</b>
<b>Pre-Requisites: High School Mathematics</b>	

<b>Module No.</b>	<b>Description of Topic</b>	<b>Lectures Hours</b>
1	<b><i>Calculus (Integration):</i></b> Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions.	8
2	<b><i>Calculus (Differentiation):</i></b> Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin's theorems with remainders; Indeterminate forms and L'Hospital's rule; Maxima and minima.	6
3	<b><i>Sequence and Series:</i></b> Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.	11
4	<b><i>Multivariate Calculus:</i></b> Limit, continuity and partial derivatives, Directional derivatives, Total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, Curl and Divergence.	9
5	<b><i>Matrices:</i></b> Inverse and rank of a matrix, Rank-nullity theorem; System of linear equations; Symmetric, Skew-symmetric and Orthogonal matrices; Determinants; Eigenvalues and Eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.	8

**Course Outcomes:**

After completing the course the student will be able to

Apply the concept and techniques of differential and integral calculus to determine curvature and evaluation of different types of improper integrals.

Understand the domain of applications of mean value theorems to engineering problems.

Learn the tools of power series and Fourier series to analyze engineering problems and apply the concept of convergence of infinite series in many approximation techniques in engineering disciplines.

Apply the knowledge for addressing the real life problems which comprises of several variables or attributes and identify extremum points of different surfaces of higher dimensions.

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Understand different types of matrices, their eigen values, eigen vectors, rank and also their orthogonal transformations which are essential for understanding physical and engineering problems.

**Learning Resources:**

1. Reena Garg, Engineering Mathematics-I, Khanna Publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. Michael Greenberg, Advanced Engineering Mathematics, Pearson.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
5. Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cenage Learning.
6. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.

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<b>Course Code :</b> ES-EE101	<b>Category :</b> Engineering Science Courses
<b>Course Title :</b> Basic Electrical Engineering	<b>Semester :</b> First
<b>L-T-P : 3-1-0</b>	<b>Credit: 4</b>
<b>Pre-Requisites:</b>	

*Detailed contents:*

**Module 1: DC Circuits (8 hours)**

Electrical circuit elements (R, L and C), voltage and current sources, Kirchoff current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.

**Module 2: AC Circuits (8 hours)**

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

**Module 3: Transformers (6 hours)**

Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

**Module 4: Electrical Machines (8 hours)**

Generation of rotating magnetic fields, Construction and working of a three-phase induction motor, Significance of torque-slip characteristic. Loss components and efficiency, starting and speed control of induction motor. Single-phase induction motor. Construction, working, torque-speed characteristic and speed control of separately excited dc motor. Construction and working of synchronous generators.

**Module 5: Power Converters (6 hours)**

DC-DC buck and boost converters, duty ratio control. Single-phase and three-phase voltage source inverters; sinusoidal modulation.

**Module 6: Electrical Installations (6 hours)**

Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

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**Course Outcomes**

To understand and analyze basic electric and magnetic circuits

To study the working principles of electrical machines and power converters.

To introduce the components of low voltage electrical installations

**Learning Recourses:**

1. Ritu Sahdev, Basic Electrical Engineering, Khanna Book Publishing Co. (P) Ltd., Delhi.
2. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
3. D. C. Kulshreshtha, “Basic Electrical Engineering”, McGraw Hill, 2009.
4. L. S. Bobrow, “Fundamentals of Electrical Engineering”, Oxford University Press, 2011.
5. E. Hughes, “Electrical and Electronics Technology”, Pearson, 2010.
6. V. D. Toro, “Electrical Engineering Fundamentals”, Prentice Hall India, 1989.

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<b>Course Code</b> : BS-PH191/ BS-PH291	<b>Category</b> : Basic Science course
<b>Course Title</b> : Physics-I Laboratory	<b>Semester</b> : First/ Second
<b>L-T-P</b> : 0-0-3	<b>Credit</b> :1.5
<b>Pre-Requisites:</b>	

**Choose 10 experiments including at least one from Optics, Electricity and Magnetism and Quantum Mechanics and at least a total of six from these three groups.**

### Experiments in Optics

1. Determination of dispersive power of the material of a prism
2. Determination of wavelength of a monochromatic light by Newton's ring
3. Determination of wavelength of a monochromatic light by Fresnel's bi-prism
4. Determination of wavelength of the given laser source by diffraction method

### Electricity & Magnetism experiments

1. Determination of thermo electric power of a given thermocouple.
2. Determination of specific charge (e/m) of electron by J.J. Thomson's method.
3. Determination of dielectric constant of a given dielectric material.
4. Determination of Hall coefficient of a semiconductor by four probe method.
5. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.
6. Determination of resistance of ballistic galvanometer by half deflection method and study of variation of logarithmic decrement with series resistance.
7. Determination of unknown resistance using Carey Foster's bridge
8. Study of Transient Response in LR, RC and LCR circuits using exppeyes
9. Generating sound from electrical energy using exppeyes

### Experiments in Quantum Physics

1. Determination of Stefan-Boltzmann constant.
2. Determination of Planck constant using photocell.
3. Determination of Lande-g factor using Electron spin resonance spectrometer.
4. Determination of Rydberg constant by studying Hydrogen spectrum.
5. Determination of Band gap of semiconductor.
6. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.

### Miscellaneous experiments

1. Determination of Young's modulus of elasticity of the material of a bar by the method of flexure
2. Determination of bending moment and shear force of a rectangular beam of uniform cross-section
3. Determination of modulus of rigidity of the material of a rod by static method
4. Determination of rigidity modulus of the material of a wire by dynamic method
5. To determine the moment of inertia of a body about an axis passing through its centre of gravity and to determine the modulus of rigidity of the material of the suspended wire
6. Determination of coefficient of viscosity by Poiseuille's capillary flow method

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<b>Course Code</b> : BS-CH191/ BS-CH291	<b>Category</b> : Basic Science Courses
<b>Course Title</b> : Chemistry-I Laboratory	<b>Semester</b> : First/ Second
<b>L-T-P</b> : 0-0-3	<b>Credit</b> :1.5
<b>Pre-Requisites:</b>	

**Choose 10 experiments from the following:**

1. Conductometric titration for determination of the strength of a given HCl solution by titration against a standard NaOH solution.
2. pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
3. Determination of dissolved oxygen present in a given water sample.
4. To determine chloride ion in a given water sample by Argentometric method (using chromate indicator solution)
5. Determination of surface tension and viscosity
6. Thin layer chromatography
7. Ion exchange column for removal of hardness of water
8. Determination of the rate constant of a reaction
9. Determination of cell constant and conductance of solutions
10. Potentiometry - determination of redox potentials and emfs
11. Saponification/acid value of an oil
12. Chemical analysis of a salt
13. Determination of the partition coefficient of a substance between two immiscible liquids
14. Adsorption of acetic acid by charcoal
15. Use of the capillary viscosimeters to demonstrate the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

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<b>Course Code :</b> ES-EE191	<b>Category :</b> Engineering Science Courses
<b>Course Title :</b> Basic Electrical Engineering Laboratory	<b>Semester :</b> First
<b>L-T-P : 0-0-2</b>	<b>Credit: 1</b>
<b>Pre-Requisites:</b>	

**Choose 10 experiments from the following:**

1. First activity: Introduction to basic safety precautions and mentioning of the do's and Don'ts. Noting down list of experiments to be performed, and instruction for writing the laboratory reports by the students. Group formation. Students are to be informed about the modalities of evaluation.
2. Introduction and uses of following instruments :
  - (a) Voltmeter
  - (b) Ammeter
  - (c) Multimeter
  - (d) Oscilloscope

Demonstration of real life resistors, capacitors with color code , inductors and autotransformer.

3. Demonstration of cut-out sections of machines: DC machine, Induction machine, Synchronous machine and single phase induction machine.
4. Calibration of ammeter and Wattmeter.
5. Determination of steady state and transient response of R-L, R-C and R-L-C circuit to a step change in voltage.
6. Determination of steady state response of R-L and R-C and R-L-C circuit and calculation of impedance and power factor.
7. Determination of resonance frequency and quality factor of series and parallel R-L-C circuit.
8. (a) Open circuit and short circuit test of a single-phase transformer  
 (b) Load test of the transformer and determination of efficiency and regulation
9. Demonstration of three phase transformer connections. Voltage and current relationship, phase shifts between the primary and secondary side.
10. Measurement of power in a three phase unbalanced circuit by two wattmeter method.
11. Determination of Torque –Speed characteristics of separately excited DC motor.
12. Determination of Torque speed characteristics and observation of direction reversal by change of phase sequence of connection of Induction motor.
13. Determination of operating characteristics of Synchronous generator.
14. Demonstration of operation of (a) DC-DC converter (b) DC-AC converter (c) DC-AC converter for speed control of an Induction motor
15. Demonstration of components of LT switchgear.

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<b>Course Code</b> : ES-ME191/ ES-ME 291	<b>Category</b> : Engineering Science Courses
<b>Course Title</b> : Engineering Graphics & Design	<b>Semester</b> : First/ Second
<b>L-T-P</b> : 1-0-4	<b>Credit</b> : 3
<b>Pre-Requisites:</b>	

Sl. No.	Content	Lecture (L)	Practical (P)
1	<b>INTRODUCTION TO ENGINEERING DRAWING</b> Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Different types of lines and their use; Drawing standards and codes.	1	4
2	<b>LETTERING, DIMENSIONING, SCALES</b> Plain scale, Diagonal scale and Vernier Scales.	1	4
3	<b>GEOMETRICAL CONSTRUCTION AND CURVES</b> Construction of polygons, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid, Involute, Archimedean Spiral.	1	4
4	<b>PROJECTION OF POINTS, LINES, SURFACES</b> Principles of Orthographic Projections-Conventions - 1st and 3rd angle projection, Projections of Points and lines inclined to both planes; Projections of planes (Rectangle, pentagon, Hexagon etc.) inclined Planes - Auxiliary Planes.	1	4
5	<b>PROJECTION OF REGULAR SOLIDS</b> Regular solids inclined to both the Planes- Auxiliary Views; Draw simple annotation, dimensioning and scale (Cube, Pyramid, Prism, Cylinder, Cone).	1	4
6	<b>COMBINATION OF REGULAR SOLIDS, FLOOR PLANS</b> Regular solids in mutual contact with each other like Spheres in contact with cones standing on their base. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.	1	4
7	<b>ISOMETRIC PROJECTIONS</b> Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions;	1	4

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8	<p><b>SECTIONS AND SECTIONAL VIEWS OF RIGHT ANGULAR SOLIDS</b></p> <p>Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only)</p>	1	4
9	<p><b>OVERVIEW OF COMPUTER GRAPHICS, CUSTOMISATION &amp; CAD DRAWING</b></p> <p>listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids]; Set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;</p>	1	4
	<p><b>ANNOTATIONS, LAYERING &amp; OTHER FUNCTIONS</b></p> <p>applying dimensions to objects, applying annotations to drawings;</p>		
10	<p>Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling;</p>	2	8

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11	<p><b>DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT</b></p> <p>Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).</p>	2	8
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**Course Outcomes**

The student will learn:

- Introduction to engineering design and its place in society
- Exposure to the visual aspects of engineering design
- Exposure to engineering graphics standards
- Exposure to solid modelling

**General Instructions**

1. In every topic some problems are to be done in the class and some are to be given to students as home assignment.
2. The problems for class work are to be prepared on drawing sheet of A1 size in the class/ using AutoCAD software.
3. The problems for home assignments are to be prepared on drawing copy/ using AutoCAD software.
4. Print out of every assignment is to be taken for CAD Drawings on Drawing sheets (A4 Sheets).
5. A title block must be prepared in each sheet/ assignment.

Following is the list of drawing instruments that required for making engineering drawings on paper with perfection.

1. Drawing Board
2. Mini drafter/ Set-squares (45°–45° & 60°–90°), T-square
3. Protractor (180°, 360°)
4. Scales (Plain, Diagonal)
5. Compass (Small and Large)
6. Divider (Small and Large)

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7. French Curves
8. Drawing paper (A1 Size)
9. Drawing pencil (H, HB, B)
10. Sharpener
11. Eraser
12. Drawing pins & clips
13. Duster or handkerchief etc.

**Learning Resources:**

1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House
3. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
6. Corresponding set of CAD Software Theory and User Manuals

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<b>Course Code :</b> ES-ME192/ ES-ME 292	<b>Category :</b> Engineering Science Courses
<b>Course Title :</b> Workshop/ Manufacturing Practices	<b>Semester :</b> First/ Second
<b>L-T-P : 1-0-4</b>	<b>Credit:3</b>
<b>Pre-Requisites:</b>	

**(i) Lectures & videos:**

Detailed contents:

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. CNC machining, Additive manufacturing
3. Fitting operations & power tools
4. Electrical & Electronics
5. Carpentry
6. Plastic moulding, glass cutting
7. Metal casting
8. Welding (arc welding & gas welding), brazing

**(ii) Workshop Practice:**

**Machine shop (8 hours)**

*Typical jobs that may be made in this practice module:*

To make a pin from a mild steel rod in a lathe.

To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and / or milling machine.

**Fitting shop (8 hours)**

*Typical jobs that may be made in this practice module:*

To make a Gauge from MS plate.

**Carpentry (8 hours)**

*Typical jobs that may be made in this practice module:*

To make wooden joints and/or a pattern or like.

**Welding shop (8 hours (Arc welding 4 hrs + gas welding 4 hrs))**

*Typical jobs that may be made in this practice module:*

ARC WELDING (4 hours): To join two thick (approx 6mm) MS plates by manual metal arc welding.

GAS WELDING (4 hours): To join two thin mild steel plates or sheets by gas welding.

**Casting (8 hours)**

*Typical jobs that may be made in this practice module:*

One/ two green sand moulds to prepare, and a casting be demonstrated.

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**Smithy (4 hours) ~ 4 hours**

*Typical jobs that may be made in this practice module:*

A simple job of making a square rod from a round bar or like.

**Plastic moulding & Glass cutting (4 hours)**

*Typical jobs that may be made in this practice module:*

For plastic moulding, making at least one simple plastic component should be made.

For glass cutting, three rectangular glass pieces may be cut to make a kaleidoscope using a black colour diamond cutter, or similar other components may be made.

**Electrical & Electronics (8 hours)**

Familiarization with LT switchgear elements, making its sketches and noting down its specification. Kitkat fuse, Glass cartridge fuse, Plastic fuse holders (optional), Iron clad isolators, MCB style isolators, Single phase MCB, Single-phase wire, wiring cable.

Demonstration of domestic wiring involving two MCB, two piano key switches, one incandescent lamp, one LED lamp and plug point.

Simple wiring exercise to be executed to understand the basic electrical circuit.

Simple soldering exercises to be executed to understand the basic process of soldering.

Fabrication of a single-phase full wave rectifier with a step down transformer using four diodes and electrolytic capacitor and to find its volt-ampere characteristics to understand basic electronic circuit fabrication.

**Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.**

**Laboratory Outcomes**

Upon completion of this laboratory course, students will be able to fabricate components with their own hands.

They will also get practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.

By assembling different components, they will be able to produce small devices of their interest.

**Learning Resources:**

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., “Elements of Workshop Technology”, Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. and Steven S. Schmid, “Manufacturing Engineering and Technology”, 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu, “Manufacturing Technology – I” Pearson Education, 2008.
4. Roy A. Lindberg, “Processes and Materials of Manufacture”, 4th edition, Prentice Hall India, 1998.
5. Rao P.N., “Manufacturing Technology”, Vol. I and Vol. II, Tata McGrawHill House, 2017.

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<b>Course Code :</b> BS-M201	<b>Category :</b> Basic Science Course
<b>Course Title :</b> Mathematics – II A	<b>Semester :</b> Second (CSE &IT)
<b>L-T-P : 3-1-0</b>	<b>Credit: 4</b>
<b>Pre-Requisites:</b> High School Mathematics and BS-M101	

<b>Module No.</b>	<b>Description of Topic</b>	<b>Lectures Hours</b>
1	<b>Basic Probability:</b> Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the Multinomial distribution, Poisson approximation to the Binomial distribution, infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.	11
2	<b>Continuous Probability Distributions:</b> Continuous random variables and their properties, Distribution functions and densities, Normal, Exponential and Gamma densities.	4
3	<b>Bivariate Distributions:</b> Bivariate distributions and their properties, distribution of sums and quotients, Conditional densities, Bayes' rule.	5
4	<b>Basic Statistics:</b> Measures of Central tendency, Moments, Skewness and Kurtosis, Probability distributions: Binomial, Poisson and Normal and evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.	8
5	<b>Applied Statistics:</b> Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.	8
6	<b>Small samples:</b> Test for single mean, difference of means and correlation coefficients, test for ratio of variances - Chi-square test for goodness of fit and independence of attributes.	4

**Course Outcomes:**

The students will be able to:

Learn the ideas of probability and random variables, various discrete and continuous probability distributions with their properties and their applications in physical and engineering environment.

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Understand the basic ideas of statistics with different characterisation of a univariate and bivariate data set.

Apply statistical tools for analysing data samples and drawing inference on a given data set.

**Learning Resources:**

1. Reena Garg, Chandrika Prasad, Advanced Engineering Mathematics, Khanna Publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons
3. S. Ross, A First Course in Probability, Pearson Education India
4. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, Wiley.
5. John E. Freund, Ronald E. Walpole, Mathematical Statistics, Prentice Hall.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
7. N.G. Das, Statistical Methods (Combined Volume), Tata-McGraw Hill.

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<b>Course Code :</b> BS-M202	<b>Category :</b> Basic Science Course
<b>Course Title :</b> Mathematics – II B	<b>Semester :</b> Second (All stream except CSE & IT)
<b>L-T-P : 3-1-0</b>	<b>Credit: 4</b>
<b>Pre-Requisites:</b> High School Mathematics and BS-M102	

<b>Module No.</b>	<b>Description of Topic</b>	<b>Lectures Hours</b>
1	<b><i>Multivariate Calculus (Integration):</i></b> Multiple Integration: Double integrals (Cartesian), change of order of integration in double integrals, change of variables (Cartesian to Polar), Applications: Areas and volumes, Center of mass and Gravity (constant and variable densities); Triple integrals (Cartesian), Orthogonal curvilinear coordinates, Simple applications involving cubes, sphere and rectangular parallelepipeds; Scalar line integrals, vector line integrals, scalar surface integrals, vector surface integrals, Theorems of Green, Gauss and Stokes.	11
2	<b><i>First order ordinary differential equations:</i></b> Exact, linear and Bernoulli's equations, Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.	5
3	<b><i>Ordinary differential equations of higher orders:</i></b> Second order linear differential equations with constant coefficients, Use of D-operators, Second order linear differential equations with variable coefficients, method of variation of parameters, Cauchy-Euler equation; Power series solutions; Legendre polynomials, Bessel functions of the first kind and their properties.	9
4	<b><i>Complex Variable – Differentiation</i></b> Differentiation of complex functions, Cauchy-Riemann equations, Analytic functions, Harmonic functions, determination of harmonic conjugate, elementary analytic functions (exponential, trigonometric, logarithmic) and their properties; Conformal mappings, Mobius transformations and their properties.	6
5	<b><i>Complex Variable – Integration</i></b> Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, Zeros of analytic functions, Singularities, Laurent's series; Residues, Cauchy residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.	9

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**Course Outcomes:**

The students will be able to:

Learn the methods for evaluating multiple integrals and their applications to different physical problems.

Understand different techniques to solve first and second order ordinary differential equations with its formulation to address the modelling of systems and problems of engineering sciences.

Learn different tools of differentiation and integration of functions of a complex variable that are used with various other techniques for solving engineering problems.

Apply different types of transformations between two 2- dimensional planes for analysis of physical or engineering problems.

**Learning Resources:**

1. Reena Garg, Chandrika Prasad, Advanced Engineering Mathematics, Khanna Publishers.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.
3. Michael Greenberg, Advanced Engineering Mathematics, Pearson.
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.
5. Kanti B. Dutta, Mathematical Methods of Science and Engineering, Cenage Learning.
6. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi.
7. E. L. Ince, Ordinary Differential Equations, Dover Publications.
8. J. W. Brown and R. V. Churchill, Complex Variables and Applications, Mc-Graw Hill.

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<b>Course Code</b> : ES-CS201	<b>Category</b> : Engineering Science Courses
<b>Course Title</b> : Programming for Problem Solving	<b>Semester</b> : Second
<b>L-T-P</b> : 3-0-0	<b>Credit</b> :3
<b>Pre-Requisites:</b>	

*Detailed contents*

**Unit 1: Introduction to Programming (4 lectures)**

Introduction to components of a computer system (disks, memory, processor, where a program is stored and executed, operating system, compilers etc.) - **(1 lecture)**.

Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples. **(1 lecture)**

From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code- **(2 lectures)**

**Unit 2: Arithmetic expressions and precedence (2 lectures)**

**Unit 3: Conditional Branching and Loops (6 lectures)**

Writing and evaluation of conditionals and consequent branching **(3 lectures)**

Iteration and loops **(3 lectures)**

**Unit 4: Arrays (6 lectures)**

Arrays (1-D, 2-D), Character arrays and Strings

**Unit 5: Basic Algorithms (6 lectures)**

Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

**Unit 6: Function (5 lectures)**

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference

**Unit 7: Recursion (4 -5 lectures)**

Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

**Unit 8: Structure (4 lectures)**

Structures, Defining structures and Array of Structures

**Unit 9: Pointers (2 lectures)**

Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation)

**Unit 10: File handling (only if time is available, otherwise should be done as part of the lab)**

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**Course Outcomes**

The student will learn

- To formulate simple algorithms for arithmetic and logical problems.
- To translate the algorithms to programs (in C language).
- To test and execute the programs and correct syntax and logical errors.
- To implement conditional branching, iteration and recursion.
- To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
- To use arrays, pointers and structures to formulate algorithms and programs.
- To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
- To apply programming to solve simple numerical method problems, namely root finding of function, differentiation of function and simple integration.

**Learning Resources:**

1. R. S. Salaria, Computer Concepts and Programming in C, Khanna Publishers
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
3. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India

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<b>Course Code :</b> ES-CS291	<b>Category :</b> Engineering Science Courses
<b>Course Title :</b> Programming for Problem Solving	<b>Semester :</b> Second
<b>L-T-P : 0-0-4</b>	<b>Credit:2</b>
<b>Pre-Requisites:</b>	

*The laboratory should be preceded or followed by a tutorial to explain the approach or algorithm to be implemented for the problem given.*

**Tutorial 1:** Problem solving using computers:

**Lab1:** Familiarization with programming environment

**Tutorial 2:** Variable types and type conversions:

**Lab 2:** Simple computational problems using arithmetic expressions

**Tutorial 3:** Branching and logical expressions:

**Lab 3:** Problems involving if-then-else structures

**Tutorial 4:** Loops, while and for loops:

**Lab 4:** Iterative problems e.g., sum of series

**Tutorial 5:** 1D Arrays: searching, sorting:

**Lab 5:** 1D Array manipulation

**Tutorial 6:** 2D arrays and Strings

**Lab 6:** Matrix problems, String operations

**Tutorial 7:** Functions, call by value:

**Lab 7:** Simple functions

**Tutorial 8 &9:** Numerical methods (Root finding, numerical differentiation, numerical integration):

**Lab 8 and 9:** Programming for solving Numerical methods problems

**Tutorial 10:** Recursion, structure of recursive calls

**Lab 10:** Recursive functions

**Tutorial 11:** Pointers, structures and dynamic memory allocation

**Lab 11:** Pointers and structures

**Tutorial 12:** File handling:

**Lab 12:** File operations

**Laboratory Outcomes**

To formulate the algorithms for simple problems

To translate given algorithms to a working and correct program

To be able to correct syntax errors as reported by the compilers

To be able to identify and correct logical errors encountered at run time

To be able to write iterative as well as recursive programs

To be able to represent data in arrays, strings and structures and manipulate them through a program

To be able to declare pointers of different types and use them in defining self-referential structures.

To be able to create, read and write to and from simple text files.

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<b>Course Code :</b> HM-HU201	<b>Category :</b> Humanities and Social Sciences including Management courses
<b>Course Title :</b> English	<b>Semester :</b> Second
<b>L-T-P : 2-0-0</b>	<b>Credit:2</b>
<b>Pre-Requisites:</b>	

**Detailed contents**

**1. Vocabulary Building**

- 1.1 The concept of Word Formation: Compounding, Backformation, Clipping, Blending.
- 1.2 Root words from foreign languages and their use in English
- 1.3 Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives.
- 1.4 Synonyms, antonyms, and standard abbreviations: Acronyms

**2. Basic Writing Skills**

- 2.1 Sentence Structures & Types: Simple, Compound, Complex
- 2.2 Use of phrases and clauses in sentences: Transformation of sentences, active, passive, narration
- 2.3 Importance of proper punctuation
- 2.4 Creating coherence: Arranging paragraphs & Sentences in logical order
- 2.5 Creating Cohesion: Organizing principles of paragraphs in documents
- 2.6 Techniques for writing precisely

**3. Identifying Common Errors in Writing**

- 3.1 Subject-verb agreement
- 3.2 Noun-pronoun agreement
- 3.3 Misplaced modifiers
- 3.4 Articles
- 3.5 Prepositions
- 3.6 Redundancies
- 3.7 Clichés

**4. Nature and Style of sensible Writing**

- 4.1 Describing
- 4.2 Defining
- 4.3 Classifying
- 4.4 Providing examples or evidence
- 4.5 Writing introduction and conclusion

**5. Writing Practices**

- 5.1 Comprehension
- 5.2 Précis Writing
- 5.3 Essay Writing
- 5.4 Business Letter, Cover Letter & CV; E-mail

**Addendum**

**Some examples of English words with foreign roots**

Greek Root/Affix	Examples
Anti	Antisocial, antiseptic

**Maulana Abul Kalam Azad University of Technology, West Bengal**  
*(Formerly West Bengal University of Technology)*  
**1<sup>st</sup> Year Curriculum Structure for B.Tech courses in Engineering & Technology**  
 (Applicable from the academic session 2018-2019)

Auto	Automatic, autograph
Anthropos	Anthropology, philanthropy
Bio	Biography
Chronos	Time
Di	Dilemma
Bio	Biology
Biblio	Bibliography
Chron	Chronology
Cracy	Contradiction
Geo	Geology
Hyper	Hyperactive
Mania	Kleptomania
Mega	Megaserial
Eu	Eulogy, euphoria
Geo	Geology
Graph	autograph, photograph
Hetero	Heterogeneous
Hyper	Hyperactive
Hypo	hypodermic, hypoglycemia
Macro	Macrocosm
Mega	megalomania
Micro	microcosm

**Maulana Abul Kalam Azad University of Technology, West Bengal**  
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**1<sup>st</sup> Year Curriculum Structure for B.Tech courses in Engineering & Technology**  
 (Applicable from the academic session 2018-2019)

Mono	Monarch
Pan	Panorama
Pathos	Pathetic
Phobia	Hydrophobia
Pod (Gk), ped (Latin)	Pseudopodia
Poly	polyglot
Tele	Telephone
Theo	Theology, theist
<b>Latin Root</b>	<b>Examples</b>
Aud	Audible
Bene	Beneficial
Brev	abbreviate, brief
circum	Circulate
Contra	Contradict
Cred	Credible
Dict	Diction
Femina	Feminine
Inter	Internet, interval
Magna	Magnificent
Mal	Malnutrition
Multi	multinational
Nova	Novel
Multi	Multiple, multiplex
Non	Nonstop

**Maulana Abul Kalam Azad University of Technology, West Bengal**  
*(Formerly West Bengal University of Technology)*  
**1<sup>st</sup> Year Curriculum Structure for B.Tech courses in Engineering & Technology**  
 (Applicable from the academic session 2018-2019)

Pre	Previous, predicate
Re	Redo, rewind
Scrib	Scripture
Spect	Spectator
Trans	Transport
Uni	Unity
Omni	Omnipotent
Semi	Semicircle
Sub	Subway
somnus	Insomnia,
Super	Superman
Sym	Sympathy
scribe	Describe, scribble(write illegibly), inscribe
Trans	Transform
Un	Unnecessary
Uni	Universal

**Learning Resources:**

- (i) Kulbushan Kumar, R S Salaria, Effective Communication Skills, Khanna Publishing House, Delhi.
- (ii) Practical English Usage. Michael Swan. OUP. 1995.
- (iii) Remedial English Grammar. F.T. Wood. Macmillan. 2007
- (iv) On Writing Well. William Zinsser. Harper Resource Book. 2001
- (v) Study Writing. Liz Hamp-Lyons and Ben Heasley. Cambridge University Press. 2006.
- (vi) Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
- (vii) Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
- (viii) Universal English Prof. Prasad Kataria Publications, 2019.
- (ix) "Communication Skills for Professionals"-Nira Konar, Prentice Hall of India 2nd edition, New Delhi, 2011
- (x) Gajendra Singh Chauhan, Smita Kashiramka and L. Thimmesha. Functional English. Cengage , 2019.

**Course Outcomes**

The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

**Maulana Abul Kalam Azad University of Technology, West Bengal**  
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**1<sup>st</sup> Year Curriculum Structure for B.Tech courses in Engineering & Technology**  
 (Applicable from the academic session 2018-2019)

<b>Course Code :</b> HM-HU291	<b>Category :</b> Humanities and Social Sciences including Management courses
<b>Course Title :</b> Language Laboratory	<b>Semester :</b> Second
<b>L-T-P : 0-0-2</b>	<b>Credit: 1</b>
<b>Pre-Requisites:</b>	

- |   |    |
|---|----|
| 1) Honing ‘Listening Skill’ and its sub skills through Language Lab Audio device;   | 3P |
| 2) Honing ‘Speaking Skill’ and its sub skills   | 2P |
| 3) Helping them master Linguistic/Paralinguistic features (Pronunciation/Phonetics/<br>Voice modulation/ Stress/ Intonation/ Pitch &Accent) of connected speech                                 | 2P |
| 4) Honing ‘Conversation Skill’ using Language Lab Audio –Visual input;<br>Conversational Practice Sessions (Face to Face / via Telephone, Mobile phone &<br>Role Play Mode)                     | 2P |
| 5) Introducing ‘Group Discussion’ through audio –Visual input and acquainting them<br>with key strategies for success   | 2P |
| 6) G D Practice Sessions for helping them internalize basic Principles<br>(turn- taking, creative intervention, by using correct body language, courtesies &<br>other soft skills) of GD        | 4P |
| 7) Honing ‘Reading Skills’ and its sub skills using Visual / Graphics/<br>Diagrams /Chart Display/Technical/Non Technical Passages<br>Learning Global / Contextual / Inferential Comprehension; | 2P |
| 8) Honing ‘Writing Skill’ and its sub skills by using<br>Language Lab Audio –Visual input; Practice Sessions  | 2P |

**Course Outcomes**

- The student will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.

# **MOOCs for B. Tech Honours**



**Maulana Abul Kalam Azad University of Technology, West Bengal**

*(Formerly West Bengal University of Technology)*

**BF- 142, Sector-I, Salt Lake, Kolkata- 700064, India**

# Maulana Abul Kalam Azad University of Technology, West Bengal

## Notice

1<sup>st</sup> May, 2018

### MOOCs for B.Tech Honours (Applicable from the session 2018-2019)

#### Preamble

All India Council for Technical Education (AICTE) has introduced Model Curriculum for Bachelor of Technology programme with 160 credits in the entire programme of 4 years, and additional 20 credits will be required to be done for the degree of Bachelor of Technology with Honours. These additional 20 credits will have to be acquired with online courses (MOOCs) as per AICTE. So students will have to complete additional 20 credits through MOOCs within 4 years of time. This creates an excellent opportunity for students to acquire the necessary skill set for employability through massive online courses where the rare expertise of world famous experts from academics and industry are available. Maulana Abul Kalam Azad University of Technology, West Bengal (MAKAUT,WB) has thus decided to introduce AICTE model curriculum for its B.Tech Programmes and suggest baskets for MOOCs available year wise for the four-year long B.Tech programme from the sessions 2018-2019. The basket for MOOCs will be a dynamic one, as courses keep on updating with time. Few essential skill sets required for employability are also identified year wise by MAKAUT,WB. For MOOCs platforms where examination or assessment is absent (like SWAYAM) or where certification is costly (like Coursera or edX), faculty members of the Institutes are to audit the courses and prepare the examination question papers, for the courses undertaken by the students of respective Institutes, so that MAKAUT,WB can conduct examination for the course. The total of 20 credits that is required to be attained for B.Tech Honours degree are distributed over four years in the following way:

For first year	:	8 credits
For second year	:	4 credits
For third year	:	4 credits
For fourth year	:	4 credits

A student of first year has to cover courses from at least three skills :

1. Computer Programing with Python / R
2. Soft skill
3. Ethics

Courses are \* marked in the above areas

If a student is unable to cover the credits assigned for the first year, he/she can do these courses in either of the subsequent years, but he/she has to choose the courses from the basket of MOOCs announced by MAKAUT,WB from time to time. The same rule will be applicable for the other years of the programme.

The basket for MOOCs for the 1<sup>st</sup> year B. Tech for the session 2018-2019 are made available herewith.

By order.

## MOOCs for First Year, Engineering and Technology

Sl. No	Course	Provider	Duration	Credits	Name of University / Institution
1.	Presentation Skills: Designing Presentation Slides	Coursera *	4 weeks	1	Tomsk State University
2.	Effective Problem-Solving and Decision-Making	Coursera	4 weeks	1	University of California
3.	Communication in the 21st Century Workplace	Coursera *	4 weeks	1	University of California
4.	Psychology at Work	Coursera *	6 weeks	2	University of Western Australia
5.	Critical Thinking & Problem Solving	EdX *	3 weeks	3	Rochester Institute of Technology
6.	Successful Career Development	Coursera	7 weeks	2	University System of Georgia
7.	Working in Teams: A Practical Guide	edX	4 weeks	1	University of Queensland
8.	Communication theory: bridging academia and practice	Coursera	9 weeks	3	Higher School of Economics
9.	Speaking Effectively	NPTEL *	8 weeks	3	Indian Institute of Technology, Kharagpur
10.	Introduction to Philosophy	Coursera	5 weeks	1	University of Edinburgh
11.	Moralities of Everyday Life	Coursera	6 weeks	2	Yale University
12.	Introduction to Logic	Coursera *	10 weeks	3	Stanford University
13	Write Professional Emails in English	Coursera *	5 weeks	2	Georgia Institute of Technology
14	Technical Writing	Coursera	5 weeks	1	Moscow Institute of Physics and Technology
15	Learn to Program: The Fundamentals	Coursera	7 weeks	2	University of Toronto
16	The Science of Everyday Thinking	edX	12 weeks	4	University of Queensland
17	Introduction to Problem Solving and Programming	NPTEL	12 weeks	4	NPTEL
18	The Science of Well Being	Coursera	6 weeks	2	Yale University
19	Developing Soft Skills and Personality	NPTEL	8 weeks	3	
20	Programming Basics	edX	9 weeks	3	IIT Bombay
21	Introduction to Python: Absolute Beginner	EdX *	5 weeks	2	Microsoft
22	Inferential Statistics	Coursera *	7 weeks	2	University of Amsterdam
23	Linear Regression and Modelling	Coursera	4 weeks	1	Duke University
24	Foundation of Data Structures	edX	6 weeks	2	IIT Bombay
25	Introduction to Logic	NPTEL	12 weeks	4	NPTEL
26	Introduction to Probability and Data	Coursera *	5 weeks	1	Duke University
27	Ethics	NPTEL *	12 weeks	4	
28	Science, Technology and Society	NPTEL	12 weeks	4	
29	Creating Innovation	Coursera	6 weeks	2	Macquarie University
30	Ethical Leadership Through Giving Voice to Values	Coursera *	4 weeks	2	University of Virginia
31	Creativity, Innovation, and Change	Coursera *	6 weeks	2	Pennsylvania State University
32	Interpersonal Communication for Engineering Leaders	Coursera	4 weeks	1	Rice University

33	Learn to Program: The Fundamentals	Coursera *	7 weeks	3	University of Toronto
34	Introduction to Mathematical Thinking	Coursera *	9 weeks	3	Stanford University
35	The Science of Everyday Thinking	edX	12 weeks	4	University of Queensland
36	A Life of Happiness and Fulfillment	Coursera	6 weeks	2	Indian School of Business
37	Model Thinking	Coursera	12 weeks	4	University of Michigan
38	Introduction to Philosophy: God, Knowledge, and Consciousness	edX	12 weeks	4	MIT
39	Soft skills	NPTEL *	12 Weeks	4	IIT Roorkee
40	Developing Soft Skills and Personality	NPTEL *	8 weeks	3	IIT Kanpur
41	Indian Fiction in English	NPTEL	12 Weeks	4	IIT Madras
42	Development of Sociology in India	NPTEL	4 Weeks	1	IIT Kanpur
43	Intellectual Property	NPTEL	12 Weeks	4	IIT Madras
44	Essential Statistics for Data Analysis using Excel	EdX *	Self Paced	3	Microsoft
45	Ethics and Law in Data and Analytics	edX	Self Paced	4	Microsoft
46	Climate Change Mitigation in Developing Countries	Coursera *	6 weeks	3	University of Cape town
47	Web Design for Everybody (Basics of Web Development and Coding) Specialization	Coursera	15weeks	4	University of Michigan
48	Ecology: Ecosystem Dynamics and Conservation	Coursera	5 weeks	1	American Museum of Natural History, Howard Hughes Medical Institute
49	Environmental Studies: A Global Perspective	EdX *	Self Paced	4	Curtin University
50	Introduction to Computer Science and Programming Using Python	edX *	Self Paced	4	MIT, USA
51	Statistics and R	edX *	Self Paced	4	Harvard University
52	Introduction to Programming in C	Coursera *	4 weeks	4	Duke University
53	Java Programming: Solving Problems with Software	Coursera	4 weeks	4	Duke University
54	Grammar and Punctuation	Coursera	4 weeks	1	University of California
55	How to Write an Essay	Coursera *	5 weeks	1	University of California, Berkeley
56	Conversational English Skills	EdX *	10 weeks	3	Tsinghua University
57	Advanced Writing	Coursera *	4 weeks	1	University of California, Irvine
58	Speak English Professionally: In Person, Online & On the Phone	Coursera *	5 weeks	1	Georgia Institute of Technology
59	English for Science, Technology, Engineering, and Mathematics	Coursera	5 weeks	1	University of Pennsylvania
60	English Composition	edX	8 weeks	3	Arizona State University
61	Take Your English Communication Skills to the Next Level	Coursera *	4 weeks	1	Georgia Institute of Technology

**Guidelines regarding  
Mandatory Induction Program for  
the new students**



**Maulana Abul Kalam Azad University of Technology, West Bengal**  
*(Formerly West Bengal University of Technology)*  
BF- 142, Sector-I, Salt Lake, Kolkata- 700064, India

Date: 06.12.2017

# Maulana Abul Kalam Azad University of Technology, West Bengal

## Guidelines regarding Induction Programme for the new students

(As per Model Curriculum for 1<sup>st</sup> Year UG degrees courses in Engineering & Technology, November 2017)

### To be followed from the 2018-19 academic session

**Preamble:** Engineering education has evolved globally in a continuous manner to address the twin needs of industry and society. It is now an accepted fact that the institutions imparting technical education should aspire to create manpower who will possess strong technical knowledge and skill, have leadership qualities and be a team player, capable of coming up with innovative solutions and be alive to societal and community concerns.

The aim of the Induction Programme is to acclimatize the students to the environment of their engineering institution, give them a flavour of the exciting new world of education that they are entering, provide them with mentoring schemes, and make them aware of their neighbourhood, society and people. This will allow them to evolve as well rounded individuals.

The following schedule is laid down by the University to implement the three week long Induction Programme:

Week 1	1 <sup>st</sup> Half	Day 1	Overall introduction of the new students to the Institution, its different Departments & Faculty Members
	2 <sup>nd</sup> Half	Day 1	(a) Assignment of faculty mentors to the new students (b) Assessment and allotment for mentoring by senior students preferably from the second year
	2 hrs	Day 2, 3, 4, 5	Lectures by eminent personalities on different areas such as (a) Introduction to Engineering (b) Various topics of science and technology (c) Innovation and entrepreneurship (d) Creative and performing arts (e) Social issues
	2 hrs.	Day 2, 3, 4, 5	Participation in Games, Yoga, Meditation etc.
	2 hrs	Day 2, 3, 4, 5	Visit to the different Departments of the Institute
Week 2 (All Days)	2hrs		Scheduled class lectures as per time table.
	2hrs		Students to be conducted through proficiency modules to be prepared by respective Colleges for ascertaining English skills & Computer knowledge of the students

			and to prepare a report on the same
	2hrs		Participation in Games, Sports, Yoga, Creative arts etc.
Week 3	2hrs		Scheduled class lectures as per time table
		Day 1	Visits to neighbourhood locations
		Day 2	Visits to natural spots in adjoining areas to understand the effect of nature on society
		Day 3	Visits to Science Museum / laboratories
		Day 4	Visits to NGOs
		Day 5	

Any other activity, as deemed fit by the Director/Principal of the affiliated Colleges, may be proposed and discussed with the Academic Coordinator of the University, by sending email to the following address: [academics.makaut@gmail.com](mailto:academics.makaut@gmail.com).

Note: 1) If necessary, networking may be established with NGOs to facilitate the different components and aspects of the Induction Programme.

**Mandatory Additional Requirement  
for earning B. Tech Degree**



**Maulana Abul Kalam Azad University of Technology, West Bengal**  
*(Formerly West Bengal University of Technology)*  
BF- 142, Sector-I, Salt Lake, Kolkata- 700064, India

**Maulana Abul Kalam Azad University of Technology, West Bengal**  
**BF-142, Sector-I, Saltlake**

**Notice**

**Mandatory Additional Requirement for earning B.Tech Degree**

**Addressing the needs of the industry and the society:** Globally, engineering education systems have continuously evolved, in order to address the needs of the industry and the society. It is becoming imperative that every University should create opportunities for the students to inculcate attributes, which are not restricted only to engineering knowledge and acumen. Industry needs professionals who can work successfully in teams, who have leadership qualities, who are alive to social and community needs and who can bring innovation and creativity to their work and who are also digitally proficient. Hence, in order to prepare its students to match these multiple requirements, MAKAUT, WB has created a unique mechanism of awarding 100 Activity Points over and above the academic grades. It is planned that the students at MAKAUT, WB will be able to reap benefits from these activities at their own pace and comfort. It is expected that by the time MAKAUT, WB's students reach their Final Year, they would have developed themselves so well both through their studies in the respective technological field and through their active participation in the co-curricular and extra-curricular activities as also through SAWYAM based learning activities that they would be well-prepared for contributing to building the India and the world of their dreams.

**The additional requirement applies to:** Every student, who is admitted to the 4 years B.Tech program from the academic year 2018-19 onwards, is required to earn minimum 100 Activity Points in addition to the required academic grades, for getting MAKAUT, WB's B.Tech degree. Similarly, it is mandatory to earn 75 Activity Points, in addition to the academic grades, for getting B.Tech degree by a student (Lateral Entry) who is admitted to the B.Tech program from the academic year 2018-19 onwards. *(Please see Table 1 for details.)* [Lateral Entry students will have a multiplying factor of 1.33 to bring uniformity in score].

<b>Level of Entry in B.Tech Course</b>	<b>Total duration for earning Points</b>	<b>Minimum Points</b>
1 <sup>st</sup> Year from the academic year 2018-19 onwards	1 <sup>st</sup> to 4 <sup>th</sup> Year	100
2 <sup>nd</sup> Year from the academic year 2018-19 onwards (Lateral Entry)	2 <sup>nd</sup> to 4 <sup>th</sup> Year	75

**Table – I**

**For existing Students (except students in the 4<sup>th</sup> year):** Every student, who is admitted to the 4 years B.Tech program prior to the academic year 2018-19, is required to earn minimum number of Activity Points as per Table II in addition to the required academic grades, for getting MAKAUT, WB's B.Tech degree.

<b>Current Semester</b>	<b>Total Points to be earned During the full course</b>
2 <sup>nd</sup>	100
4 <sup>th</sup>	75
6 <sup>th</sup>	50

**Table –II**

These points must be earned on the basis of active participation in co-curricular and extracurricular activities spanning through all the semesters of study. Every student may choose, as per his/her liking, activities in order to achieve the mandatory points (as per Table-III, depending on his/her entry level), before becoming eligible for award of the Degree. These activities can be spread over the years, as per convenience of the student.

**Notes:**

- **Current 4<sup>th</sup> year students who are going to sit for Final Semester examination in May-June, 2018 are outside the preview of this Mandatory Additional Requirement**
- Every student shall participate in the co-curricular and extra-curricular activities and produce documentary proof to the designated Faculty Members appointed by the Head of Department / Principal / Director in the respective college. Thereby the student should earn the required Points before *her* she appears for his/ her Final Examinations.
- A student's result of his/her Final Examinations will be withheld until he/she completes the minimum Activity Points by the end of his/her B.Tech Program.
- In every semester, every student is required to prepare a file containing documentary proofs of activities, done by him / her. This file will be duly verified and Activity Points will be assigned by the teachers as appointed above, at the end of every semester.
- The college will form a 3 members committee and finalize the Activity Points for each student before entering them into the Online Point Entry System (at the URL, as specified by the COE of the University).
- Every student has to earn at least 100 activity points. The points students has earned will be reflected in the student's marksheet.
- Activity points earned by Lateral Entry students will be multiplied by 1.33.

Table III provides a List of Activity Heads and Sub-Activity Heads along with their capping of the Activity Points that can be earned by the students during the entire B.Tech duration.

Sl. No.	Name of the Activity	Points	Maximum Points Allowed
1.	MOOCS (SWAYAM/NPTEL/Spoken Tutorial) (per course)	20	40
2.	Tech Fest/Teachers Day/Freshers Welcome		
	Organizer	5	10
	Participants	3	6
5.	Rural Reporting	5	10
6.	Tree Plantation (per tree)	1	10
7.	Participation in Relief Camps	20	40
8.	Participation in Debate/Group Discussion/ Tech quiz	10	20
9.	Publication of Wall magazine in institutional level (magazine/article/internet)	10	20
10.	Publication in News Paper, Magazine & Blogs	10	20
11.	Research Publication (per publication)	15	30
12.	Innovative Projects (other than course curriculum)	30	60
13.	Blood donation	8	16
	Blood donation camp Organization	10	20
15.	Participation in Sports/Games		
	College level	5	10
	University Level	10	20
	District Level	12	24
	State Level	15	30
	National/International Level	20	20
21.	Cultural Programme (Dance, Drama, Elocution, Music etc.)	10	20
22.	Member of Professional Society	10	20
23.	Student Chapter	10	20
24.	Relevant Industry Visit & Report	10	20
25.	Photography activities in different Club( Photography club, Cine Club, Gitisansad)	5	10
26.	Participation in Yoga Camp (Certificate to be submitted)	5	10
27.	Self-Entrepreneurship Programme	20	20
28.	Adventure Sports with Certification	10	20
29.	Training to under privileged/Physically challenged	15	30
30.	Community Service & Allied Activities	10	20

Suggestions from the College Principals will be considered to append in the above Table-III.

Sd/-

Registrar(Acting)  
MAKAUT,WB

**Maulana Abul Kalam Azad University of Technology, West Bengal**  
**Record of Activities for Mandatory Additional Requirement**

Annexure-I  
Rev:00

College Name (College Code):				Department:									
Student Name:			University Roll No:			Registration No:							
Sl No	Activity	Points	Max. Points Allowed	Points Earned								Total	
				Sem1	Sem2	Sem3	Sem4	Sem5	Sem6	Sem7	Sem8		
1	<i>MOOCS (SWAYAM/NPTEL/Spoken Tutorial) per course</i>												
	For 12 weeks duration	20	40										
	For 8 weeks duration	16											
2	<i>Tech Fest/Teachers Day/Freshers Welcome</i>												
	Organizer	5	10										
	Participants	3	6										
3	Rural Reporting	5	10										
4	Tree Plantation and up keeping (per tree)	1	10										
5	Participation in Relief Camps	20	40										
6	Participation in Debate/Group Discussion/ Tech quiz	10	20										
7	<i>Publication of Wall magazine in institutional level (magazine/article/internet)</i>												
	Editor	10	20										
	Writer	6	12										
8	Publication in News Paper, Magazine & Blogs	10	20										
9	Research Publication (per publication)	15	30										
10	Innovative Projects (other than course curriculum)	30	60										
11	Blood donation	8	16										
	Blood donation camp Organization	10	20										

**Maulana Abul Kalam Azad University of Technology, West Bengal**  
**Record of Activities for Mandatory Additional Requirement**

Annexure-I  
Rev:00

Sl No	Activity	Points	Max. Points Allowed	Points Earned								Total
				Sem1	Sem2	Sem3	Sem4	Sem5	Sem6	Sem7	Sem8	
12	<i>Participation in Sports/Games</i>											
	College level	5	10									
	University Level	10	20									
	District Level	12	24									
	State Level	15	30									
	National/International Level	20	20									
13	Cultural Programme (Dance, Drama, Elocution, Music etc.)	10	20									
14	Member of Professional Society	10	20									
15	Student Chapter	10	20									
16	Relevant Industry Visit & Report	10	20									
17	Photography activities in different Club(Photography club, Cine Club, Gitisansad)	5	10									
18	Participation in Yoga Camp (Certificate to be submitted)	5	10									
19	Self-Entrepreneurship Programme	20	20									
20	Adventure Sports with Certification	10	20									
21	Training to under privileged / Differently abled	15	30									
22	Community Service & Allied Activities	10	20									
<b>Total Points</b>												
<b>Signature of Mentor</b>												
<b>Signature of HOD</b>												
*Please abide strictly to the <b>Notes at the end of the Notice by Registrar, MAKAUT, WB</b> regarding <b>Mandatory Additional Requirement for earning B.Tech Degree</b>												
* <i>Annexure-I</i> is to be retained in the Institute records with all documentary proofs of activities (to be verified by the University as and when required).												

**Maulana Abul Kalam Azad University of Technology, West Bengal**  
(Formerly West Bengal University of Technology)

Syllabus for B. Tech in Biomedical Engineering  
(Applicable from the academic session 2018-2019)

**SEMESTER-III**

<b>Name of the Course</b>	<b>MATHEMATICS – III (PROBABILITY &amp; STATISTICS)</b>
<b>Course Code: BS-M301</b>	<b>Semester: Third</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To familiarize the students with probability and statistical methods.
2	To equip the students with standard concepts and tools at an intermediate to advanced level for tackling various problems in the discipline.
<b>Pre-Requisite: Mathematics (10+2)</b>	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Basic Probability:</b> Probability spaces, conditional probability, independence; Discrete random variables, Independent random variables, the multinomial distribution, Poisson approximation to the binomial distribution infinite sequences of Bernoulli trials, sums of independent random variables; Expectation of Discrete Random Variables, Moments, Variance of a sum, Correlation coefficient, Chebyshev's Inequality.	12
2	<b>Continuous Probability Distributions:</b> Continuous random variables and their properties, distribution functions and densities, normal, exponential and gamma densities.	4
3	<b>Bivariate Distributions:</b> Bivariate distributions and their properties, distribution of sums and quotients, conditional densities, Bayes' rule.	4
4	<b>Basic Statistics: Measures of Central Tendency:</b> Moments, skewness and Kurtosis-Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression - Rank correlation.	8
5	<b>Applied Statistics:</b> Curve fitting by the method of least squares- fitting of straight lines, second degree parabolas and more general curves. Test of significance: Large sample test for single proportion, difference of proportions, single mean, difference of means, and difference of standard deviations.	8
6	<b>Small Samples:</b> Test for single mean, difference of means and correlation coefficients, test for ratio of variances-Chi-square test for goodness of fit and independence of attributes.	4

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Demonstrate the ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
2. Apply the concept of testing of hypothesis for small and large samples in real life problems.
3. Apply statistical methods for studying data samples.

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4. Apply the basic concepts of classifications of design of experiments in the field of engineering and statistical quality control.
5. Demonstrate the basic ideas of statistics including measures of central tendency, correlation and regression.
6. Apply the notion of sampling distributions and statistical techniques for solving engineering and management problems.

**Text/Reference Books:**

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9<sup>th</sup> Edition, John Wiley & Sons, 2006.
2. P. G. Hoel, S. C. Port and C. J. Stone, Introduction to Probability Theory, Universal Book Stall, 2003 (Reprint).
3. S. Ross, A First Course in Probability, 6th Ed., Pearson Education India, 2002.
4. W. Feller, An Introduction to Probability Theory and its Applications, Vol. 1, 3rd Ed., Wiley, 1968.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
7. Veerarajan T., Engineering Mathematics (for semester III), Tata McGraw-Hill, New Delhi, 2010.
8. Chandrika Prasad & Reena Garg, Advanced Engineering Mathematics, Khanna Publishing House, 2018.

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<b>Name of the Course</b>	<b>ANALOG ELECTRONIC CIRCUITS</b>
<b>Course Code: ES-EC301</b>	<b>Semester: Third</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand the structure & properties of different components of Analog Electronics.
2	To learn different techniques to analyze Analog electronic circuit.
3	To learn application of different components of Analog electronics.
4	To understand principle and operation of different Analog electronic circuits.
5	To acquire problem solving skills of electronic circuits.
<b>Pre-Requisite: Physics (10 +2)</b>	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Semiconductors and Signal Amplifiers:</b> Overview of semiconductors, PN junction diode-structure, operation and V-I characteristics, Rectifiers, Zener diode, BJT amplifiers: CE, CB and CC amplifiers, Gain and frequency response, designing of BJT amplifier networks, structure and characteristics of FET and MOSFET, CMOS basic principles.	10
2	<b>Filters and Regulators:</b> Capacitor filter, $\pi$ -section filter, ripple factor, series and shunt voltage regulator, percentage regulation, 78xx and 79xx series, concept of SMPS.	4
3	<b>Operational Amplifiers and Applications:</b> Ideal OPAMP, Differential Amplifier, Constant current source, level shifter, CMRR, Open & Closed loop circuits, inverting & non-inverting amplifiers, voltage follower, adder, subtractor, integrator & differentiator, comparator, Schmitt Trigger, V-I & I-V converter, instrumentation amplifier.	8
4	<b>Feedbacks and Oscillator Circuits:</b> Feedback Circuits: Concept of feedback, effect of negative feedback, feedback connection types, practical feedback circuits, designing of feedback amplifiers, Oscillators circuits: Oscillation principles, LC oscillators, RC oscillators, crystal oscillators, designing of oscillator circuits.	8
5	<b>Power Amplifiers and Tuned Amplifiers:</b> Class A, B, AB & C amplifiers, conversion efficiency, heat sink, designing of power amplifier circuits, tuned amplifier, synchronously tuned and impedance matching gain control.	6
6	<b>Waveform Generators and Switching Circuits:</b> Types of waveforms, transistor switching times, multivibrator, astable, monostable and bistable multivibrator, design of multivibrator.	4

### **COURSE OUTCOMES**

At the end of the course, students should able to:

1. Demonstrate and apply working principle of different electronic circuit in real life.
2. Explain the operation and performance of semiconductor devices.
3. Choose correct electronic devices to solve problems.
4. Analyse the effectiveness of electronic circuit used in day to day life.
5. Evaluate the feedback circuits and frequency response of amplifier.

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6. Design and conduct experiments using analog electronic circuits to function as switch, regulator, clippers, clampers, oscillators, power amplifiers.

**Text/ Reference Books:**

1. Robert L. Boylestad, Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, Sixth edition, 2009.
2. A.K. Maini, Analog Electronics, Khanna Publishing House, New Delhi 2018.
3. Franco-Design with Operational Amplifiers & Analog Int. Circuits,3/e,MGH.
4. Boylested & Nashelsky- Electronic Devices and Circuit Theory- Pearson/PHI
5. Millman & Halkias – Integrated Electronics, McGraw Hill.
6. Rashid-Microelectronic Circuits-Analysis and Design- Thomson.
7. Schilling & Belove—Electronic Circuit:Discrete & Integrated , 3/e , McGraw Hill
8. Razavi- Fundamentals of Microelectronic s- Wiley
9. Malvino—Electronic Principles , 6/e , McGraw Hill
10. Horowitz & Hill- The Art of Electronics; Cambridge University Press.
11. Bell- Operational Amplifiers and Linear ICs- Oxford UP
12. Tobey & Grame – Operational Amplifier: Design and Applications, Mc GrawHill.
13. Gayakwad R.A -- OpAmps and Linear IC's, PHI
14. L.K. Maheshwari, Analog Electronics, Laxmi Publications.

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<b>Name of the Course</b>	<b>SIGNALS AND SYSTEMS IN BIOMEDICAL ENGINEERING</b>
<b>Course Code: PC-BME301</b>	<b>Semester: Third</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand the basic properties of signal & systems in everyday life.
2	To gain knowledge about various signal acquisition, analysis and feedback control mechanism.
3	To familiarize with techniques suitable for analyzing and synthesizing both continuous-time and discrete time signals & systems.
4	To develop the fundamental basis of signals and systems for biomedical engineering along with characterization and understanding of bio-signals & physiological systems.
<b>Pre-Requisite:</b> Mathematics-IB (BS-M102) & Mathematics-IIB (BS-M202), Biophysics	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Classification of Signals and Systems</b> Signals and systems in everyday life, standard signals: step, ramp, impulse, exponential and sinusoids; Continuous Time (CT) and Discrete Time (DT) signals, Periodic and Aperiodic signals, Deterministic and Random signals, Energy and Power signals, Transformation in independent variable of signals: time scaling, time shifting and time inverting, LTI systems-convolution and stability, physiological signals and their properties, Time invariant and time varying physiological systems.	7
2	<b>Analysis of Time Signals</b> Laplace transform in analysis of continuous systems, Basic concepts and development of the Fourier Series, Determination of the Fourier series representation of Continuous and Discrete time periodic signal, Properties of continuous and discrete time Fourier series, Continuous Time Fourier Transform (CTFT) and Discrete Time Fourier Transform (DTFT), ECG signal analysis.	8
3	<b>Sampling Theorem and Z-Transforms</b> Representation of continuous time signals by its sample, Sampling theorem and its implications, Reconstruction of a Signal from its samples, aliasing, Basic principles of z-transform, z-transform definition, Properties of z-transform, Poles and Zeros, inverse z-transform.	8
4	<b>Noise and Feed Back System</b> Sources and types of noise, noise factor and temperature, equivalent noise resistance and noise factor in cascade amplifier, Basic Feedback concept, Positive and Negative Feedback, Sensitivity analysis, Distortion analysis by Feed Back, Control system, Open loop Control System, Control system with Feed Back, Application of feed back in physiological systems and its importance.	8
5	<b>Filtering Techniques</b> Types of filter (Active and Passive), General idea of L.P.F, H.P.F, B.P.F and N.F. First order Passive Filters (L.P, H.P, B.P & N.F), First order active filter (L.P, H.P, B.P & N.F), use of filter for biomedical signal analysis, design of	5

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	filter suitable for Bio-medical signal analysis.	
6	<b>Application of Mathematical Transfer Function in Physiological System:</b> Cardiovascular System: Block diagram representation of cardio vascular system, Electrical circuit model of Blood Pressure, Electrical analog of blood vessels and its transfer function, model of coronary circulation ant its analysis. Immune response: system equation and transfer function of Germ, Plasma cell & Antibody.	4

### **COURSE OUTCOMES**

At the end of the course, students should able to:

1. Analyze different types of signals and systems in everyday life.
2. Represent continuous and discrete systems in time and frequency domain using different transforms.
3. Describe and classify physiological signals and develop system for different signals.
4. Analyze and characterize physiological signals and systems.
5. Illustrate and explain the mode of operation of filtering techniques especially for physiological signals.
6. Proposed and solve engineering problems using transform techniques.

### **Text/ Reference Books:**

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Prentice Hall, 1983.
2. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems - Continuous and Discrete", 4th edition, Prentice Hall, 1998.
3. Papoulis, "Circuits and Systems: A Modern Approach", HRW, 1980.
4. B.P. Lathi, "Signal Processing and Linear Systems", Oxford University Press, c1998.
5. Douglas K. Lindner, "Introduction to Signals and Systems", McGraw Hill International Edition: c1999.
6. Simon Haykin, Barry van Veen, "Signals and Systems", John Wiley and Sons (Asia) Private Limited, c1998.
7. Robert A. Gabel, Richard A. Roberts, "Signals and Linear Systems", John Wiley and Sons, 1995.
8. M. J. Roberts, "Signals and Systems - Analysis using Transform methods and MATLAB", TMH, 2003.
9. J. Nagrath, S. N. Sharan, R. Ranjan, S. Kumar, "Signals and Systems", TMH New Delhi, 2001.
10. Ashok Ambardar, "Analog and Digital Signal Processing", 2nd Edition, Brooks/ Cole Publishing Company (An international Thomson Publishing Company), 1999.
11. Rishabh Anand, Signals and Systems, Khanna Publishing House, New Delhi

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<b>Name of the Course</b>	<b>ENGINEERING PHYSIOLOGY &amp; ANATOMY</b>
<b>Course Code: PC-BME302</b>	<b>Semester: Third</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand structure and functions of the various organs of human body.
2	To understand structure-function relationship of physiological systems.
3	To develop knowledge of anatomical features and physiology of human system in order to make measurement and interpret data of physiological processes in living systems.
<b>Pre-Requisite: Biology (10 +2)</b>	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Cell, Tissue &amp; Blood:</b> Structure of cell and functions of sub organelles, cell membrane, membrane receptors, cell-to-cell signaling, cell division, types of specialized tissues and functions, blood cells and functions, haemoglobin, plasma proteins, hematocrit, ESR, blood coagulation and factors, bleeding and clotting time, blood groups.	6
2	<b>Skeletal &amp; Muscular System:</b> Structure of bone and function, anatomy of long bone, bone marrow, growth and repair, types of joints and function, types of muscles, microscopic structure of skeletal muscle, salient properties of muscles, muscles as energy transducer, muscle contraction-sliding filament theory.	6
3	<b>Nervous, Endocrine, Lymphatic &amp; Immune System:</b> Structure and functions of neuron, synapse and impulse propagation, motor unit-neuromuscular junction, brain, spinal cord, reflex mechanism, classification of nerves, autonomic nervous system and functions, pituitary and thyroid glands, parts and functions of lymphatic system, lymphatic organs and vessels, component of immune system, immune response & physiological regulation.	8
4	<b>Cardiovascular &amp; Respiratory Systems:</b> Structure of heart and role as pump, circulation types, heart valves, special junctional tissues, ECG, heart sounds, cardiac output, cardiac cycles, blood pressure, types of blood vessels, regulation of heart beat and blood pressure, diseases in cardiovascular systems, parts of respiratory system, types of respiration, mechanism of breathing, respiratory membrane and gaseous exchange, regulation of respiration, volumes and capacities of lung, types of hypoxia.	10
5	<b>Digestive &amp; Excretory System:</b> Organization of GI System, digestion and absorption, stomach, intestine, liver, pancreas, structure of kidney and nephron, mechanism of urine formation, micturition, skin and sweat gland, temperature regulation.	6
6	<b>Vision, Auditory &amp; Reproductive System:</b> Structure of eye, refractive medias of the eye, formation of image on the retina, physiology of middle and internal ear, auditory pathway, mechanism of hearing, male and female reproductive system, androgens, oestrogens and progesterone.	4

**COURSE OUTCOMES**

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At the end of the course, students should be able to:

1. Describe the structure and function of various organs of physiological systems.
2. Explain interconnection of various systems and mechanism of communication and integration.
3. Develop and apply critical reasoning skills in human physiology and anatomy.
4. Analyze and interpret the structural and functional aspects of living organisms.
5. Comprehend the probable causes of anomaly in organs and systems in human body and assess the situation technically.
6. Build knowledge to aid diagnosis and to simulate engineering systems.

**Text/ Reference Books:**

1. Essential of Medical Physiology, Anil Baran Singha Mahapatra, Current Books International
2. Human Physiology - C.C.Chatterjee, Medical Allied Agency
3. Essential of Human Anatomy and Physiology, Elaine.N. Marieb Eight Edition, Pearson Education, New Delhi
4. Anatomy and Physiology – Ross & Wilson, Churchill Livingstone publications.
5. Modern Physiology & Anatomy for Nurses - J Gibson, Black-well Scientific Publishers
6. Medical Physiology, Guyton & Hall, 13th Edition, Elsevier Saunders
7. Concise Medical Physiology-by Sujit K. Chaudhuri, 5th Edition, New Central Book Agency PvtLtd
8. Review of Medical Physiology, 22nd Edition, William F.Ganong, Mc Graw Hill, New Delhi

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<b>Name of the Course</b>	<b>BIOPHYSICS &amp; BIOCHEMISTRY</b>
<b>Course Code: PC-BME303</b>	<b>Semester: Third</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To study and understand the biophysical phenomena/activities using physical principles.
2	To develop knowledge of the fundamental concepts in physics and chemistry that underlies biological processes.
3	To study structural and functional properties of carbohydrates, proteins, lipids and nucleic acids
4	To emphasize the role of biomolecules in providing basic information on specific metabolic process and disorders.
<b>Pre-Requisite: Biology (10 +2)</b>	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Biophysical Processes:</b> Diffusion, facilitated diffusion, active transport, phagocytosis and pinocytosis, absorption, reabsorption, osmosis, dialysis, ultrafiltration, ultracentrifugation, cellular fractionation, electrophoresis, plasmapheresis, radioimmunoassay.	4
2	<b>Biophysics of Membrane and Hemodynamics:</b> Microscopic structure & composition of cell membrane, Donnan membrane equilibrium, membrane potential, action potential, membrane permeability and transport, ion channel, electrical properties of excitable membranes, capacitance, resistance, conductance and dielectric properties of membrane, equivalent electrical circuit for membrane, biophysical properties of plasma, viscosity of blood, rheological properties of blood, laminar blood flow, turbulent blood flow and Reynold's number, vascular resistance.	9
3	<b>Biophysical Activities:</b> Biological rhythm and its significance, origin, nature and types of biosignals, stimuli, receptor potential, strength-duration relationship, skin impedance, total body impedance, patient safety, electrical shock and hazards, leakage current, ECG, EEG, EMG and EOG wave forms.	7
4	<b>Introduction to Biochemistry:</b> Chemical bonds, bio-fluids, electrolytes, weak acid and bases, pH, buffers, physiological buffers in living systems, Energy in living organism.	2
5	<b>Carbohydrates, Lipids &amp; Enzymes:</b> Classification of carbohydrates, glycolysis, glycogenesis, TCA cycle, oxidative phosphorylation, Diabetes Mellitus and glycogen storage diseases, classification and functions of lipids, synthesis and degeneration of fatty acids, biosynthesis of cholesterol, disorders of lipid metabolism, chemical nature and classification of enzymes, M-M-Kinetics, Isozymes and Allosteric enzymes, measurement of enzyme activity and isolation techniques.	10
6	<b>Nucleic Acids and Proteins:</b> Structure of DNA, Genetic code, structure of RNA and its types, DNA replication, transcription & translation, Recombinant DNA, Structure and properties of proteins, protein biosynthesis, classification of amino acids, protein metabolism, urea cycle, separation of proteins.	8

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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the consequence of different biophysical and biochemical processes.
2. Explain the biopotential and source of biosignals.
3. Make use of stimuli and experiments with biological signals.
4. Categorize the major biomolecules and infer their structure function relationships.
5. Describe the synthesis of macromolecules and their role in metabolic pathways along with their regulation.
6. Apply and evaluate the analytical techniques used in molecular biology.

**Text/ Reference Books:**

1. Bio-Physics – Roland Glaser- Springer; 2nd printing edition (November 23, 2004)
2. The Biomedical Engineering Hand Book 3<sup>rd</sup> Ed (Biomedical Engineering Fundamentals)- Joseph D. Bronzino, CRC, Tylor Francis–2006 (Section-III–Bio-Electrical Phenomena)
3. Lehninger Principles of Biochemistry, Edition 5 - by David L. Nelson & Michael M.Cox , - W. H. Freeman; 2008.
4. Text book of Medical Physiology- Guyton
5. Jain, J L, Jain, Nitin, Sunjay Jain, “*Fundamentals of Biochemistry*,” S. Chand Group, ISBN: 8121924537
6. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer, “*Biochemistry*,” Edition 7, W. H. Freeman, 2012
7. Fundamentals of Biochemistry: Life at the Molecular Level - by Donald J. Voet , Judith G. Voet & Charlotte W. Pratt. – Wiley
8. Robert Weaver, “*Molecular Biology*”, MCGraw-Hill, 5<sup>th</sup> edition, 2012.
9. Outlines of Biochemistry, Conn, E.E; Stumpf, P.K; Bruening,G; Doi, R.H., John Wiley & Sons
10. Principles of Biochemistry (V Ed., By Nelson, D. L.; and Cox, M. M.W.H. Freeman & Co.
11. Molecular Genetics (Second edition), Stent, G. S.; and Calender, R.W.H. Freeman and company, Distributed by Satish Kumar Jain for CBS Publisher
12. Microbiology, Prescott, L.M J.P. Harley and C.A. Klein 1995. 2nd edition Wm, C. Brown Publishers

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<b>Name of the Course</b>	<b>TECHNICAL ENGLISH</b>
<b>Course Code: HM-HU301</b>	<b>Semester: Third</b>
<b>L-T-P-C: 2-0-0-2</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To gain familiarity with learning approaches connected to successful writing.
2	To foster the ability to write convincing job applications and effective reports.
3	To develop the speaking skills to make technical presentations and participate in group discussions.
<b>Pre-Requisite: English (10+2), English (HM-HU201)</b>	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Technical Writing, Grammar and Editing:</b> Technical writing process, forms of discourse, Writing drafts and revising, Collaborative writing, creating indexes, technical writing style and language. Basics of grammar, study of advanced grammar, editing strategies to achieve appropriate technical style. Introduction to advanced technical communication, Usability, Human factors, Managing technical communication projects, time estimation, Single sourcing, Localization.	9
2	<b>Self-Development and Assessment:</b> Self-assessment, Awareness, Perception and Attitudes, Values and belief, Personal goal setting, career planning, Self-esteem. Managing Time; Personal memory, Rapid reading, Taking notes; Complex problem solving; Creativity.	8
3	<b>Communication and Technical Writing:</b> Public speaking, Group discussion, Oral; presentation, Interviews, Graphic presentation, Presentation aids, Personality Development. Writing reports, project proposals, brochures, newsletters, technical articles, manuals, official notes, business letters, memos, progress reports, minutes of meetings, event report.	9

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the ability to read and comprehend engineering and technology texts.
2. Develop speaking skills to make technical presentation and participate in group discussion.
3. Express and exchange ideas effectively through various modes of communication.
4. Analyze content to identify main and subordinate ideas, distinguish various modes of argument and outline methods of development.
5. Evaluate technical reports and judge its authenticity.
6. Formulate strategies for persuasive arguments and tools for success.

### **Text/Reference Books:**

1. David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey, New York, 2004
2. Diane Hacker, Pocket Style Manual, Bedford Publication, New York, 2003. (ISBN 0312406843)
3. Shiv Khera, You Can Win, Macmillan Books, New York, 2003.

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4. Raman Sharma, Technical Communications, Oxford Publication, London, 2004.
5. Kulbhushan Kumar, Effective Communication Skills, Khanna Publishing House, New Delhi
6. Dale Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004. (ISBN: 07828357-4)
7. Sharma, R. and Mohan, K. Business Correspondence and Report Writing, TMH New Delhi 2002.
8. Xebec, Presentation Book, TMH New Delhi, 2000. (ISBN 0402213)

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**PRACTICAL**

<b>Name of the Course</b>	<b>ANALOG ELECTRONIC CIRCUITS LABORATORY</b>
<b>Course Code: ES-EC391</b>	<b>Semester: Third</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To understand application of p-n junction Diode, Zener diode , Rectifier etc
2	To analyze the performance of multistage amplifier and power amplifier.
3	To study and analyze the performance of multivibrators.
4	To impart technical skills to construct and analyze transistor amplifiers & to understand application of OP AMP

**LIST OF EXPERIMENTS:**

1. Study of Diode as clipper & clamper.
2. Study of Zener diode as a voltage regulator.
3. Study of ripple and regulation characteristics of full wave rectifier without and with capacitor filter.
4. Study of characteristics curves of BJT & FET.
5. Construction of R-C coupled amplifier & study the gain and Bandwidth.
6. Study of class A & class B power amplifiers.
7. Study of class C & Push-Pull amplifiers.
8. Realization of current mirror & level shifter circuit using Operational Amplifiers.
9. Construction & study of astable multivibrator using NE 555.
10. Construction & study of monostable & Bistable multivibrator using NE 555.
11. Study of Switched Mode Power Supply & construction of a linear voltage regulator using regulator IC chip.
12. Mandatory Design and Implementation of Mini Project.

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Choose electronic components to construct circuits for tailor made applications.
2. Conduct experiments and verify the results practically.
3. Assess and recommend an application device of their interest.
4. Design and test fundamental analog electronic circuits.

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<b>Name of the Course</b>	<b>SIGNAL ANALYSIS LABORATORY</b>
<b>Course Code: PC-BME391</b>	<b>Semester: Third</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To impart the fundamental knowledge and application of versatile types of signals in experimental point of view.
2	To gain clear knowledge about tools and techniques in signal processing and analyzing with firm understanding of physiological signals and systems.

**LIST OF EXPERIMENTS:**

1. Familiarization with MATLAB and generation of various types of waveforms (sine, cosine, square, triangular etc.).
2. Generation of different functions (unit impulse, unit step, RAMP, etc.)
3. Find out the signal energy and power
4. Analysis CTFT & DTFT
5. Study Z- transform of: a) Sinusoidal signals b) Step functions.
6. Compare Fourier and Laplace transformations of a signal.
7. Study sampling theorem for low pass signals and band pass signals.
8. Determine the components of: a) Square wave b) Clipped sine wave.
9. Generation of various types of noise (uniform white, Gaussian, coloured, etc.).
10. Study LPF &HPF, band pass and reject filters using RC circuits
11. ECG signal analysis / Equivalent electrical circuit analysis of blood vessels.
12. Mandatory Design and Implementation of Mini Project.

Note: An Institution/College may opt for some other software or hardware simulation wherever possible in place of MATLAB.

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Identify and select appropriate software tools for analyzing various signals.
2. Evaluate signal using mathematical transfer function.
3. Generate various types of signal and noise waveforms.
4. Analyze versatile biosignals and interpret the result clinically.

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<b>Name of the Course</b>	<b>PHYSIOLOGY &amp; BIOCHEMISTRY LABORATORY</b>
<b>Course Code: PC-BME392</b>	<b>Semester: Third</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To understand the gross and microscopic approach to Anatomy & Physiology.
2	To quantify blood cells and identification of blood groups.
3	To estimate haematological parameters and measurement of pH, conductivity & viscosity of blood.
4	To estimate biomolecules and interpret the physiological parameter.

**LIST OF EXPERIMENTS:**

1. Identification and enumeration of various histological slides
2. Blood film making and identification of different blood corpuscles.
3. Measurement of total count for RBC & WBC & differential count for WBC.
4. Determination of ESR, BT, CT
5. Determination of Blood Group (ABO; Rh).
6. Estimation of Hemoglobin
7. Determination of blood pressure
8. Measurement of pH, and conductivity of body fluid.
9. Measurement of viscosity of Blood
10. Recording and analysis of ECG, EMG, EEG
11. Quantitative estimation of glucose (spectrophotometer / colorimeter)
12. Quantitative estimation of proteins (spectrophotometer / colorimeter)

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Identify and select appropriate tools for measurement of physiological and biochemical parameters.
2. Conduct experiments and analyze the outputs practically.
3. Evaluate the compatibility for any clinical measurements.
4. Propose analytical methods and plan for quantitative measurement.

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<b>Name of the Course</b>	<b>INTERPERSONAL SKILL &amp; REPORT WRITING [SESSIONAL]</b>
<b>Course Code: HM-HU381</b>	<b>Semester: Third</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To inculcate a sense of confidence in the students.
2	To help them to become a good communicators both socially and professionally.
3	To assist them to enhance their power of Technical Communication.
<b>Pre-Requisite: English (10+2), English (HM-HU201)</b>	

**Detailed Course Outlines:**

- A. Technical Report Writing:*  
Report Types (Organizational / Commercial / Business / Project)  
Report Format & Organization of Writing Materials  
Report Writing (Practice Sessions & Workshops)
- B. Language Laboratory Practice*
1. *Introductory Lecture to help the students get a clear idea of Technical Communication & the need of Language Laboratory Practice Sessions*
  2. *Conversation Practice Sessions: (To be done as real life interactions)*  
*Training the students by using Language Lab Device/Recommended Texts/cassettes /cd's to get their Listening Skill & Speaking Skill honed*  
*Introducing Role Play & honing over all Communicative Competence*
  3. *Group Discussion Sessions:*  
*Teaching Strategies of Group Discussion*  
*Introducing Different Models & Topics of Group Discussion*  
*Exploring Live /Recorded GD Sessions for mending students' attitude/approach & for taking remedial measure*
  4. *Interview Sessions:*  
*Training students to face Job Interviews confidently and successfully*  
*Arranging Mock Interviews and Practice Sessions for integrating Listening Skill with Speaking Skill in a formal situation for effective communication.*
  5. *Presentation:*  
*Teaching Presentation as a skill*  
*Strategies and Standard Practices of Individual /Group Presentation*  
*Media & Means of Presentation: OHP/POWER POINT/ Other Audio-Visual Aids.*
  6. *Competitive Examination:*  
*Making the students aware of Provincial /National/International Competitive Examinations*  
*Strategies/Tactics for success in Competitive Examinations*  
*SWOT Analysis and its Application in fixing Target*

**COURSE OUTCOMES:**

At the end of the course, students should able to:

1. Develop listening, speaking, reading and writing skills.
2. Develop self-confidence and able to reach corporate expectations.
3. Answer questions successfully in interviews and take international examination.

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4. Develop interpersonal skills on current problems and events.
5. Make presentations and participate in Group Discussions.
6. Produce well versed technical report in recognized format.

***Books/Reference– Recommended:***

*Nira Konar: English Language Laboratory: A Comprehensive Manual, PHI Learning, 2011*

*Kulbhushan Kumar, Effective Communication Skills, Khanna Publishing House, New Delhi, 2019*

*Sudharani: Advanced Manual for Communication Laboratories & Technical Report Writing Pearson Education (W.B. edition), 2011:*

Adrian Duff et. al. (ed.): Cambridge Skills for Fluency

A) Speaking (Levels 1-4 Audio Cassettes/Handbooks)

B) Listening (Levels 1-4 Audio Cassettes/Handbooks)

Cambridge University Press 1998 Mark Hancock: English Pronunciation in Use

4 Audio Cassettes/CD'S OUP 2004

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**SEMESTER-IV**

<b>Name of the Course</b>	<b>NUMERICAL METHODS</b>
<b>Course Code: BS-M401</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 2-0-0-2</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To understand different numerical methods required to solve engineering problems.
2	To familiarize with numerical solution of equations, finite differences and interpolation.
3	To expose with numerical solutions of linear, non-linear and ordinary differential equations.
<b>Pre-Requisite: Mathematics (10+2)</b>	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	Approximation in numerical computation: Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors. Interpolation: Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation. Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms.	11
2	Numerical solution of a system of linear equations: Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method. Numerical solution of Algebraic equation: Bisection method, Regula-Falsi method, Newton- Raphson method. Solution of nonlinear algebraic equations	9
3	Numerical solution of ordinary differential equation: Iterative methods for solving differential equations: Euler's method, Runge-Kutta methods, Predictor-Corrector methods and Finite Difference.	6

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Demonstrate the use of interpolation methods to find intermediate values in given graphical and/or tabulated data.
2. Apply appropriate algorithms to solve selected problems, both manually and by writing computer programs.
3. Analyze the errors obtained in the numerical solution of problems.
4. Compare different algorithms with respect to accuracy and efficiency of solution.
5. Assess the reliability of the numerical results and find out the effect of round off error.

**Text/Reference Books:**

1. C.Xavier: C Language and Numerical Methods.
2. R.S. Salaria, Computer Oriented Numerical Methods, Khanna Publishing House
3. Dutta & Jana: Introductory Numerical Analysis.
4. J.B.Scarborough: Numerical Mathematical Analysis.

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5. Jain, Iyengar , & Jain: Numerical Methods (Problems and Solution).
6. Balagurusamy: Numerical Methods, Scitech.
7. Baburam: Numerical Methods, Pearson Education.
8. N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
9. Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
10. Srimanta Pal: Numerical Methods, OUP.

<b>Name of the Course</b>	<b>DIGITAL ELECTRONICS &amp; INTEGRATED CIRCUITS</b>
<b>Course Code: ES-EC401</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits.
2	To prepare students to perform the analysis and design of various digital electronic circuits.
<b>Pre-Requisite: Physics (10+2)</b>	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Number System &amp; Codes</b> Number systems: Decimal, binary, octal and hexadecimal number systems, arithmetic operations and their conversions, 1's and 2's complements. Codes: Binary, BCD, excess 3, alphanumeric, EBCDIC and gray codes, code conversions, error detecting and error correcting codes.	6
2	<b>Boolean Algebra &amp; Logic Gates</b> Venn diagram, Boolean theorem, Logic Gates, operations, truth tables and universal gates, representation in SOP and POS forms, minimization of logic expressions by algebraic method, K-map and Quine- McClauskey method.	6
3	<b>Combinational Logic Circuits</b> Half and Full Adders, Half and Full Subtractors, Binary parallel Adder, Composite Adder, Carry look ahead Adder, BCD Adder, Applications and circuits of Decoder, Encoder, Multiplexer, Demultiplexer, magnitude comparator and Parity Generator, Implementation of combinational logic by standard IC's.	8
4	<b>Sequential Logic Circuits</b> S-R latch, J-K flip flop, D & T flip flop, triggering of flip flops, asynchronous inputs, master-slave configuration, conversion and application of flip flops, shift registers, universal shift registers, application of register, asynchronous / ripple counters, synchronous counters, Modulo-N counter, ring and Johnson counter, UpDown counter, preset and load in a counter, typical IC's for counters, State table and state transition diagram, sequential circuits design methodology.	8
5	<b>Analog To Digital and Digital To Analog Converters</b> Analog and digital data conversions, specification of D/A converter, R-2R ladder	6

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	type, weighted resistor type, voltage and current mode, switches for D/A converters, high speed sample and hold circuits, specification for A/D converter, flash type, successive approximation type, dual slope type, sigma-delta converter.	
6	<b>Memory Devices &amp; Digital Logic System</b> Memory Devices: ROM, PROM, EPROM, EEPROM, RAM, SRAM, DRAM, Programmable Logic Array (PLA), Programmable Array Logic (PAL), Field Programmable Gate Array (FPGA), implementation of combinational logic circuits using PLA, PAL. Digital Logic System: Logic levels, propagation delay, power dissipation, fan-out and fan-in, IC families and their characteristics – RTL, TTL, ECL, CMOS.	6

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Understand and explain different kinds of logic families.
2. Analyze digital circuits and arrive at suitable conclusions.
3. Develop digital logic circuits and apply it to solve real life problems.
4. Classify and explain the design of different semiconductor memories.
5. Design and develop applications of combinational and sequential circuits.
6. Engage in self-study to formulate, design, implement, analyze and demonstrate an application of digital electronic circuits.

### **Text/ Reference Books:**

1. S.Salivahanan, S.Aribazhagan, Digital Circuit & Design, 3rd Ed., Vikas Publishing House Pvt. Ltd
2. Anand Kumar, Fundamentals of Digital Circuits- PHI
3. Rishabh Anand, Digital Electronics- Khanna Publishing House 2019
4. A.K.Maini- Digital Electronics- Wiley-India
5. Kharate- Digital Electronics- Oxford
6. R.P. Jain, “Modern digital Electronics”, Tata McGraw Hill, 4th edition, 2009.
7. Schilling & Belove, Digital Integrated Electronics, Tata McGraw Hill,
8. W.H. Gothmann, “Digital Electronics- An introduction to theory and practice”, PHI, 2<sup>nd</sup> edition ,2006.
9. D.V. Hall, “Digital Circuits and Systems”, Tata McGraw Hill, 1989
10. Morris Mano- Digital Logic Design- PHI
11. R.P.Jain—Modern Digital Electronics, 2/e , Mc Graw Hill
12. H.Taub & D.Shilling, Digital Integrated Electronics- Mc Graw Hill.
13. D.Ray Chaudhuri- Digital Circuits-Vol-I & II, 2/e- Platinum Publishers

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<b>Name of the Course</b>	<b>BIOSENSORS &amp; TRANSDUCERS</b>
<b>Course Code: PC-BME401</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To acquire knowledge about the biological sensors and their working principles.
2	To know the principle of working, classification and characteristics of different transducers and their applications in medical field.
3	To understand the physical principles that governs the measurement of a biological variable or system.
4	To familiarize with the constructions and measurement of physiological parameters using sensors and transducers.
<b>Pre-Requisite: Physics-I (BS-PH201), Engineering Anatomy &amp; Physiology (PC-BME301)</b>	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to Biological Sensors:</b> Sensors / receptors in the human body, basic organization of nervous system-neural mechanism, hot and cold receptors, baro receptors, sensors for smell, sound and vision.	3
2	<b>Transducers principles and Medical applications:</b> Classification of transducers, characteristic of transducers, Resistance temperature detector (RTD), Thermistor, Thermocouple, p-n junction, chemical thermometry, potentiometer, inductive & capacitive transducer, magnetic sensors, Hall effect sensors, variable capacitance pressure transducers, LVDT transducers, strain gauge transducers, semiconductor transducers, p-i-n transducers, catheter tip transducers, Piezoelectric transducer, LDR, photo-emissive tubes, photodiodes, LED, avalanche photo diode (APD).	15
3	<b>Optical Sensor and Radiation Detectors:</b> Principles of optical sensors, optical fiber sensors, indicator-mediated transducers, optical fiber temperature sensors, LASER detector, Proportional counter, Gas-ionisation chamber, Geiger counters, Scintillation detectors.	6
4	<b>Biochemical Transducers:</b> Electrode theory: electrode-tissue interface, metal-electrolyte interface, electrode-skin interface, electrode impedance, Biopotential electrodes: microelectrodes, body surface electrodes, needle electrodes, electrodes for ECG, EEG, and EMG. Reference electrodes: hydrogen electrodes, silver-silver chloride electrodes, Calomel electrodes, Ion electrodes: specific ion electrodes, pH electrode, O <sub>2</sub> electrode, CO <sub>2</sub> electrode.	10
5	<b>Special Medical Applications of Sensors:</b> Gas sensor, Microbial sensor, electro analytical sensor, Enzyme based sensor-- Glucose sensor, Electronic nose-halitosis, Advances in sensor technology: Lab-on-a-chip, Smart sensor, MOSFET biosensors, Bio-MEMS and Nano sensor.	6

### **COURSE OUTCOMES**

At the end of the course, students should able to:

1. Classify sensors and transducers based on functions.
2. Explain the working principles of biosensors and transducers.
3. Select appropriate transducers for measurements of physical parameters.

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4. Analyze various electrical parameters with accuracy and precision.
5. Measure physiological parameters and interpret the data.
6. Design and develop systems for tailor made applications.

**Text/ Reference Books:**

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.
2. S.C. Cobbold, "Transducers for Biomedical Instruments", Prentice Hall.
3. Brown & Gann, "Engineering Principles in Physiology Vol. I", Academic Press.
4. Jon Cooper, "Biosensors A Practical Approach" Bellwether Books, 2004.
5. Carr & Brown, Introduction to Biomedical Equipment Technology Pearson Edn, Asia.
6. Rao & Guha,"Principles of Medical Electronics & Biomedical Instrumentation", University Press, India.
7. Iberall & Guyton, Regulation & Control in Physiological System, Instruments Soc.USA.
8. A.V.S. De Renck , "Touch Heat & Pain", Churchill Ltd. London.
9. Harry Thomas, "Handbook of Bio medical Instrumentation", Reston, Virginia.
10. D. L. Wise, "Applied Bio Sensors", Butterworth, London.

<b>Name of the Course</b>	<b>BIOMEDICAL INSTRUMENTATION</b>
<b>Course Code: PC-BME402</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 3-1-0-4</b>	<b>Contact: 4 hrs/week</b>
<b>Objectives:</b>	
1	To study the instrumentation concerned with measuring various physiological parameters.
2	To understand the purpose of measurement, the method of measurement and errors associated with measurement.
3	To understand the operation, applications and underlying physiological principles associated with medical devices.
4	To give a complete exposure of various recording mechanism and to understand the basic principles, working of biomedical instruments.
<b>Pre-Requisite:</b> Physics-I (BS-PH201), Engineering Anatomy & Physiology (PC-BME301), Biophysics & Biochemistry (PC-BME303)	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to Medical Instrumentation</b> Sources of Biomedical Signals, Basic medical Instrumentation system, Performance requirements of medical Instrumentation system, Microprocessors in medical instruments, PC based medical Instruments, General constraints in design of medical Instrumentation system, Regulation of Medical devices.	5
2	<b>Measurement, Display &amp; Recording Systems</b> Units and standards of measurements, systematic and random error, accuracy and	15

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	precision index, linearity, hysteresis, threshold, sensitivity, speed of response, fidelity, calibration, digital voltmeter & multimeter, PMMC, MI and dynamometer type instruments, dc potentiometers, AC bridges, general features of ink-jet, thermo-sensitive and optical recorders, CRT, General purpose oscilloscope, Dual trace, Dual beam, Sampling oscilloscope, Digital storage oscilloscope, Function generator.	
3	<b>Biosignal Measurement Systems</b> Biosignals characteristics, frequency and amplitude ranges, ECG- Einthoven's triangle, standard 12 lead system, Principles of vector cardiography, ECG block diagram and circuits. Evoked potential, EEG-10-20 electrode system, unipolar, bipolar and average mode, EEG bio-feedback instrumentation. EMG-unipolar and bipolar mode, EMG bio-feedback instrumentation, Recording of EOG, Blood ERG, EGG, PCG & GSR.	12
4	<b>Bioamplifier &amp; Signal Conditioning Circuits</b> Bio-amplifier and its characteristics, single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers-transformer and optical isolation, isolated DC amplifier and AC carrier amplifier, Power line interference, Right leg driven ECG amplifier, Band pass and notch filtering, data acquisition system.	11
5	<b>Patient Monitoring Systems &amp; Biotelemetry</b> Introduction to patient monitoring system, selection of parameters, computerized patient monitoring system, bedside and central monitoring system, heart rate monitor, pulse rate monitor, Holter monitor and Cardiac stress test, Cardiac catheterization instrumentation, phonocardiography, Organization and equipments used in ICCU & ITU.	9

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Measure various electrical parameters with accuracy, precision, resolution.
2. Illustrate and explain the mode of operation of various instrument and its medical applications.
3. Demonstrate and adjust the technical factors of the instruments.
4. Understand electrical safety and the ability to design relevant protection systems.
5. Analyze and interpret the static and dynamic characteristics of bioinstrumentation systems
6. Identity and solve the problem and servicing the instrument properly.

**Text/ Reference Books:**

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2<sup>nd</sup> Edition, Tata McGraw Hill.
2. J.J.Carr & J.M.Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
3. Cromwell, Weibell & Pfeiffer, "Biomedical Instrumentation & Measurement", Prentice Hall, India
4. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg . , Boston.

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5. J. Webster, "Bioinstrumentation", Wiley & Sons.
6. Joseph D. Bronzino, "The Biomedical Engineering handbook", CRC Press.

<b>Name of the Course</b>	<b>ANALYTICAL AND DIAGNOSTIC EQUIPMENTS</b>
<b>Course Code: PC-BME403</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To familiarize the students with the principles and applications various analytical and diagnostic instruments.
2	To expose the students to the diagnostic features of medical devices used routinely in hospitals.
3	To impart fundamental knowledge of versatile analytical and diagnostic equipments used in the healthcare system.
<b>Pre-Requisite: Physics-I (BS-PH201), Engineering Anatomy &amp; Physiology (PC-BME301).</b>	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Clinical Equipments</b> Principles of photometric measurement, Radiation sources, Optical filters, Colorimeter, Spectrometer, Design of Monochromators, Flame photometer, Atomic absorption spectrophotometer, Automated biochemical analyzer-Auto analyzer, Electromechanical analyzer-Chromatographs, Microscopes, Scanning Electron Microscope, Transmission Electron Microscope, Centrifuge-principles and applications.	10
2	<b>Blood Gas Analyzers and Oximeters</b> Blood pH measurement, Blood pCO <sub>2</sub> measurement, Blood pO <sub>2</sub> measurement, complete blood gas analyzer, Fiber optic based blood gas sensors, Oximetry, Principles of oximetric measurements, Ear oximeter, Pulse oximeter, Intravascular oximeter.	7
3	<b>Blood Cell Counters and Blood Pressure Measurement</b> Blood cell counters, optical method-Flow Cytometry, electrical impedance method-Coulter Counters, automatic recognition and differential counting of cells, blood pressure measurement, indirect method-auscultatory & oscillatory, automated indirect method, direct method-electronic manometer, pressure amplifiers, systolic, diastolic and mean detector circuit.	7
4	<b>Blood Flow and Cardiac Output Measurement</b> Electromagnetic blood flow meter, Ultrasonic blood flow meter-Transit time and Doppler blood flow meter, Cardiac output measurement-Dye dilution, thermal dilution and Impedance method.	6
5	<b>Pulmonary Function Analyzers</b> Lung volume and vital capacity, Compliance and related pressure, Spirometer, Pneumotachometer, impedance pneumograph / plethysmograph, apnea monitor.	6
6	<b>Endoscopy</b> Basic endoscopic equipments, Fiberoptic instruments and video-endoscopes, Accessories-illumination, instrument tips, instrument channels, tissue sampling	4

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	devices, suction traps and fluid-flushing devices, Various endoscopic applications, Maintenance and storage.	
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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Classify and explain different types of clinical instruments for medical diagnosis.
2. Demonstrate the basic principle of working, mode of operation and various advancements.
3. Choose appropriate instruments for specific application and accurate measurement.
4. Integrate knowledge of engineering and biology to repair and calibrate the instruments.
5. Make measurement, analyze and interpret the results for clinical purposes.
6. Exhibit competency in suggesting, designing and offering reliable and optimum solution.

**Text/ Reference Books:**

1. R. S. Khandpur “Handbook of Bio-Medical Instrumentation”, 2<sup>nd</sup> Edition, Tata McGraw Hill.
2. J.J.Carr & J.M.Brown, “Introduction to Biomedical Equipment Technology” Pearson Education, Asia.
3. Cromwell, Weibell & Pfeiffer, “Biomedical Instrumentation & Measurement”, Prentice Hall, India
4. Joseph Bronzino, “Biomedical Engineering & Instrumentation”, PWS Engg Boston.
5. J.Webster, “Bioinstrumentation”, Wiley & Sons.
6. Joseph D.Bronzino, “The Biomedical Engineering handbook”, CRC Press.

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<b>Name of the Course</b>	<b>ELECTRIC CIRCUITS AND NETWORK ANALYSIS</b>
<b>Course Code: PE-EE401</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand the structure and properties of different type of electric circuits and sources.
2	To learn circuit analysis techniques such as nodal analysis, mesh analysis, theorems, source transformation and several methods to simplify electric networks.
3	To acquire problem solving skills of electric circuit through the application of techniques and principles of electrical circuit analysis to common circuit problems.
<b>Pre-Requisite:</b> Basic Electrical Engineering (ES-EE-101), Mathematics ( BS-M-102, BS-M202), Signals & Systems in Biomedical Engineering (PC-BME301).	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Voltage &amp; Current Sources:</b> Current sources: active, passive, dependent, independent, ideal & practical current sources; AC & DC current, AC & DC voltage, Voltage sources: dependent, independent, ideal & practical voltage sources.	6
2	<b>A.C. Fundamentals</b> Sinusoidal voltage and currents, mathematical and graphical representation, concept of cycle period, frequency, instantaneous, peak, average, r.m.s. values, peak and form factor, phase difference, lagging, leading and in phase quantities, phasor representation: Rectangular and polar representation of phasors.	8
3	<b>Resonance Circuits and Coupled Circuits</b> Series and Parallel Resonance, Impedance and Admittance Characteristics, Q-factor, Half-Power Points, Bandwidth, Resonant voltage rise, Transform diagrams, Magnetic Coupling, polarity of coils, polarity of induced voltage, concept of self and mutual inductance, coefficient of coupling, modeling of coupled circuits, Solution of Problems.	10
4	<b>Methods of Analyzing Circuits</b> Concept of Tree, Branch, Tree Link, junctions, Incident matrix, Tie-set matrix, Cut-set matrix, determination of loop current and node voltages, formulation of mesh equation, formulation of node equation, nodal and super nodal analysis, solution of problems with DC and AC sources, analyzing simple biomedical circuits.	6
5	<b>Network Theorem and Transient Analysis</b> Network equations: Kirchoff's Voltage Law & Current Law, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Compensation Theorem, Maximum Power Transfer Theorem, Millman's Theorem, Star-Delta transformations, representation of network in time and frequency domain, free and forced responses of RL, RC RLC circuits with DC and AC excitation, applying theorems in biomedical circuits.	10

### **COURSE OUTCOMES**

At the end of the course, students should able to:

1. Apply different techniques for analysis of electrical circuit.

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2. Analyze circuits using mesh current and nodal voltage method.
3. Analyze and solve transient behavior of the network.
4. Analyze RLC circuits and coupled circuits.
5. Design resonant circuits for given bandwidth.
6. Compute responses of first order and second order networks using time domain analysis.

**Text/Reference Books:**

1. Van, Valkenburg.; “Network analysis” ; Prentice hall of India, 2000
2. Ashaq Husain, Networks and Systems, Khanna Publishing House, New Delhi-2019
3. Sudhakar, A., Shyammohan, S. P.; “Circuits and Network” ; Tata McGraw-Hill New Delhi, 1994
4. A William Hayt, “Engineering Circuit Analysis” 8th Edition, McGraw-Hill Education
5. AChakrabarty,” Circuit Theory Analysis & Synthesis”, DhanpatRai
6. S P Ghosh, “Circuit Theory and Networks”, Tata McGraw Hill.
7. Hayt“Engg Circuit Analysis 6/e Tata McGraw-Hill
8. D.A.Bell- Electrical Circuits- Oxford
9. Skilling H.H.: “Electrical Engineering Circuits”, John Wiley & Sons.
10. Edminister J.A.: “Theory & Problems of Electric Circuits”, McGraw-Hill Co.
11. D.Roy Choudhary Networks and Systems, Newage Publications, New Delhi
12. Kuo F. F., “Network Analysis & Synthesis”, John Wiley & Sons.
13. R.A.DeCarlo & P.M.Lin- Linear Circuit Analysis- Oxford
14. P.Ramesh Babu- Electrical Circuit Analysis- Scitech
15. Roy Choudhury D., “Networks and Systems”, New Age International Publishers.
16. D.Chattopadhyay and P.C.Rakshit: “Electrical Circuits” New Age

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<b>Name of the Course</b>	<b>ELECTRICAL AND ELECTRONIC MEASUREMENTS</b>
<b>Course Code: PE-EE402</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To gain knowledge about the electrical and electronic measuring instruments and the methods of measurement.
2	To acquire knowledge about the working and operation of various analog and digital signal recording and analysing instruments.
3	To introduce students with PC based instrumentation and data acquisition system.
<b>Pre-Requisite:</b> Basic Electrical Engineering (ES-EE-101)	

<b>M#</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Basic Measurement System</b> Measurement and generalized measurement system, static and dynamic characteristics, units and standards of measurements, errors analysis, moving iron meters, dynamometer, wattmeter, multimeter, true rms meters, Bridge measurements: Wheatstone Bridge, Kelvin, Wein, Maxwell, Hay, Schering and Anderson Bridge. D.C. and A.C. potentiometers, Measurement of high voltage, Measurement of power in polyphase circuits.	10
2	<b>Data Display and Recording System</b> Electronic multimeter, current measurement with analog electronic instruments, chopper stabilized amplifier for measurement of very low voltage and currents, graphic recorders, Cathode Ray Oscilloscopes- Block Schematic, Principles and applications. Dual Trace and Dual Beam Oscilloscopes, sampling oscilloscope, Digital Storage Oscilloscope.	9
3	<b>Signal Generator and Analysis</b> Function Generators, RF Signal Generators, Sweep Generators, Frequency Synthesizer, Wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer.	7
4	<b>Digital Instruments</b> Comparison of analog & digital techniques, digital voltmeter, mutlimeter, frequency counters and time interval, extension of frequency range, measurement errors.	7
5	<b>Data Acquisition Systems</b> Elements of digital data acquisition system, interfacing of transducers, multiplexing, Computer controlled instrumentation: IEEE 488 Bos. Optical Power Measurement, Optical Time Domain Reflectometer.	7

### **COURSE OUTCOMES**

At the end of the course, students should able to:

1. Explain the working principles and operation of measuring instruments.
2. Analyze the performance characteristics of measuring instruments.
3. Measure various electrical parameters with accuracy and precision.
4. Select appropriate measuring instruments for measuring the specific physical parameters.
5. Test and troubleshoot electronic circuits using various measuring instruments.

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6. Propose data acquisition system and transfer data for digital signal processing and analysis.

**Text/Reference Books:**

1. Modern Electronic Instrumentation & Measurement Techniques – Albert D. Helfrick & William D. Copper, Prentice Hall of India, 2003
2. Elements of Electronics Instrumentation & Measurement, Pearson Education 2003
3. J.G. Joshi, Electronic Measurement and Instrumentation, Khanna Publishing House, 2019
4. Measurement System- Application & Design – Ernest O. Doebelin, Tata McGraw Hill 2004.
5. Electronic Instrumentation by H. S. Kalsi. 3rd Ed. Tata McGraw-Hill Education
6. A Course in Electrical and Electronic Measurements and Instrumentation by A.K. Sawhney, Puneet Sawhney, Dhanpati Rai Publication.

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**PRACTICAL**

<b>Name of the Course</b>	<b>DIGITAL ELECTRONIC CIRCUITS LABORATORY</b>
<b>Course Code: ES-EC491</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To introduce students with the working of basic components of digital electronics.
2	To familiarize students with different Digital ICs corresponding to different logic gates
3	To familiarize students with the design of sequential and combinational circuits.
4	To introduce with small counter circuits using simple ICs.

**LIST OF EXPERIMENTS:**

1. Realization of basic gates using Universal logic gates.
2. Code conversion circuits- BCD to Excess-3 & vice-versa.
3. 4-bit parity generator & comparator circuits.
4. Construction of simple Decoder & Multiplexer circuits using logic gates.
5. Design of combinational circuit for BCD to decimal conversion to drive 7-segment display using multiplexer.
6. Construction of simple arithmetic circuits-Adder, Subtractor.
7. Realization of RS-JK & D flip-flops using Universal logic gates.
8. Construction of Adder circuit using Shift Register & full Adder.
9. Realization of Asynchronous Up/Down counter.
10. Realization of Synchronous Up/Down counter.
11. Realization of Ring counter & Johnson's counter.
12. Mandatory Design and Implementation of Mini Project.

Note: An Institution/College may opt for some other software or hardware simulation wherever possible in place of MATLAB.

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Understand the basic of the Digital systems to solve real life problems.
2. Explain the application of Digital ICs in the designing circuit.
3. Describe, design and analyze sequential and combinational circuits.
4. Design various functional circuits using simple ICs.

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<b>Name of the Course</b>	<b>BIOSRNSORS &amp; TRANSDUCERS LABORATORY</b>
<b>Course Code: PC-BME491</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To study and analyze the theory and practical characteristics of the various transducers for the measurement of vital physiological parameters.
2	To get familiar with the various types of transducers and to study the compatibility for any clinical measurements.

**LIST OF EXPERIMENTS:**

1. Characteristics of temperature sensors: RTD, Thermocouple, P-N junction diode transistor.
2. Measurement of displacement: Capacitive transducer, LVDT
3. Characteristics of light sensors: LDR, Photodiode, Phototransistor
4. Study of load cell with tensile and compressive load
5. Measurement of torque using strain gauge transducer
6. Study of proximity detector: ultrasonic, IR
7. Measurement of respiration rate: Thermistor, Piezoelectric sensors.
8. Study of the characteristics of level sensor for saline IV set.
9. Study & characterization of Biotransducers: Pressure, Temperature, Humidity
10. Study & characterization of Bioelectrodes: ECG, EMG, EEG
11. Mandatory Design and Implementation of Mini Project.

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Select proper sensors and transducers for measurement of biophysical phenomenon.
2. Conduct experiments and analyze the result practically.
3. Evaluate and compare the measure data for clinical representation.
4. Design and test system for detection of physiological signals.

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<b>Name of the Course</b>	<b>BIOMEDICAL INSTRUMENTATION LABORATORY</b>
<b>Course Code: PC-BME492</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To make students aware about the measuring instruments and the methods of measurement routine used in the medical field.
2	To acquaint student with signal acquisition, recording and analysis of physiological parameters.
3	To familiarize students with the measuring principles, probable troubleshoot and maintenance of biomedical instruments.

**LIST OF EXPERIMENTS:**

1. Power isolation: isolation transformer and DC-DC converters
2. Timer circuits: ON delay and OFF delay study
3. Characterization of biopotential amplifier for ECG & EMG signals
4. Isolation of bio-signal (EMG / ECG)
5. Study on ECG lead selection circuits
6. ECG processing and analysis
7. EMG processing and analysis
8. EEG processing and analysis
9. PCG processing and analysis / electronic stethoscope
10. Detection of QRS component from ECG signals
11. Measurement of heart rate using F-V converter
12. Mandatory Design and Implementation of Mini Project.

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Explain the principle of operation and design background of medical instrument for specific application.
2. Make measurement on and interpret data from living systems, and ability to communicate properly.
3. Design and conduct experiments, as well as to analyze and interpret data.
4. Check and calibrate medical instruments at par with standard protocol.

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<b>Name of the Course</b>	<b>CIRCUITS AND NETWORK LABORATORY</b>
<b>Course Code: PE-EE491</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To gain the practical knowledge about the basic electrical circuits and the circuit theorems.
2	To understand the transient response of RL, RC and RLC circuits, and transient analysis of AC circuits.
3	To gain hand on experience in Thevinin & Norton theorem, KVL & KCL, and Super Position Theorems.

**LIST OF EXPERIMENTS:**

1. Characteristics of Series & Parallel Resonant circuits
2. Verification of Network Theorems
3. Transient Response in R-L & R-C Networks ; simulation / hardware
4. Transient Response in RLC Series & Parallel Circuits & Networks; simulation/hardware
5. Determination of Impedance (Z), and Admittance (Y) parameters of networks.
6. Frequency response of LP and HP filters
7. Frequency response of BP and BR filters
8. Generation of periodic, exponential, sinusoidal, damped sinusoidal, step, impulse, and ramp signals using MATLAB
9. Representation of Poles and Zeros in z-plane, determination of partial fraction expansion in z-domain and cascade connection of second-order systems using MATLAB
10. Determination of Laplace Transform, different time domain functions, and Inverse Laplace Transformation using MATLAB
11. Spectrum analysis of different signals /Analysis of simple biomedical signals.
12. Mandatory Design and Implementation of Mini Project.

Note: An Institution / college may opt for some other hardware or software simulation wherever possible in place of MATLAB

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Generate various signals, represent poles and zeros, determine partial functions and cascade connection using software tools / simulation kits.
2. Characterize Series and Parallel Resonant circuits, and validate network theorems.
3. Design Transient Response in R-L & R-C Networks and Transient Response in RLC Series & Parallel Circuits & Networks.
4. Determine Laplace transform, different time domain functions and inverse Laplace.

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<b>Name of the Course</b>	<b>ELECTRICAL AND ELECTRONIC MEASUREMENTS LABORATORY</b>
<b>Course Code: PE-BME492</b>	<b>Semester: Fourth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To acquire knowledge of internal structure of electrical and electronic measuring instruments and calibrate different types of ammeter, voltmeter and wattmeter and single phase AC energy meter.
2	To gain knowledge about the measuring of low resistance, inductance and capacitance using DC and AC Bridges.

**LIST OF EXPERIMENTS:**

1. Instrument workshop- observe the construction of PMMC, Dynamometer, Electro thermal and Rectifier type instrument, Oscilloscope and digital multimeter
2. Calibrate moving iron and electro-dynamometer type ammeter/volmeter by potentiometer
3. Calibrate dynamometer type Wattmeter by potentiometer
4. Calibrate A.C. energy meter
5. Measure the resistivity of material using Kelvin Double Bridge
6. Measurement of Power using Instrument transformer
7. Measurement of Power in Polyphase circuits
8. Measurement of Frequency by Wien Bridge using Oscilloscope
9. Measurement of Inductance by Anderson Bridge
10. Measurement of Capacitance by De Sauty Bridge
11. Measurement of Capacitance by Schering Bridge
12. Mandatory Design and Implementation of Mini Project.

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Identify various measuring equipment/meters and to evaluate their performance.
2. Measure Resistance, Inductance, Capacitance, Frequency, Voltage, Current, Power and Energy.
3. Demonstrate variety of practical electrical circuits and conduct experiments to analyze and interpret data.
4. Prepare graphical presentations of laboratory data and computational results, incorporating standard data analysis methods to develop technically sound reports of outcomes.

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**SEMESTER-V**

<b>Name of the Course</b>	<b>THERAPEUTIC EQUIPMENTS &amp; ASSISTIVE DEVICES</b>
<b>Course Code: PC-BME501</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To enable the students to gain knowledge on the working and safety standards of therapeutic clinical equipment.
2	To learn the principles of cardiac assist devices and equipment for neonatal care unit.
3	To develop clear understanding of the physiotherapy and diathermy equipment and their operation.
4	To understand the need and use of lasers in medicine and drug delivery system.
<b>Pre-Requisite:</b> Engineering Physiology & Anatomy (PCBME302), Biophysics & Biochemistry (PCBME303), Biomedical Instrumentation (PCBME402)	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Cardiac Pacemakers &amp; Defibrillators:</b> Effects of electric field on cardiac muscles and laws of stimulation, need for pacemaker, external pacemakers, implantable pacemakers and types, codes for pacemakers, pulse generator and power sources, electrodes and leads system, pacing system analyzers, programmable pacemakers, rate-responsive and ventricular synchronous pacemakers, microprocessor based modern pacemakers, need for defibrillators, DC defibrillator, synchronous operation, implantable defibrillators, defibrillator analyzers and safety.	11
2	<b>Ventilators &amp; Anaesthetic System:</b> Artificial ventilations, ventilators and types, terminology of ventilators, classification of ventilators and modern ventilators, need for anaesthesia, anaesthesia gases and vapors, anaesthesia delivery system, humidifiers, nebulizers and aspirators.	6
3	<b>Physiotherapy &amp; Electrotherapy Equipment:</b> IR diathermy, UV diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy, electrotherapy and different waveforms, electrode system, electrical stimulators and types, nerve-muscle stimulators, ultrasonic stimulators, pain relief through electrical stimulators, hazards and safety procedure.	8
4	<b>Surgical Diathermy &amp; LASER:</b> Principles and applications of surgical diathermy, electrosurgery machine, electrosurgery circuits, different electrodes, electrosurgery techniques, solid state electrosurgery, generator circuits, testing of electrosurgery units, electrosurgery safety, basic principle of ultrasonic lithotripter and extracorporeal shock wave lithotripter, principles of cryogenic technique and applications, principle of operation of LASER, laser tissue interactions, various application of CO <sub>2</sub> , Ar, He-Ne, Nd-YAG and pulsed ruby LASER, application of LASER in surgery, laser safety procedure.	11
5	<b>Neonatal Care &amp; Drug Delivery Systems:</b> Baby incubator, radiant warmer and phototherapy unit, suction apparatus, infusion pumps, syringe pumps, peristaltic pumps, implantable infusion pumps, programmable volumetric pumps,	4

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automated drug delivery system.	
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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the working of therapeutic equipment and assistive devices.
2. Classify and recommend suitable therapeutic devices for specific applications.
3. Analyze different types of therapeutic devices including pediatric applications and support.
4. Justify the application of lasers and laser in surgery.
5. Outline the potential electrical hazards for therapeutic equipment and evaluate the patient safety.
6. Plan and contribute in design, development and effective usage of therapeutic equipment and assistive devices.

**Text/Reference Books:**

1. R.S.Khandpur "Handbook of Bio-Medical Instrumentation", 2<sup>nd</sup> Edition, TMH.
2. J.J.Carr & J.M.Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
3. J.Webster, "Bioinstrumentation", Wiley & Sons
4. Joseph Bronzino, "Biomedical Engineering & Instrumentation" PWS Engg. Boston.
5. Willard Van Nostrand, ".Instrumental Methods of Analysis"-
6. Sharns, "Instrumental Methods", S Chand & Co.
7. Harry Bronzino E, "Handbook of Biomedical Engineering and Measurements", Reston, Virginia.
8. Jacobson & Websler, "Medicine & Clinical Engg"
9. Leslie Cromwell, "Biomedical Instrumentation and Measurements"

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<b>Name of the Course</b>	<b>MEDICAL IMAGING TECHNIQUES</b>
<b>Course Code: PC-BME502</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To expose the student on different medical imaging techniques for diagnosis of internal organs and structures.
2	To understand the physics and principles of underlying operation of different medical imaging equipment.
3	To gain knowledge on radiographic and ultrasonographic medical imaging system.
4	To learn the preferred medical imaging methods and safety considerations for routine clinical applications.
<b>Pre-Requisite:</b> Engineering Physiology & Anatomy (PCBME302), Biophysics & Biochemistry (PCBME303), Biomedical Instrumentation (PCBME402)	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>X-ray Machine:</b> Physics and production of X-rays, soft X-rays and hard X-rays, X-ray equipment-block diagram, X-ray tube and tube enclosure, stationary and rotating anode tube, stator-rotor assembly, rating charts of X-ray tubes, causes of X-ray tube failure, conventional electrical circuit of X-ray machine, power supply-high voltage generation, high frequency generator X-ray machine, control circuits-high voltage control, filament control and tube current, exposure timing, automatic exposure control, collimators and Bucky grids, mammographic and dental X-ray machines, portable and mobile X-ray units.	12
2	<b>X-ray Image &amp; Radiotherapy:</b> X-ray screen-film system, film sensitometry, radiographic film image formation, dark room accessories-developer and fixer, image quality factors, MTF, X-ray image intensifier, digital radiography, flat panel detector, detector quantum efficiency, radiation doses, dose equivalent and REM, radiation protection and radiation measuring instruments, radiotherapy principles and types, external beam radiotherapy, dose measurement and treatment planning.	9
3	<b>Fluoroscopy &amp; Angiography:</b> Fluoroscopic imaging system, digital fluoroscopy-c-arm system, angiography, cine angiography, digital subtraction angiography (DSA), digital subtraction programming, angioplasty.	5
4	<b>Infra-Red Imaging:</b> Physics of thermography, Infrared detectors, Infrared imaging systems, clinical thermography, liquid crystal thermography, modern application.	3
5	<b>Ultra-Sound Imaging:</b> Physics and production of ultrasound, medical ultrasound, acoustic impedance, absorption and attenuation of ultrasound energy, pulse geometry, ultrasonic field, ultrasonic transducers and probe design, types of probes, beam steering, principles of image formation, image processing, display systems and applications: A-mode, B-mode and M-mode, real-time ultrasonic imaging systems, electronic scanners, image artifacts, Doppler ultrasound and colour velocity mapping, duplex ultrasound and power doppler, bio-effects and safety levels.	11

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### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Classify different imaging techniques and suggest suitable imaging methodology for specific applications.
2. Demonstrate the physics and principles of operation of X-ray and ultrasound imaging modality.
3. Explain the principles of image formation and implement various techniques to analyze the medical images for clinical purposes.
4. Identify and interpret the most effective imaging modality for particular examination.
5. Apply the tools for different problems in medical imaging and respond technically.
6. Demonstrate the potential radiation hazards and implement relevant protective systems.

### **Text/Reference Books:**

1. R.S. Khandpur "Handbook of Bio-Medical Instrumentation", 2<sup>nd</sup> Edition, TMH.
2. J.J. Carr & J.M. Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
3. J. Webster, "Bioinstrumentation", Wiley & Sons
4. Dowsett, Kenny & Johnston, "The Physics of Diagnostic Imaging", Chapman & Hall Medical, Madras/London.
5. Brown, Smallwood, Barber, Lawford & Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol.
6. Massey & Meredith, "Fundamental Physics of Radiology", John Wright & Sons.
7. S. Webb, "The Physics of Medical Imaging", Adam Hilger, Bristol.
8. Sybil M Stockley, "A Manual of Radiographic Equipments", Churchill Livingstone.
9. Chistrmis, "Physics of Diagnostic Radiology"

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<b>Name of the Course</b>	<b>TELEHEALTH TECHNOLOGY</b>
<b>Course Code: PE-BME501</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To acquire knowledge on the basic concepts of telemedicine and the technology used in healthcare system.
2	To study the need for digital imaging and picture archiving and communications systems (PACS)
3	To learn telemedical standards, security, mobile telemedicine and its applications
4	To know scope, benefits and limitations of telemedicine.
<b>Pre-Requisite:</b> Mathematics, Signals & Systems in Biomedical Engineering (PCBME301), Analog & Digital Electronics, Biomedical Instrumentation (PCBME402)	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Fundamental of Telemedicine &amp; Types of Information :</b> History of telemedicine, definition of telemedicine, telemedicine systems, telehealth, telecare, origins and development of telemedicine, scope, benefits and limitations of telemedicine, audio, video, still images, text and data fax.	6
2	<b>Communication &amp; Network System:</b> Public switched telephone network, plain old telephone services, integrated services, digital network, asynchronous transfer mode, internet, wireless communications: GSM, satellite and micro wave, mobile health and ubiquitous healthcare, real-time telemedicine.	9
3	<b>Picture Archiving &amp; Communication System:</b> Introduction to radiology information system, image acquisition system, display system, communication network, interpretation, types of image format, DICOM standard, PACS strategic plan and needs assessment, technical issues, and PACS architecture.	9
4	<b>Applications of Telemedicine:</b> Teleradiology, teleaudiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e-health and cyber medicine, acute care and monitoring for elderly care, virtual doctor systems for medical practices.	8
5	<b>Ethical &amp; Legal Aspects:</b> Confidentiality and law, patient rights and consent, patient-doctor relationship, access to medical records, consent treatment, data protection and security, jurisdictional issues, intellectual property rights.	8

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the types of communication and network systems used in tele health technology.
2. Explain the communication standards, ethical and legal issues involved in telehealth system.
3. Apply telemedicine and e-health services in professional field.
4. Identify the conditions for successful implementation of telemedicine and e-health systems and services.
5. Promote and introduce telemedicine and e-health services and programmes.
6. Plan and contribute in the design, implementation and use of telemedicine and e-health systems.

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**Text/Reference Books:**

1. A.C. Norris, Essential of Telemedicine and Telecare, John Wiley & Sons, 2002
2. Olga Ferrer-Roca, M.SosaLudicissa, Handbook of Telemedicine, IOS press 2002.
3. Bernard Fong, ACM Fong, CK Li, Telemedicine Technologies: Information Technologies in Medicine and Telehealth, Wiley, 1<sup>st</sup> edition, 2015.
4. GeorgiGGraschew, Stefan rakowsky, Telemedicine Techniques and Applications, In Tech, 1<sup>st</sup> edition, 2011.
5. HalitEren, John G Webster, The E-Medicine, E-Health, Telemedicine, and Telehealth Handbook, CRC Press, 1<sup>st</sup> edition, 2015.
6. Khandpur R S, Telemedicine-Technology and Applications, PHI Learning Pvt. Ltd., New Delhi, 2017.
7. H K Huang, PACS and Imaging Informatics: Basic Principles and Applications, Wiley, New Jersey, 2010.

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<b>Name of the Course</b>	<b>COMMUNICATION ENGINEERING &amp; BIO-TELEMETRY</b>
<b>Course Code: PE-BME502</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To study and understand the principles of electronic communication.
2	To gain knowledge about transmission of analog and digital information using various modulation techniques and methods of enabling secured communication.
3	To learn data and pulse communication techniques.
4	To study wireless communication network and understand basics of bio-telemetry systems.
<b>Pre-Requisite:</b> Mathematics, Signals & Systems in Biomedical Engineering (PCBME301), Analog & Digital Electronics, Biomedical Instrumentation (PCBME402)	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction:</b> Elements of analog and digital communication system, baseband communication, carrier communication, concept of modulation, source coding, channel coding.	2
2	<b>Analog Communication:</b> Amplitude modulation (AM)-Frequency domain and time domain representation, modulation index, transmission bandwidth, single tone and multi-tone modulation, power calculation for single tone, types and advantages of AM: DSB-SC and SSB-SC, generation and demodulation of AM-square law modulator and envelope detector, super heterodyne receiver for AM Radio, angle Modulation(FM/PM)- frequency modulation, phase modulation, time and frequency domain representation of FM, narrow band and wideband FM, generation of FM-Armstrong's method, introduction to Phase-Locked-Loop (PLL), demodulation of FM using PLL.	13
3	<b>Digital Communication:</b> Concept of sampling, pulse amplitude modulation (PAM), pulse code modulation (PCM), line coding- unipolar, polar, NRZ, RZ, Manchester and AMI, coding control, digital modulation techniques-ASK, PSK, FSK and QPSK, multiple access: FDMA, TDMA and CDMA.	13
4	<b>Wireless Communication Networks:</b> Introduction to communication networks, centralized network-GSM, ad-hoc network-Bluetooth, introduction to PACS, PACS architecture, DICOM network.	5
5	<b>Bio-Telemetry System:</b> Components of telemetry system, bio-telemetry and its importance, single and multi-channel biotelemetry, ECGtelemetry system, temperature telemetry system, telemetry of ECG and respiration, sports telemetry, multi-patient telemetry, ambulatory patient monitoring, implantable telemetry systems, transmission of physiological signals over telephone line, telemedicine and applications.	7

### **COURSE OUTCOMES**

At the end of the course, students should able to:

1. Choose and apply different modulation techniques for various applications.

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2. Analyze the performance of communication system in terms of error rate and spectral efficiency.
3. Demonstrate the concepts of sampling, pulse modulation techniques and their comparison.
4. Inspect recent trend and performance issues for different digital modulation techniques
5. Identify the types of devices and their uses on a digital imaging network.
6. Design and evaluate the biotelemetry system.

### **Text/Reference Books:**

1. P Ramakrishna Rao , “Analog Communication”,., Mc-GrawHill
2. B.P.Lathi -Communication Systems- BS Publications
3. V Chandra Sekar – Analog Communication- Oxford University Press
4. S. Haykin, - Digital Communications, Wiley India.
5. R.S.Khandpur “Handbook of Bio-Medical Instrumentation”, 2nd Ed. TMH.
6. A.B. Carlson—Communication System, 4/e ,Mc-GrawHill
7. Proakis & Salehi Fundamentals of Communication Systems-Pearson
8. P K Ghosh- Principles of Electrical Communications- University Press
9. S Sharma, Analog Communication Systems- Katson Books Millman & Halkias,
10. B.P. Lathi and Z. Ding, Modern Digital and Analog Communication Systems,
11. Georgi G. Grashew, Stefan rakowsky, Telemedicine Techniques and Applications, In Tech, 1<sup>st</sup> edition, 2011.
12. Halit Eren, John G Webster, The E-Medicine, E-Health, Telemedicine, and Telehealth Handbook, CRC Press, 1<sup>st</sup> edition, 2015

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<b>Name of the Course</b>	<b>MICROPROCEESOR &amp; MICROCONTROLLER</b>
<b>Course Code: OE-EI501</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To introduce the architecture and organization of typical microprocessors and microcontroller.
2	To develop assembly language programming skill of microprocessor and microcontroller along with applications.
3	To familiarize the technique for interfacing memory and peripheral devices to microprocessor, including several specific standard I/O devices.
4	To understand the hardware/software trade-offs involved in the design of microprocessor based systems.
<b>Pre-Requisite:</b> Digital Electronics and Integrated Circuits (ESEC401)	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>8085 Processor:</b> Architecture, pin description, functional building blocks of processor, memory organization and interfacing, I/O ports and data transfer concepts, timing diagram, interrupts.	8
2	<b>Programming of 8085 Processor:</b> Instruction, format and addressing modes, assembly language format, data transfer, data manipulation and control instructions, programming: Loop structure with counting and indexing, Look up table, subroutine instructions, stack.	10
3	<b>8051 Micro Controller:</b> Architecture, pin description, functional building blocks of processor, memory organization and interfacing, I/O ports and data transfer concepts, timing diagram, interrupts.	6
4	<b>Peripheral Interfacing:</b> Architecture, configuration and interfacing with ICs: 8255, 8254, 8251, A/D and D/A converters and interfacing with 8085.	6
5	<b>Micro Controller Programming &amp; Applications:</b> Data transfer, manipulation, control algorithms and I/O instructions, simple programming exercises key board and display interface.	4
6	<b>Architecture of Typical 16-Bit Microprocessors (Intel 8086):</b> Introduction to a 16 bit microprocessor, architecture and register organization, memory address space and data organization.	6

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Construct and analyze assemble language program in 8085 and 8086 microprocessor to solve various complex engineering problem.
2. Evaluate processing time of program and devise technique to reduce execution time to improve microprocessor performance.
3. Design interfacing circuits to the microprocessor to communicate with external devices, which can be associated with public safety, health, security and other societal and environmental concerns.

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4. Design memory devices using memory chips and utilize the knowledge in memory based devices used in academics and industry.
5. Design and implement 8051 microcontroller based system for using it in real life applications.
6. Compare memory mapped I/O and peripheral mapped I/O and their interfacing procedure and also compare microprocessor with microcontroller.

### **Text/Reference Books:**

1. Ramesh S. Gaonkar, "Microprocessor Architecture, Programming and Applications with the 8085A /8080A", Wiley Eastern Ltd.
2. Mazidi, Mazidi, McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011.
3. A.H. Mukhopadhyay, "Microprocessor, Microcomputer and Their Applications", 3rd Edition Alpha Science International Ltd.
4. Soumitra Kumar Mandal, "Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085, 8086, 8051", McGraw Hill Edu, 2013.
5. M. Rafiquzzman: Microprocessors: Theory & Applications (Intel & Motorola), PHI.
6. Berry .B. Bray INTEL 8086/88, 80186, 286, 386, 486, Pentium Pro & Pentium IV.

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<b>Name of the Course</b>	<b>VLSI &amp; EMBEDDED SYSTEM</b>
<b>Course Code: OE-EI502</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To study the fundamental concept and structures of MOS transistor and designing VLSI circuits.
2	To understand the different combinational circuit design, sequential MOS logic gates and CMOS dynamic logic circuits including their transient analysis, design steps and behavior.
3	To study of various semiconductor memory like ROM, RAM with input/output circuits.
4	To develop strong fundamental knowledge on embedded system and RTOS fields.
<b>Pre-Requisite:</b> Analog Electronics Circuits (ESEC301), Digital Electronics & Integrated Circuits (ESEC401)	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to MOSFETs &amp; MOS Inverter:</b> MOS-transistor structure, operation, characteristics, VLSI design flow and design hierarchy, brief overview of circuit design techniques (hierarchical design, design abstraction, and computer aided design), simple inverter structure, VTC, critical voltages, different types of inverter, noise margin.	4
2	<b>CMOS Combinational &amp; Sequential Logic Circuits:</b> Basic gates, adder, CMOS transmission gates, simple circuits design with CMOS transmission gate, SR Latch, JK Latch, D latch, edge triggered Flip-flops, switching, short circuit and leakage power dissipation, variable threshold CMOS circuits, multiple threshold CMOS circuits, pipelining and parallel processing approach, switching activity estimation and optimization, adiabatic logic circuits.	10
3	<b>Dynamic Logic Circuits &amp; Subsystem Design:</b> Basics of dynamic logic circuits pre-charge and evaluate logic, cascading problem, domino logic, single bit adder, serial-parallel multiplier, RAM, ROM, SRAM, and DRAM.	8
4	<b>Introduction to Embedded Systems:</b> Definition, difference between embedded system and general computing systems, importance of embedded systems, hardware architecture of the real-time systems, different hardware units and processor overview for embedded systems.	4
5	<b>Programming Concepts for Embedded systems:</b> ALP and high level language, macros, functions, data types, data structures, modifiers, statements, loops, pointers queue, stack, lists and ordered lists, compilers and cross compilers.	4
6	<b>Real Time Operating Systems :</b> Operating system basics, tasks, process and threads, multiprocessing and multitasking, task communication, task synchronization, multiple tasks scheduling in real-time systems by RTOS	10

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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Describe MOS transistor structure and operation and write current-voltage equations for nMOS & pMOS.
2. Explain the operation of CMOS combinational and sequential circuits.
3. Solve the problem of static and dynamic circuit design with CMOS.
4. Generate different subsystems using MOS circuits.
5. State the basic programming concepts for embedded systems.
6. Explain the basic OS fundamentals and the RTOS for embedded systems.

**Text/Reference Books:**

1. Neil H. Weste, Kim Haase, David Harris, A. Banerjee, "CMOS VLSI Design: A Circuits & Systems Perspective", Pearson Education.
2. Wayne Wolf, "Modern VLSI Design – System-on-chip Design", Prentice Hall India/Pearson Education.
3. Sung-Mo Kang & Yusuf Leblebici, "CMOS Digital Integrated Circuits, Analysis & Design", Tata McGraw-Hill Edition.
4. K.V. Shibu, "Introduction to Embedded System", Tata McGraw-Hill.
5. F. Vahid, "Embedded System Design - A unified hardware and software introduction", John Wiley.
6. F. Vahid, "Embedded Systems", Tata McGraw-Hill.

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<b>Name of the Course</b>	<b>DATA STRUCTURE &amp; ALGORITHM</b>
<b>Course Code: OE-CS501</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To impart the basic concepts of data structures and algorithms.
2	To understand concepts about searching and sorting techniques
3	To understand basic concepts about stacks, queues, lists, trees and graphs.
4	To enable them to write algorithms for solving problems with the help of fundamental data structures
<b>Pre-Requisite:</b> Mathematics (M101 & M201), Basic Computation and Principles of C (CS 201)	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction:</b> Basic Terminologies: Elementary Data Organizations, Data Structure operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Techniques and their complexity analysis.	6
2	<b>Stacks &amp; Queues:</b> ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT Queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each type of Queues: Algorithms and their analysis.	8
3	<b>Linked Lists:</b> Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.	8
4	<b>Trees:</b> Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.	6
5	<b>Sorting, Hashing &amp; Graphs:</b> Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing. Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.	12

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Select and apply appropriate data structure and algorithmic methods in solving problem.
2. Analyze algorithms to determine the time complexity and justify the correctness.
3. Write algorithms and compare their performance in terms of space and time complexity.

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4. Implement the computational efficiency of the principal algorithms for sorting, searching, and hashing.
5. Design and implement programs for manipulating stacks, queues, linked lists, trees, and graphs.
6. Compare and contrast the benefits of dynamic and static data structures implementations.

**Text/Reference Books:**

1. R.S. Salaria, "Data Structures and Algorithms Using C", Khanna Publishing House.
2. Ellis Horowitz, Sartaj Sahni, "Fundamentals of Data Structures", Illustrated Edition, Computer Science Press.
3. Robert L. Kruse, Bruce P. Leung, "Data Structures and Program Design In C", 2/E.
4. Ellis Horowitz, Sartaj Sahni, Susan Anderson "Fundamentals of Data Structures of C"
5. Aaron M. Tenenbaum, "Data Structures in C".
6. S. Lipschutz, "Data Structures".
7. Reema Thareja, "Data Structures Using C".
8. A.K. Rath, A. K. Jagadev, "Data Structure Using C", 2/e.
9. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, "Introduction to Algorithms".
10. R.B. Patel, "Expert Data Structures With C", Khanna Publishing House.

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<b>Name of the Course</b>	<b>DATA BASE MANAGEMENT SYSTEM</b>
<b>Course Code: OE-CS502</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand the different issues involved in the design and implementation of a database system.
2	To study the physical and logical database designs, database modeling, relational, hierarchical, and network models.
3	To understand and use data manipulation language to query, update, and manage a database.
4	To develop an understanding of essential DBMS concepts such as: database security, integrity, concurrency, distributed database, intelligent database, client/server and data warehousing.
5	To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.
<b>Pre-Requisite:</b> Mathematics (M101 & M201), Basic Computation and Principles of C (CS 201)	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Database system architecture:</b> Data Abstraction, Data Independence, Data Definition Language (DDL), Data Manipulation Language (DML). <b>Data models:</b> Entity-relationship model, network model, relational and object oriented data models, integrity constraints, data manipulation operations.	7
2	<b>Relational query languages:</b> Relational algebra, Tuple and domain relational calculus, SQL3, DDL and DML constructs, Open source and Commercial DBMS - MYSQL, ORACLE, DB2, SQLserver. <b>Relational database design:</b> Domain and data dependency, Armstrong's axioms, Normal forms, Dependency preservation, Lossless design. <b>Query processing and optimization:</b> Evaluation of relational algebra expressions, Query equivalence, Join strategies, Query optimization algorithms.	13
3	<b>Storage strategies:</b> Indices, B-trees, hashing.	4
4	<b>Transaction processing:</b> Concurrency control, ACID property, Serializability of scheduling, Locking and timestamp based schedulers, Multi-version and optimistic Concurrency Control schemes, Database recovery.	7
5	<b>Database Security:</b> Authentication, Authorization and access control, DAC, MAC and RBAC models, Intrusion detection, SQL injection.	5
6	<b>Advanced topics:</b> Object oriented and object relational databases, Logical databases, Web databases, Distributed databases, Data warehousing and data mining.	4

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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Write relational algebra expressions and optimize the developed expressions for a given query.
2. Design the databases using E-R method and normalization for a given specification of the requirement.
3. Construct the SQL queries for open source and commercial DBMS -MySQL, ORACLE, and DB2 for a given specification.
4. Optimize its execution using query optimization algorithms for a given query.
5. Determine the transaction atomicity, consistency, isolation, and durability for a given transaction-processing system.
6. Implement the isolation property, including locking, time stamping based on concurrency control and serializability of scheduling.

**Text/Reference Books:**

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts" 6<sup>th</sup> Edition, McGraw-Hill.
2. J. D. Ullman, "Principles of Database and Knowledge-Base Systems", Vol-1, Computer Science Press.
3. R. Elmasri and S. Navathe, "Fundamentals of Database Systems", 5<sup>th</sup> Edition, Pearson Education.
4. Serge Abiteboul, Richard Hull, Victor Vianu, "Foundations of Databases", Reprint Addison-Wesley.
5. R.P. Mahapatra, "Database Management Systems", Khanna Publishing House, New Delhi (AICTE Recommended Textbook-2018)
6. Martin James, "Principles of Database Management Systems", PHI.
7. A.K. Majumder, Pritimay Bhattacharjya, "Database Management Systems", Tata McGraw Hill.
8. Salaria, "Database Management Systems", Khanna Publishing House.

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<b>Name of the Course</b>	<b>ENVIRONMENTAL SCIENCE &amp; SAFETY</b>
<b>Course Code: MC-ES501</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 2-0-0-0</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To study the interrelationship between living organism and environment.
2	To study the integrated themes and biodiversity, natural resources, pollution control and waste management.
3	To find out and implement scientific and technological solutions to environmental problems.
4	To pursue life-long learning to effectively practice within a rapidly evolving, continually changing and increasingly diverse global environment.
<b>Pre-Requisite:</b> Basic Knowledge on Biology and Management	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to Environmental Science:</b> Ecological concepts: biotic and abiotic components, ecosystem process: producers, consumers and decomposers, energy flow, food chains, water cycle, oxygen cycle, nitrogen cycle, biodiversity: genetic, species and ecosystem diversity, environmental gradients, Indian environmental law, chemistry in environmental engineering: atmospheric chemistry and soil chemistry, water quality standards and parameters, ground water, water conservation, rain water harvesting, renewable and non-renewable energy sources, use of alternate energy sources, different types of energy.	8
2	<b>Waste Management &amp; Pollution Control:</b> Solid Waste Management: Source classification and composition of MSW, separation, storage and transportation, reuse and recycling, waste minimization techniques, hazardous waste and their generation, hazardous waste management, transportation and treatment, incinerators, inorganic waste treatment, E.I.A., environmental audit.  Waste Water Treatment: COD and BOD in wastewater, pretreatment, primary and secondary treatment of waste water, activated sludge treatment-anaerobic digestion, reactor configurations and methane production.  Noise & Air Pollution: Noise pollution, noise standards, measurement and control, air pollution and pollutants, acid deposition, greenhouse gases and global warming, ozone layer depletion, air pollution meteorology, atmospheric dispersion, industrial air emission control, flue gas desulphurization, NOx removal, fugitive emissions.	12
3	<b>Safety Management:</b> Occupational safety and health acts, safety procedures, type of accidents, chemical and heat burns, prevention of accidents involving hazardous substances, human error and hazard analysis, hazard control measures, fire prevention and detection, extinguishing fire, electrical safety, product safety, safety management, handling and storage of hazardous materials, corrosive substances, gas cylinders, hydrocarbons and wastes, personal protective equipment.	6

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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
2. Assess and demonstrate the importance of interdisciplinary nature of environmental and health risk assessment.
3. Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
4. Identify the major pollutants and devices for environmental management and sustainable development.
5. Make aware of professional development, life-long learning, and current global and contemporary issues in environmental and safety assessment.
6. Make aware of professionalism, ethics, and environmental laws and regulations.

**Text/Reference Books:**

1. M.P. Poonia & S.C. Sharma, Environmental Studies, Khanna Publishing House.
2. M.P. Poonia & S.C. Sharma, Environmental Engineering, Khanna Publishing House.
3. G. Kiely, "Environmental Engineering", Irwin/McGraw Hill International Edition, 1997.
4. Prof B.K. Mohapatra, "Environmental Engineering", DhanpatRai & Co Publication.
5. L. M. Deshmukh, "Industrial Safety Management", Tata McGraw Hill Publication.
6. Arcadio P. Sincero, Gergoria A. Sincero, "Environmental Engineering", PHI Publication.
7. M. L. Davis, S. J. Masen, "Principles of Environmental Engineering and Science", McGraw Hill International Edition, 2004.
8. Curringham & Saigo, "Environmental Science", TMH.
9. Dash & Mishra, "Man and Environment".
10. Gilbert M. Masters & Wendell P. Ela, "An Introduction to Environmental Engineering and Science", PHI Publication.
11. Colling. D A, "Industrial Safety Management and Technology", Prentice Hall, New Delhi.

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<b>Name of the Course</b>	<b>MEDICAL EQUIPMENTS AND SIMULATION LABORATORY</b>
<b>Course Code: PC-BME591</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To get familiar with the various types of biomedical analytical and diagnostic equipment and their operation.
2	To understand the fundamental principles and utilization of different biomedical analytical devices.
3	To study therapeutic equipment using trainer kits and simulated devices.
4	To emphasize on the maintenance of various biomedical instruments.

**LIST OF EXPERIMENTS:**

1. Study on colorimeter
2. Study on spectrophotometer
3. Study on flame photometer / infusion pump
4. Study on galvanic skin resistance
5. Study on blood flow velocity measurement - ultrasonic method
6. Study on pulse oximeter
7. Study on pulmonary function analyzer-spirometer
8. Study on EMG-muscle Threshold (Fatigue, Twitch, Summation, Incomplete & complete Tetanus)
9. Study on Pacemaker Circuits / Pacemaker simulator
10. Study on simulated DC defibrillator / X-ray simulator
11. Study on ECG simulator and servicing of ECG machine
12. Study on muscle stimulator and EMG biofeedback system

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the working principle of different analytical and therapeutic devices.
2. Make measurement, interpret the data and produce report technically.
3. Evaluate the performance and carry out the periodic maintenance.
4. Test and calibrate the equipment at par with standard protocol.

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<b>Name of the Course</b>	<b>MEDICAL INSTRUMENTS &amp; SYSTEM LABORATORY</b>
<b>Course Code: PC-BME592</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To familiarize with the operation of various medical instruments and physiological parameter monitoring system.
2	To understand the monitoring principles and applications of different biomedical instruments and system.
3	To emphasize the maintenance and calibration of various biomedical instruments.

**LIST OF EXPERIMENTS:**

1. Study on electronic BP and BP calibration
2. Study on respiratory rate meter & apnea detection
3. Study on ECG heart rate monitoring system
4. Study on peripheral pulse rate monitoring system
5. Study on digital body/skin temperature monitoring system
6. Study on multi-parameter monitoring system
7. Spectral analysis of biopotentials -Physiograph
8. Study on cardiac stress analysis
9. Study on US Doppler / Foetal monitor / US diathermy
10. Study on hearing aid and audiometer: air and bone conduction
11. Study on nerve conduction velocity measuring system
12. Study on ultrasonic devices-transmitter and detector/bio-telemetry system

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the operation of versatile medical instruments and monitoring of medical parameters.
2. Make measurement, interpret the data and produce report for clinical purposes.
3. Select suitable monitoring instruments and evaluate the performance.
4. Plan and carry out maintenance and calibration of medical instruments.

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<b>Name of the Course</b>	<b>MICROPROCESOR &amp; MICROCONTROLLER LABORATORY</b>
<b>Course Code: OE-EI591</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To study programming based on 8086 microprocessor and 8051 microcontroller.
2	To expose students to the operation of typical microprocessor (8085) trainer kit.
3	To learn the design aspects of I/O and memory interfacing circuits.
4	To prepare the students to be able to solve different problems by developing different programs

**LIST OF EXPERIMENTS:**

1. Familiarization with 8085 & 8051 simulator on PC.
2. Study of prewritten programs using basic instruction set (data transfer, Load/Store, Arithmetic, Logical) on the KIT. Assignments based on above
3. Programming using kit and simulator for:
  - i) Table look up
  - ii) Copying a block of memory
  - iii) Shifting a block of memory
  - iv) Packing and unpacking of BCD numbers
  - v) Addition of BCD numbers
  - vi) Binary to ASCII conversion
  - vii) String Matching, Multiplication using shift and add method and Booth's Algorithm
4. Program using subroutine calls and IN/OUT instructions using 8255 PPI on the trainer kit e.g. subroutine for delay, reading switch state and glowing LEDs accordingly.
5. Study of timing diagram of an instruction on oscilloscope.
6. Interfacing of 8255: Keyboard and Multi-digit Display with multiplexing using 8255
7. Study of 8051 Micro controller kit and writing programs as mentioned in S/L3. Write programs to interface of Keyboard, DAC and ADC using the kit.
8. Serial communication between two trainer kits.

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Construct and apply the assembly level programming of microprocessor and microcontroller.
2. Develop the programming logic and concept with the help of algorithm or flowchart.
3. Troubleshoot assembly language program along with interactions between software and hardware.
4. Practice the interfacing of microprocessor with peripheral devices for various applications.

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<b>Name of the Course</b>	<b>VLSI &amp; EMBEDDED SYSTEM LABORATORY</b>
<b>Course Code: OE-EI592</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To provide an introduction to the characteristics of digital logic and the design, construction, testing and debugging of simple digital circuits.
2	To provide an introduction to the development of application using microcontrollers.
3	To learn the concepts and architecture of embedded systems.
4	To learn different design platforms used for an embedded systems application.

**LIST OF EXPERIMENTS:**

1. Design and simulation of CMOS AND, NAND, NOR gates by static CMOS design.
2. Design and simulation of 1-bit full adder and subtractor.
3. Design and simulation of single stage dynamic circuit (precharge and evaluate).
4. Design and simulation of a ROM circuit.
5. Design and Simulate SR, JK Latch and Flipflop.
6. Basics of Arduino Board and different board component identification.
7. Write a code to perform switching activity by Arduino.
8. Write a code to perform serial communication between Arduino and Host PC.
9. Write a code to read sensor data and visualization of the data.
10. Write code to interface Arduino with relay with condition.

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Generate any CMOS based circuit static as well as dynamic and simulate.
2. Analyze transient and VTC response of different CMOS logic gates.
3. Evaluate the DRC and LVS of layout of different CMOS circuits.
4. Write embedded code for communication, display data and interfacing.

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<b>Course Code: OE-CS591</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To know the concept of linear data structure like array along with its applications for solving various mathematical problems concerned with different topics like the operations of matrices.
2	To be acquainted with the concept of linked list with its classification and the relevance of the usage of such concepts according to the nature of the problems.
3	To be aware with various algorithms applied for searching and sorting purposes with the differences regarding their working principles.
4	To understand the significance of non-linear data structures by the implementations of operations done by binary search tree and also find the importance of hashing in case of any searching problems.

**LIST OF EXPERIMENTS:**

1. Implementation of array operations.
2. Stacks and Queues: adding, deleting elements Circular Queue: Adding & deleting elements.
3. Merging Problem : Evaluation of expressions operations on Multiple stacks & queues.
4. Implementation of linked lists: inserting, deleting, and inverting a linked list.  
Implementation of stacks & queues using linked lists.
5. Polynomial addition, Polynomial multiplication.
6. Sparse Matrices: Multiplication, addition.
7. Recursive and Non-recursive traversal of Trees.
8. Threaded binary tree traversal. AVL tree implementation.
9. Application of Trees. Application of sorting and searching algorithms.
10. Hash tables implementation: searching, inserting and deleting, searching & sorting techniques.

Any experiment specially designed by the college

(Detailed instructions for Laboratory Manual to be followed for further guidance)

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Implement concepts of linear and non-linear data structures.
2. Analyze the concepts of static and dynamic data structure algorithms.
3. Apply different sorting and searching algorithms.
4. Evaluate time complexity of different data structure algorithms.
5. Create data structure and algorithm for real world applications.

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<b>Name of the Course</b>	<b>DATA BASE MANAGEMENT SYSTEM LABORATORY</b>
<b>Course Code: OE-CS592</b>	<b>Semester: Fifth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To provide a strong formal foundation in database concepts, technology and practice.
2	To give a good formal foundation on the relational model of data and to present PL/SQL and procedural interfaces to PL/SQL comprehensively.
3	To familiarize with PL/SQL for database creation, manipulation and control.

**LIST OF EXPERIMENTS:**

Structured Query Language

1. Creating Database:

- Creating a Database
- Creating a Table
- Specifying Relational Data Types
- Specifying Constraints
- Creating Indexes

2. Table and Record Handling:

- INSERT statement
- Using SELECT and INSERT together
- DELETE, UPDATE, TRUNCATE statements
- DROP, ALTER statements

3. Retrieving Data from a Database

- The SELECT statement
- Using the WHERE clause
- Using Logical Operators in the WHERE clause
- Using IN, BETWEEN, LIKE , ORDER BY, GROUP BY& HAVING clause
- Using Aggregate Functions
- Combining Tables Using JOINS
- Subqueries

4. Database Management

- Creating Views
- Creating Column Aliases
- Creating Database Users
- Using GRANT and REVOKE

**Cursors in Oracle PL / SQL**

**Writing Oracle PL / SQL Stored Procedures**

Any experiment specially designed by the college

(Detailed instructions for Laboratory Manual to be followed for further guidance)

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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Design and implement a database schema for given problem.
2. Populate and query a database using SQL DML/DDL commands.
3. Programming PL/SQL including stored procedures, stored functions, cursors, packages.
4. Design and build a GUI application using a 4GL.

**Special Remarks:**

The above mentioned outcomes are not limited. Institute may redefine course outcomes based on their Program Educational Objectives (PEOs).

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**SEMESTER-VI**

<b>Name of the Course</b>	<b>BIOMEDICAL DIGITAL SIGNAL PROCESSING</b>
<b>Course Code: PC-BME601</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To impart knowledge about filter characteristics and to design various digital filters.
2	To develop competency for transforming discrete signals and systems from time domain to frequency domain.
3	To build the required base for developing algorithms for signal processing systems.
4	To understand the fundamental techniques and applications of digital signal processing for biomedical signals.
5	To provide an in-depth knowledge about the basic concepts of wavelet and speech analysis.
<b>Pre-Requisite:</b> Signals & Systems in Biomedical Engineering (PCBME301), Digital Electronics & Integrated Circuits (ESEC401), Biomedical Instrumentation (PCBME402)	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction:</b> Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, simple signal conversion systems, frequency domain representation, spectral analysis, cepstral analysis, linear filtering, adaptive filters-general structure, LMS adaptive filter, noise cancellation, feature extraction and pattern recognition.	7
2	<b>Digital Filters Realizations:</b> Characteristics of practical frequency selective filters, analog filter approximations-Butterworth and Chebychev filters, design of IIR filters from analog filters (LPF, HPF, BPF, BRF)- impulse invariance method, bilinear transformation, spectral transformation, characteristics of FIR filters, symmetric and anti-symmetric FIR filters, design of FIR filters using windowing techniques-rectangular, Hamming and Hanning window, comparison of FIR and IIR filters.	12
3	<b>Cardiological &amp; Electromuscular Signal Processing:</b> ECG signal processing, P-wave detection, QRS complex detection, rhythm analysis, arrhythmia detection algorithms, automated ECG analysis, ECG pattern recognition, analysis of heart rate variability, EMG signal processing, rectification and averaging.	8
4	<b>Neurological Signal Processing:</b> EEG signals processing, EEG analysis-time frequency domain method, linear prediction theory and autoregressive (AR) method, detection of spikes and spindles, detection of alpha, beta and gamma waves, least squares and polynomial modeling-Markov model and Markov chain, dynamics of sleep-wake transition, hypnogram model parameters, analysis of evoked potential.	8
5	<b>Data Compression &amp; Wavelet:</b> Data reduction algorithms-TP, AZTEC, and CORTES, special example to ECG signal, introduction to wavelets, time frequency representation, discrete wavelet transform, pyramid algorithm, speech analysis.	5

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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Apply DFT for the analysis of digital signals and systems.
2. Implement algorithms based on discrete time signals.
3. Apply appropriate signal processing techniques in analyzing various bio-signals.
4. Design IIR and FIR filters for bio-signal processing.
5. Explain and employ sampling and quantization procedures for digitally recording physiological data.
6. Develop measurement systems for bio-signals and its signal conditioning circuits.

**Text/Reference Books:**

1. D.C.Reddy, "Biomedical signal processing-Principles and Technique", Tata McGraw-Hill.
2. Wills J.Tompkins, "Biomedical digital signal processing", PHI Pvt.Ltd.
3. L.R.Rabiner, B.Gold, "Theory and application of Digital Signal Processing".
4. S.K.Mitra, "Digital Signal Processing: A computer based approach", TMH.
5. J.G.Proakis, D.G.Manolakis,  
"Digital Signal Processing: Principles, Algorithm and Applications", PHI/Pearson Education.
6. S.Salivahanan et al, "Digital Signal Processing", TMH.
7. Oppenheim, Ronald W Schafer, "Digital Signal Processing", Prentice Hall India.
8. Andreas Antoniou, "Digital Filters Analysis & Design", Prentice Hall India.
9. Rabiner, B. Gold, "Theory & Application of Digital Signal processing", PHI.

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<b>Name of the Course</b>	<b>BIOMATERIALS &amp; TISSUE ENGINEERING</b>
<b>Course Code: PC-BME602</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 3-1-0-4</b>	<b>Contact: 4 hrs/week</b>
<b>Objectives:</b>	
1	To study the physical and mechanical properties of different types of biomaterials and various factors that influence failure of implants.
2	To learn the significance of biocompatibility and acquaint with different toxicological screening tests and methods for sterilization of implantable biomaterials.
3	To understand the principles of tissue engineering and clinical requirement for tissue engineering systems.
4	To know about scaffold, biomimetic scaffold preparation and its application in engineered tissue.
<b>Pre-Requisite:</b> Engineering Physiology & Anatomy (PCBME301), Biophysics & Biochemistry (PCBME303), Basic Knowledge on Material Science and Mechanics	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Characterization &amp; Properties of Biomaterials:</b> Introduction to biomaterials, criteria for biomaterials, classification of biomaterials, selection and performance of biomaterials, biological responses, surface and physical properties, mechanical properties-stress strain behavior and hardness, mechanical failures, electrical, optical and magnetic properties.	6
2	<b>Metallic &amp; Ceramic Biomaterials:</b> Metallic biomaterials: stainless steels, Co-Cr alloys and Ti alloys, properties of metal: corrosion and cracking, applications of metallic biomaterials, definition of bioceramics, non-absorbable materials: alumina, carbons and zirconia, biodegradable ceramics: calcium phosphate and aluminum-calcium-phosphate (ALCAP) ceramics, bioactive ceramics: glass ceramics and hydroxyapatite, applications of bioceramics.	10
3	<b>Polymeric &amp; Composite Biomaterials:</b> Polymeric biomaterials: polyethylene (PE), polypropylene (PP), polyvinylchloride (PVC), polyamide (Nylon), polytetrafluoroethylene (PTFE), polymethylmethacrylate (PMMA), polyetherether ketone (PEEK), silicone rubber and hydrogels, biodegradable polymers, applications of polymers in medical field, definition of composites, properties and types of composites, composite theory of fiber reinforcement, polymers filled with osteogenic fillers, medical applications.	10
4	<b>Biocompatibility &amp; Sterilization of Biomaterials:</b> Introduction to biocompatibility, blood compatibility and tissue compatibility, toxicity screening tests of biomaterials: systemic toxicity, haemolysis, cytotoxicity and special tests, sterilization of implantable biomaterials, sterilization techniques: autoclaving, ETO and gamma radiation, effects of sterilization on material properties.	8
5	<b>Introduction to Tissue Engineering:</b> Definition, current scope of development, engineering wound healing and sequence of events, cells as therapeutic agents, different cell types, cell differentiation and cell migration, extracellular matrix (ECM), cell-matrix and cell-cell interactions, cell signaling molecules, growth factors, cell surface markers, cell separation, cell culture and storage, cell lines, fundamental of stem cell tissue engineering,	10

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	inflammatory and immune response to tissue engineered devices, tissue engineering applications.	
6	<p><b>Biomimetic Scaffolds &amp; Tissue Engineering Case Studies</b></p> <p>Natural scaffold materials, synthetic biomaterial scaffolds, scaffold fabrication and tailoring, cell substrates, cell incorporation, growth factor delivery, oxygen transport, diffusion, Michaelis-Menten kinetics, tissue morphogenesis and angiogenesis, bioreactors and cryopreservation, skin tissue engineering, vascular graft, liver tissue engineering, bone, muscle and nerve regeneration.</p>	8

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Classify and select biomaterials for hard and soft tissue replacement.
2. Characterize the complex host tissue-implant interaction and explain the probable causes of implant failure.
3. Analyze the design of various implants and improve the functionality.
4. Evaluate the biocompatibility and toxicological screening of biomaterials.
5. Explain the significance, current status and future potential of tissue engineering.
6. Demonstrate the design, fabrication and biomaterials selection criteria for tissue engineering scaffolds.

**Text/Reference Books:**

1. JB Park, "Biomaterials-Science and Engineering", Plenum Press, 1984.
2. Sujata V. Bhat, "Biomaterials", Narosa Publishing House, 2002.
3. Bronzino JD, "The Biomedical Engineering Handbook", 2nd ed. Vol-II, CRC Press
4. Jonathan Black, "Biological Performance of materials", Marcel Decker, 1981
5. C.P. Sharma, M. Szycher, "Blood compatible materials and devices", Tech. Pub. Co. Ltd., 1991.
6. Piskin, A.S. Hoffmann, "Polymeric Biomaterials", Martinus Nijhoff Publishers.
7. Buddy D. Ratner, Allan S. Hoffman, "Biomaterial Sciences-Introduction to Materials in Medicine"
8. Frederick H. Silver, "Biomaterials, Medical devices and Tissue Engineering", Chapman & Hall
9. Bernhard O. Palsson, Sangeeta N. Bhatia, "Tissue Engineering", Pearson Prentice Hall Bioengineering.
10. Cato T. Laurencin, Lakshmi S. Nair, "Nanotechnology and Tissue engineering - The Scaffold", CRC Press.

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<b>Name of the Course</b>	<b>BIOMECHANICS &amp; IMPLANTS</b>
<b>Course Code: PC-BME603</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand the fundamentals of mechanics and its application in human system.
2	To know the flow properties of blood, various properties of hard and soft tissues.
3	To study the deformability, strength, viscoelasticity of bone and flexible tissues, modes of loading and failure.
4	To learn the mechanics of orthopedic implants and joint replacement, artificial heart valve, mechanical properties of cardiovascular system, etc.
<b>Pre-Requisite:</b> Physics-1 (PH201), Engineering Mechanics & Fluid Mechanics (ME201), Engineering Physiology & Anatomy (PCBME302).	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to Engineering Mechanics:</b> Free-body diagrams and equilibrium, trusses and frames, virtual work, kinematics and dynamics of particles and of rigid bodies in plane motion, impulse and momentum (linear and angular) energy formulations, collisions.	6
2	<b>Hard Tissues Mechanics:</b> Definition of stress and strain, deformation mechanics, bone and its composition, mechanical and electrical properties of bones, cortical and cancellous bones, viscoelasticity, Maxwell and Voigt models-anisotropy, fatigue analysis, biomechanics of fracture healing, electrical stimulation for bone healing, external and internal fixation, intramedullary nails, plates, screws.	10
3	<b>Biomechanics of Joints &amp; Locomotion:</b> Skeletal joints, forces and stresses in human joints, types of joints, biomechanical analysis of joints, kinetics and kinematics of joints, human locomotion, gait analysis and goniometry, ergonomics, foot pressure measurements.	6
4	<b>Soft Tissues &amp; Bio-Fluid Mechanics:</b> Structure and functions of soft tissues, materials properties and modeling of soft tissues-cartilage, tendon and ligament, muscle-Hodgkin-Huxley Model, flow properties of blood, dynamics of fluid flow in the intact human cardiovascular system-modeling and experimental approaches, pulse wave velocities in arteries, measurement of in-vivo elasticity of blood vessels.	10
5	<b>Implants &amp; Prostheses:</b> General concepts of implants, classification of implants, basic considerations and limitations, body response to implants, dental implants, ear and eye implants, prostheses: total hip joint, knee joint, shoulder joint, small joints, cardiovascular implants: prosthetic heart valves, biological & mechanical valves, different heart valve prosthesis.	8

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Apply knowledge of biomechanics to analyze the properties of biofluid, hard and soft tissues and identify the appropriate model to demonstrate mechanical behavior.

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2. Analyze the biomechanics of different human joints and also forces for various static and dynamic human activities.
3. Demonstrate a detailed understanding of the design requirements of medical implants based on the human anatomy and biological responses to biomaterials.
4. Interpret and explain the mode of operation of different artificial implants and its medical applications.
5. Interpret technically to the quest of biomechanical team and formulate design specification.
6. Perform a systematic qualitative biomechanical analysis of human movement activities or skills in sport, exercise, rehabilitation, work, and daily living.

### **Text/Reference Books:**

1. Alexander R Mc Neill, "Biomechanics", Chapman and Hall, 1975
2. D. Dawson, V. Wright, "Introduction to Biomechanics of joints and joint replacement"
3. D N Ghista, "Biomechanics of Medical Devices", Macel Dekker, 1982
4. D.O. Cooney, "Biomedical Engineering Principles", Macel Dekker, INC, New York
5. A.Z. Tohen, C.T. Thomas, "Manual of Mechanical Orthopaedics".
6. D.N. Ghista, Roaf, "Orthopaedic Mechanics", Academic Press
7. V.C. Mow, W.C. Hayes, "Basic Orthopedic Biomechanics", Lippincott, Raven publishers.

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<b>Name of the Course</b>	<b>ADVANCED MEDICAL IMAGING TECHNIQUES</b>
<b>Course Code: PC-BME604</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To impart the versatile advanced imaging techniques and related modalities in healthcare system.
2	To develop a comprehensive understanding of the functionality and specific applications of advanced medical imaging systems.
3	To understand the fundamental principle and working of the advanced medical imaging systems involved in the diagnosis of healthcare.
4	To know the advanced instruments and latest techniques used for visualizing various sections of the body.
<b>Pre-Requisite:</b> Engineering Physiology & Anatomy (PCBME302), Biophysics & Biochemistry (PCBME303), Biomedical Instrumentation (PCBME402), Medical Imaging Techniques (PCBME502)	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Computed Tomography:</b> Introduction, principles of computed tomography, CT generations, scanning system, detectors in CT, data acquisition system and processing, storing and viewing system, gantry geometry, different information from gantry, Hounsfield and CT numbers, image reconstruction techniques: back projection, iterative and analytical methods, image quality and artifacts, Dose in CT, Spiral CT, multi-slice CT, 3D imaging and its application.	10
2	<b>Magnetic Resonance Imaging System:</b> Introduction, fundamentals of magnetic resonance, interaction of nuclei with static magnetic field and radio frequency wave, rotation and precession, induction of magnetic resonance signals, bulk magnetization, relaxation process-T1 and T2, gradient pulse, slice selection, phase encoding, frequency encoding, data acquisition and image reconstruction. MRI instrumentation: system magnet, gradient magnetic field coils, radio frequency coils (transmitter & receiver) and shim coils, diagnostic utility and clinical MRI, functional MRI (fMRI), magnetic resonance angiography (MRA), magnetic resonance spectroscopy (MRS), diffusion MRI, bio-effects and safety levels.	12
3	<b>Nuclear Medical Imaging System:</b> Introduction to emission tomography, physics of radioisotope imaging, Compton cameras for nuclear imaging, radio nuclides for imaging, nuclear decay and energy emissions, brief of radionuclide production, pulse height analyzer, uptake monitoring equipment, gamma camera principles, rectilinear scanners, single-photon emission computed tomography (SPECT), positron emission tomography (PET), scintigraphy, dual isotope imaging.	10
4	<b>Advanced Imaging Applications:</b> Clinical aspects of PET/CT and SPECT/CT, optical coherence tomography (OCT), perfusion CT, cone beam CT for radiotherapy, 3D-CRT, IMRT, IGRT, cyber knife, gamma knife, functional brain imaging, bone marrow scanning, CSF imaging, thyroid and parathyroid imaging, liver and spleen imaging, Cath Lab imaging system.	8

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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Explain the underlying physics and mode of operation of CT, MRI and SPECT-PET system.
2. Demonstrate the advanced imaging instruments and apply mathematical methods for image reconstruction.
3. Justify the utility of advanced imaging system and explain the principles of working.
4. Analyze and interpret the images for clinical purposes.
5. Compare and interpret the techniques used for visualizing various sections of the body.
6. Plan and minimize the risks and health hazards.

**Text/Reference Books:**

1. Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
2. R. S. Khandpur, "Handbook of Bio-Medical Instrumentation", Tata McGraw Hill.
3. J. Webster, "Bioinstrumentation", Wiley & Sons
4. Dowsett, Kenny & Johnston, "The Physics of Diagnostic Imaging", Chapman & Hall Medical, Madras/London.
5. Brown, Smallwood, Barber, Lawford & Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol.
6. Massey & Meredith, "Fundamental Physics of Radiology", John Wright & Sons.
7. S. Webb, "The Physics of Medical Imaging", Adam Hilger, Bristol.
8. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", Prentice-Hall of India, 2nd Edition, 1997.
9. Wolfgang Drexler James G. Fijimoto "Optical coherence tomography technology and applications", Springer, First edition, 2008
10. P Raghunathan, "Magnetic Resonance Imaging & Spectroscopy in Medicine- Concept and Techniques" Orient Longman Pvt. Ltd., 2006.

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<b>Name of the Course</b>	<b>ARTIFICIAL ORGANS &amp; REHABILITATION ENGINEERING</b>
<b>Course Code: PE-BME601</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To give abasic ideaof theartificialorgansthatcan aida human to live anormal life.
2	To acquaint the studentwith modern artificial organs, devices and methods used to partially support or completely replace pathological organs.
3	Tolearnthebasicconceptsofrehabilitationengineeringandtounderstandthe importanceofbiomedicalengineeringinrehabilitation.
4	To gainknowledgeoftherecent developmentsinthe fieldofrehabilitationengineering and get aware of how a helpcan be rendered to adifferently-abled person.
<b>Pre-Requisite:</b> Engineering Physiology & Anatomy (PCBME302), Biomaterials & Biomechanics, Biomedical Instrumentation (PCBME402).	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>IntroductiontoArtificialOrgans:</b> Needofartificialorgans,designconsiderationan devaluationprocess, problem associated with extra-corporeal devices,circulatory assist devices-IABP, cardiac catheterization, stents, CVP and SWAN catheters, artificialheart and engineering design,artificial blood-haemoglobin solutions and perfluorocarbon emulsions, liversupportsystem,artificialpancreas,artificialskin.	8
2	<b>Artificial Kidney:</b> Brief of kidney filtration, basic methods of artificial waste removal, hemodialysis, equation for artificial kidney, middle molecule hypothesis, artificial kidney machine (block diagram), hemodialyzers: flat plate, coil and hollow fiber, analysis of mass transfer in dialyzers (cross current flow), regeneration of dialysate, membrane configuration, wearable artificial kidney machine, electrical safety and maintenance.	8
3	<b>Artificial Heart-Lung Machine:</b> Brief of lungs gaseous exchange, artificial heart-lung devices, oxygenators: bubble, film oxygenators and membrane oxygenators, gas flow rate and area for membrane oxygenators.	4
4	<b>Introduction to Rehabilitation Engineering:</b> Impairments, disabilities and handicaps, measurement and assessment,engineering concepts in sensory and motor rehabilitation, rehabs for locomotion, visual and speech rehabilitation, spinal rehabilitation, rehabilitation in sports, robots in rehabilitation, role of biomedical engineering in rehabilitation.	6
5	<b>Orthotic &amp; Prosthetic Devices:</b> Anatomy of upper and lower extremities,types of amputation, orthotic and prosthetic materials,artificial limb and hands, intelligent prosthetics, externally powered and controlled orthotics and prosthetics, FES system-restoration of standing and walking, hybrid assistive system, myoelectric hand and arm prostheses, MARCUS intelligent hand prostheses.	8
6	<b>Hearing &amp; Mobility Aids:</b> Engineering concept in communication disorders, common tests-audiograms, air conduction, bone conduction andmasking, hearingaids-principles,types,drawbacksintheconventionalunit,DSPbasedhearingaids,	6

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	mobility aids-crutches, wheelchairs, laser cane, ultrasound torch and guide.	
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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Explain the structure and role of artificial organs and rehabilitation devices for sustaining functions.
2. Describe the expected functionalities of an artificial organ, orthotics and prosthesis.
3. Test and apply different types of hearing and mobility aids for the benefit of the society.
4. Identify available technology and recognize the user needs and benefits.
5. Prioritize in technological innovations for longer, healthier and more productive lives.
6. Design and develop various aids for physically challenged.

**Text/Reference Books:**

1. Bronzino. Joseph, "Hand book of biomedical engineering".
2. R.S.Khandpur, "Hand book of biomedical instrumentation".
3. Erie.D.Blom, Howard.B.Rotham, "Artificial Organs".
4. David O. Cooney, "Biomedical Engineering Principles" Vol-II, Marcel Dekker Inc.
5. Robinson C.J., Rehabilitation Engineering. CRC press 1995
6. Ballabio E. et al, "Rehabilitation Engineering". IOS press 1993.
7. Dr. S.Sundar, "Rehabilitation Medicine". Jaypee Medical Pub., New Delhi.
8. Kopff W.J, "Artificial Organs", John Wiley and sons, New York, 1976 (Unit II).

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<b>Name of the Course</b>	<b>LASER &amp; FIBER OPTICS IN MEDICINE</b>
<b>Course Code: PE-BME602</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand the fundamentals of different types of laser, its operations and applications in medical field.
2	To study about the principles and applications of laser and fiber optics in medical field especially in diagnosis and therapy.
<b>Pre-Requisite:</b> Physics-1 (PH201), Engineering Physiology & Anatomy (PCBME302),	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>LASER Fundamentals:</b> Characteristics of lasers, spontaneous and stimulated emission, Einstein's co-efficient, population inversion, three level and four level lasers, properties of laser, laser modes, resonator configuration, cavity damping, types of lasers: gas lasers, solid lasers, liquid lasers and semiconductor lasers.	8
2	<b>Lasers in Surgery:</b> Surgical instrumentation of CO <sub>2</sub> , Ruby, Nd-YAG, He-Ne, argon ion, Q-switched operations, continuous wave, quasi-continuous, surgical applications: removal of tumors of vocal cords, brain surgery, plastic surgery, gynaecology and oncology.	8
3	<b>Laser Specific Applications:</b> Lasers in tissue welding, lasers in dermatology, lasers in ophthalmology, laser photocoagulations, laser in dentistry, laser flow cytometry, laser transillumination and diaphanography, speckle interferometry, holography, application safety with biomedical Lasers.	8
4	<b>Optical Fibers Fundamentals:</b> Principles of light propagation through a fiber, different types of fibers and their properties, fiber characteristic, transmission of signal in SI and GI fibers, attenuation in optical fibers, connectors and splicers, fiber termination, optical sources, optical detectors.	8
5	<b>Optical Fiber Bundles &amp; Applications:</b> Introduction and construction details of optical fibers, non-ordered fiber optic bundles for light guides-fundamentals and principles, ordered fiber-optic bundles for imaging devices-fundamentals and principles, fiberscopes and endoscopes-fundamentals, fiber optic imaging systems-advances, optical fiber in communication.	8

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Explain the principle of laser action and the characteristics of laser.
2. Recognize and classify various types of laser and its mode of operation.
3. Relate various applications of lasers in medical field and apply appropriately.
4. Demonstrate the basic concepts of optical fibers and their properties.
5. Illustrate the construction, working principle and selection criteria of optical fiber cables.
6. Propose and integrate lasers and optical fibers for diagnostic, therapeutic and imaging purposes.

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**Text/Reference Books:**

1. Leon Goldman, “ The Biomedical laser Technology and ClinicalApplications  
“ Springer-Verlar
2. Leon Goldman, “ Lasers in Medicine”,Springer-Verlac
3. E.D.R.Pratesi, Sacchi, “Lasers in photomedicine and photo biology”,Springer-Verlay
4. BashtM.L.Wel,  
“Laserapplicationsinmedicineandbiology”, Voll,II,III,PlenumPress(1971&1974).
5. Nandini K. Jog, “Electronics in medicine and biomedical instrumentation”,PHI
6. J.U.Wilson, Hawkes J.F.B., “Opto Electronics: An Introduction”, Prentice Hall  
Int.1983
7. H.C.Allen,“AnIntroductiontoopticalfibers”,McGrawHill, NewYork,1983.

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<b>Name of the Course</b>	<b>IOT &amp; ARTIFICIAL INTELLIGENCE</b>
<b>Course Code: PE-BME603</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand IoT architectures and application areas of IoT.
2	To learn about various IOT-related protocols.
3	To build simple IoT systems using Arduino and Raspberry Pi.
4	To provide a strong foundation of fundamental concepts in Artificial Intelligence (AI).
5	To provide a basic exposition to the goals and methods of Artificial Intelligence.
<b>Pre-Requisite:</b> Basic Knowledge on Mathematics, Science and, Computer programming	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Fundamentals of IoT:</b> Evolution of Internet of Things, enabling technologies, IoT architectures: oneM2M, IoT World Forum (IoTWF) and alternative IoT models, simplified IoT architecture and core IoT functional stack, fog, edge and cloud in IoT, functional blocks of an IoT ecosystem, sensors, actuators, smart objects and connecting smart objects.	9
2	<b>IoT Protocols:</b> IoT access technologies: physical and MAC layers, topology and security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN, network layer: IP versions, constrained nodes and constrained networks, optimizing IP for IoT: from 6LoWPAN to 6Lo, routing over low power and lossy networks, application transport methods: supervisory control and data acquisition, application layer protocols: CoAP and MQTT.	9
3	<b>Design &amp; Development:</b> Design methodology, embedded computing logic, system on chips, IoT system building blocks, developing on the Arduinos, Raspberry Pi, mobile phone and tablet, laser cutting, 3D printing, CNC milling.	8
4	<b>Introduction to AI:</b> Definition of Artificial Intelligence, history and applications, components of AI structures, strategies for state space search, data driven and goal driven search, depth first and breadth first search, DFS with iterative deepening, heuristic search- best first search, A* algorithm, constraint satisfaction.	6
5	<b>Knowledge Representation in AI:</b> Knowledge representation - propositional calculus, predicate calculus, theorem proving by resolution, answer extraction, AI representational schemes- semantic nets, conceptual dependency, scripts, frames.	8

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Explain the concept of IoT and application areas of IoT.
2. Analyze various protocols for IoT.
3. Design a PoC of an IoT system using Raspberry Pi/Arduino
4. Apply IoT in industrial and commercial automation and real world design constraints.
5. Demonstrate fundamental understanding of AI and its foundations.
6. Apply basic principles of AI for problem solving, inference, perception and knowledge representation.

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**Text/Reference Books:**

1. George FLuger, "Artificial Intelligence- Structures and Strategies for Complex Problem Solving", 4/e, 2002, Pearson Education.
2. Jeeva Jose, "Internet of Things", Khanna Publishing House.
3. Arshdeep Bahga, Vijay Madisetti, "Internet of Things-A hands-on approach", Universities Press, 2015
4. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things- Key applications and Protocols", Wiley, 2012 (for Unit 2).
5. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand.
6. David Boyle, "From Machine-to-Machine to the Internet of Things- Introduction to a New Age of Intelligence", Elsevier, 2014.
7. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
8. Stuart Russel, Peter Norvig, "Artificial Intelligence: A Modern Approach", 3rd Edition, Pearson Education,
9. Elaine Rich, Kevin Knight and Shivashankar B Nair, "Artificial Intelligence" 3rd Edition, Tata McGraw Hill, 2008.
10. M.C. Trivedi, "Artificial Intelligence", Khanna Publishing House.

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<b>Name of the Course</b>	<b>OBJECT ORIENTED PROGRAMMING</b>
<b>Course Code: OE-CS601</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand object oriented programming concepts and basic characteristics programming.
2	To develop an object oriented programming application with threads and generics classes.
3	To know the principles of packages, inheritance and interfaces.
4	To design and build simple graphical user interfaces.
<b>Pre-Requisite:</b> Basic knowledge of algorithm and Procedural Programming Language	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	Abstract data types and their specification, How to implement an ADT, Concrete state space, Concrete invariant, Abstraction function, Implementing operations, illustrated by the Text example.	8
2	Basic concepts of Object Oriented Programming using Java / C++/ Python	6
3	Features of objectoriented programming, Encapsulation, Object identity, Polymorphism.	8
4	Inheritance in OO design, Design patterns, Introduction and classification, Theiterator pattern.	6
5	Model-view-controller pattern, Commands as methods and as objects, Implementing OO language features, Memory management.	6
6	Generic types and collections-GUIs, Graphical programming with Scale and Swing, The software development process.	6

### **COURSE OUTCOMES**

At the end of the course, students should able to:

1. Differentiate between proceduraloriented programmingand object orientedprogramming.
2. Specify simple abstract data types and design implementations, using abstraction functions to documentthem.
3. Recognize features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on objectidentity.
4. Design applications with an event-driven graphical userinterface.
5. Design, write and apply straightforward programs using the knowledge of object orientedprogramming.
6. Analyze the complex problems and provide awareness of the need for a professional approach to design and the importance of good documentation to the finished programs.

### **Text/Reference Books:**

1. R.S. Salaria, Mastering Object Oriented Programming Using C++, Khanna Publishing House.
2. Rambaugh, James Michael, Blaha, "Object Oriented Modelling and Design", PHI.

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3. Ali Bahrami, "Object Oriented System Development", McGraw Hill.
4. Patrick Naughton, Herbert Schildt, "The complete reference-Java2", TMH.
5. R.K Das, "Core Java For Beginners", Vikas Publishing.
6. Deitel and Deitel, "Java How to Program", Pearson.
7. Ivor Horton's Beginning Java 2 SDK - Wrox
8. E. Balagurusamy, "Programming With Java: A Primer", TMH.
9. Barbara Liskov, "Program Development in Java", Addison-Wesley,2001.
10. E.Balaguruswamy, "ObjectOrientedProgrammingwithC++",6<sup>th</sup>Ed, 2013 TMH.
11. R.S.Salaria, Khanna, "ObjectOrientedProgrammingwithC++",Publishing House,NewDelhi.
12. Brian Jones, David Beazley, "Python Cookbook: Recipes for Mastering Python 3", 3<sup>rd</sup> Edition, O'Reilly.
13. Paul Barry, Head-First Python: A Brain-Friendly Guide", 2<sup>nd</sup>Edition, O'Reilly.
14. Dusty Phillips, "Python 3 Object-Oriented Programming", 3<sup>rd</sup>Edition,Packt.

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<b>Name of the Course</b>	<b>COMPUTER NETWORK</b>
<b>Course Code: OE-CS602</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To develop an understanding of the fundamental concepts of computer networking.
2	To familiarize the student with the basic taxonomy and terminology of the computer networking area.
3	To introduce about advanced networking concepts, preparing the student for entry in advanced courses in computer networking.
4	To gain expertise in some specific areas of networking such as the design and maintenance of individual networks.
<b>Pre-Requisite:</b> Communication Engineering, Basic Knowledge of Computer Organization	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Data communication Components:</b> Representation of data and its flow networks, various connection topology, protocols and standards, OSI model, transmission media, LAN: wired LAN, wireless LANs, connecting LAN and virtual LAN, techniques for bandwidth utilization: multiplexing-frequency division, time division and wave division, concepts on spread spectrum.	6
2	<b>Data Link Layer &amp; Medium Access Sub Layer:</b> Error detection and error correction-fundamentals, block coding, Hamming Distance, CRC; flow control and error control protocols-stop and wait, go back- N ARQ, selective repeat ARQ, sliding window, piggybacking, random access, multiple access protocols - pure ALOHA, slotted ALOHA, CSMA/CD, CDMA/CA	12
3	<b>Network Layer:</b> Switching, logical addressing-IPV4, IPV6; address mapping -ARP, RARP, BOOTP and DHCP-delivery, forwarding and unicast routing protocols.	8
4	<b>Transport Layer:</b> Process to process communication, user datagram protocol (UDP), transmission control protocol (TCP), SCTP congestion control; quality of service, QoS improving techniques: leaky bucket and token bucket algorithm.	8
5	<b>Application Layer:</b> Domain name space (DNS), DDNS, TELNET, EMAIL, File transfer protocol (FTP), WWW, HTTP, SNMP, bluetooth, firewalls, basic concepts of cryptography.	6

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Explain the functions of the different layers of the OSI protocol.
2. Draw the functional block diagram for different networks and describe the function of each block.
3. Design and implement small scale networks for a given specification.
4. Develop network programming for a given TCP/IP related problem.
5. Configure application layer protocols using open source available software and tools.
6. Describe, analyze and evaluate various technical, administrative and social aspects of specific computer network protocols.

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**Text/Reference Books:**

1. Behrouz A. Forouzan, “Data Communication and Networking”, 4<sup>th</sup>Ed, McGraw Hill.
2. William Stallings, “Data and Computer Communication”, 8<sup>th</sup>Ed, Pearson Prentice Hall India.
3. Andrew S. Tanenbaum, “Computer Networks”, 8<sup>th</sup> Ed, Pearson New International.
4. Douglas Comer, “Internetworking with TCP/IP”, Volume 1, 6<sup>th</sup>Ed, PHI.
5. W. Richard Stevens, Addison-Wesley, “TCP/IP Illustrated”, Volume 1, United States of America.
6. Bhavneet Sidhu, “An Integrated Approach to Computer Networks”, Khanna Publishing House

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<b>Name of the Course</b>	<b>SOFTWARE ENGINEERING</b>
<b>Course Code: OE-CS603</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To learn the fundamentals of software engineering principles and practices, including project management.
2	To provide the idea of decomposing the given problem into analysis, design, implementation, testing and maintenance phases.
3	To provide an idea of using various process models in the software industry according to given circumstances.
4	To gain the knowledge of how analysis, design, implementation, testing and maintenance processes are conducted in a software project.
<b>Pre-Requisite:</b> Basic Programming Skills, Basic Management Concepts	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Overview of System Analysis &amp; Design:</b> Business system concept, system development life cycle, waterfall model, spiral model, feasibility analysis, technical feasibility, cost-benefit analysis, COCOMO model.	10
2	<b>System Design:</b> Context diagram and DFD, problem partitioning, top-down and bottom-up design, decision tree, decision table and structured english, functional vs. object oriented approach.	5
3	<b>Coding &amp; Documentation:</b> Structured programming, OO programming, information hiding, reuse, system documentation, testing, levels of testing, integration testing, test case specification, reliability assessment, validation and verification metrics, monitoring and Control.	11
4	<b>Software Project Management:</b> Project scheduling, staffing, software configuration management, quality assurance, project monitoring.	6
5	<b>Static &amp; Dynamic Models:</b> Brief of modeling, UML diagrams: class diagram, interaction diagram: collaboration diagram, sequence diagram, state chart diagram, activity diagram, implementation diagram.	8

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Identify, formulate and solve software engineering problems, including the specification, design, implementation, and testing of software systems.
2. Analyze and specify software requirements through a productive working relationship with various stakeholders of a software development project.
3. Elicit professional, ethical and social responsibility of a software engineer.
4. Participate in design, development, deployment and maintenance of a medium scale software development project.
5. Use unified modeling language in software specification documents.
6. Evaluate the impact of potential solutions to software engineering problems in a global society, using the knowledge of contemporary issues and emerging software engineering trends, models, tools, and techniques.

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**Text/Reference Books:**

1. Pressman, "Software Engineering: A practitioner's approach", TMH.
2. PankajJalote, "Software Engineering", Wiley-India.
3. N.S. Gill, "Software Engineering", Khanna Publishing House.
4. Rajib Mall, "Software Engineering", PHI.
5. Agarwal and Agarwal, "Software Engineering", PHI.
6. Sommerville, "Software Engineering", Pearson.
7. Martin L. Shooman, "Software Engineering", TMH.

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<b>Name of the Course</b>	<b>BIOMEDICAL DIGITAL SIGNAL PROCESSING LABORATORY</b>
<b>Course Code: PC-BME691</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To introduce the basic principles, methods, and applications of digital signal processing.
2	To explore DSP algorithmic, computational, and programming aspects.
3	To learn programming of DSP hardware for real-time signal processing applications
4	To familiarize with biomedical signals conditioning using FIR and IIR filters and to plot and observe the nature of these signals.

**LIST OF EXPERIMENTS:**

1. Computation of convolution
2. Computation of correlation
3. Auto-correlation, cross correlation techniques of biosignal
4. Design and application of digital IIR filter
5. Design and application of digital FIR filter
6. Frequency domain description of signal-DFT
7. FFT and IEFT computation of ECG signal
8. Design of 50 Hz adaptive filter
9. Power spectral density of any sequence
10. Estimation of power spectral density
11. Reduction of ECG signal
12. Wavelet transform
13. A mini project based on biosignal processing

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Perform basic signal processing operations and implement various DSP systems.
2. Design and implement digital filters for biosignal processing.
3. Program the digital signal processing algorithm using software.
4. Analyze biosignals and perform computation depending on the application.

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<b>Name of the Course</b>	<b>BIOMATERIALS &amp; BIOMECHANICS LABORATORY</b>
<b>Course Code: PC-BME692</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To study mechanical properties of biomaterials using destructive and non-destructive method.
2	To provide hands-on experience in characterization of biomaterials for medical applications.
3	To study forces, momentum, torque, stresses and strains in biological tissues for a given loading conditions and material properties.

**LIST OF EXPERIMENTS:**

1. Mechanical characterization of metallic biomaterials
2. Mechanical characterization of polymeric biomaterials
3. Hardness testing of biomaterials
4. Surface roughness measurement of biomaterials
5. Estimation of haemocompatibility of biomaterials by hemolysis studies
6. Ultrasonic characterization of biomaterials-NDE
7. Biomechanical arm muscle analysis
8. Determination of moment of inertia of human limb using dynamometer.
9. Determination of moment of inertia of human bone using compound pendulum method
10. Dynamic measurements using force plate
11. Measurement of torque required to tap and screwing in jaw bone
12. Stress-strain analysis of hip prosthesis

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Measure and evaluate the mechanical characteristics and compatibility properties of biomaterials and implants.
2. Perform dynamics analysis and interpret force and momentum for a recorded motion.
3. Analyze and interpret the forces at a skeletal joint for various static and dynamic human activities.
4. Evaluate the stresses and strains in biological tissues for a given the loading conditions and material properties.

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<b>Name of the Course</b>	<b>OBJECT ORIENTED PROGRAMMING LABORATORY</b>
<b>Course Code: OE-CS691</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To gain the basic knowledge on object oriented concepts and applications using object oriented programming concepts.
2	To understand the principles and practice of object oriented analysis and design in the construction of robust, maintainable programs which satisfy their requirements.
3	To provide hands-on experience to students in implementing object oriented programming concepts.

**LIST OF EXPERIMENTS:**

1. Assignments on class, constructor, overloading, inheritance, overriding
2. Assignments on wrapper class, arrays
3. Assignments on developing interfaces-multiple inheritance, extending interfaces
4. Assignments on creating and accessing packages
5. Assignments on multithreaded programming

Any experiment specially designed by the college

(Detailed instructions for Laboratory Manual to be followed for further guidance)

Note: Use Java / C++ / Python for programming

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Write, compile, test and execute straightforward programs using the knowledge of object oriented programming.
2. Implement features of object oriented programming to solve real world problems.
3. Apply the major object-oriented concepts to implement object oriented programs.
4. Design, develop and troubleshoot software based on object oriented programming methodologies.

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<b>Name of the Course</b>	<b>COMPUTER NETWORK LABORATORY</b>
<b>Course Code: OE-CS692</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To understand different transmission media and design cables for establishing a network.
2	To understand the basic concepts of network and application layer protocol design; including client/server models, peer to peer models.
3	To learn the major software and hardware technologies used on computer networks and device sharing on network.

**LIST OF EXPERIMENTS:**

1. NIC Installation & Configuration (Windows/Linux)
2. Understanding IP address, subnet etc  
Familiarization with
  - Networking cables (CAT5, UTP)
  - Connectors (RJ45, T-connector)
  - Hubs, Switches.
3. TCP/UDP Socket Programming
  - Simple, TCP based, UDP based
  - Multicast & Broadcast Sockets
  - Implementation of a Prototype Multithreaded Server
4. Implementation of
  - Data Link Layer Flow Control Mechanism (Stop & Wait, Sliding Window)
  - Data Link Layer Error Detection Mechanism (Cyclic Redundancy Check)
  - Data Link Layer Error Control Mechanism (Selective Repeat, Go Back N)
5. Server Setup/Configuration: FTP, TelNet, NFS, DNS, Firewall

Any experiment specially designed by the college  
 (Detailed instructions for Laboratory Manual to be followed for further guidance)

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Identify and use various networking components and commands.
2. Install a network system consists of various computers using NIC, networking cables, connector, hubs and switches.
3. Implement networking in software using various socket programming and various networking protocols.
4. Anticipate software and hardware technologies used on computer networks and implements device sharing on network.

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<b>Name of the Course</b>	<b>SOFTWARE ENGINEERING LABORATORY</b>
<b>Course Code: OE-CS693</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To understand the phases of software projects and practice the activities of each phase.
2	To acquire the generic software development skill through various stages of software life cycle.
3	To provide project-rich learning experiences for success in a rapidly evolving computing field.
4	To acquainted with modern software methodologies and take part in part in project management.

**LIST OF EXPERIMENTS:**

Using project management software - MS Project

Exercises using CASE tool for software engineering practice.

**These are few sample projects but not limited to:**

**Project 1:**

Hospital Management System: It provides relevant information across the hospital.

Inputs: • Hospital information (name, address, branch, department, facilities) • Employee information (name, employee id, address, contact details) • Doctor Information (name, employee id, address, contact details, specialization, degrees) • Patient information (name, id, address, age, payment, others)

Output: • Patient details • Patients list • Receipt generation • Report generation.

**Project 2:**

Railway Reservation System: This project is to take up this to develop a reservation system.

Functions: • Availability check • Booking ticket • Canceling Ticket.

Output: • Results on availability for a given date with capacity • Booking confirmation • Cancellation of an existing booking.

**Project 3:**

Social Networking: We are living in the age of Social Networking like Facebook, LinkedIn, Google + etc. Operations: • User can register into the application with their name, email id and password. • Registered user may be able to login into the application. • There should be options to get the basic information like date of birth, address, phone no, education, upload his/her picture, professional information, hobby etc. • After login, user should be able to see their profile information, etc.

**Project 4:**

Airline Management System: It helps the users to book flights without visiting offline booking counters. In such a system, a passenger should be able to view the availability of flights' details, as per their requirement. They can book the flights online and can also cancel the reservation. • To view the available flight details, passenger has to give source, destination, and date and time. • After confirmation of reservation request, passenger can see the status.

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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Apply modern software methodologies to the needs of the dynamic global computing-based society.
2. Ensure the quality of software through software development with various protocol based environment.
3. Convert the requirements model into the design model and demonstrate use of software and user interface design principles.
4. Generate team and organizational leadership in computing project settings and application of computing-based solutions to societal and organizational problems.

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<b>Name of the Course</b>	<b>GROUP DISCUSSION &amp; SEMINAR</b>
<b>Course Code: HM-HU681</b>	<b>Semester: Sixth</b>
<b>L-T-P-C: 0-1-2-2</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To introduce different models and topics in terms of skills, content mastery, attitudes, or values.
2	To learn to control the conversation through listening attentively and then having the perseverance to mould it towards his/her own direction.
3	To know the latest happenings in their field and explore an appreciation of the self in relation to its larger diverse social and academic contexts.

**GUIDELINES:**

- Seminar topics must relate to the current trend in technology depending on the students interest in the field of medical electronics.
- Carry out an elaborate literaturesurvey on the related field referring standard international journals/conferences.
- Make an oral presentation and also submit a technical report.

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Improve oral, written and technical communications skills.
2. Communicate with other health professionals in a respectful and responsible manner.
3. Participate in any interactive session and succeed in competitive examinations.
4. Formulate strategies for audience-centric visual presentations with concrete professional objectives.

**Special Remarks:**

The above mentioned outcomes are not limited. Institute may redefine course outcomes based on their Program Educational Objectives (PEOs).

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**SEMESTER-VII**

<b>Name of the Course</b>	<b>PRINCIPLES OF MANAGEMENT &amp; ORGANIZATION BEHAVIOUR</b>
<b>Course Code: HM-HU701</b>	<b>Semester: Seventh</b>
<b>L-T-P-C: 4-0-0-4</b>	<b>Contact: 4 hrs/week</b>
<b>Objectives:</b>	
1	To enable the students to study the evolution, functions and principles of management.
2	To know about organizational structure, organizational behaviour and personality development.
3	To learn about motivational techniques and skill required to work in a group and the process of group decision making.
4	To know various leadership styles and the role of leader in achievement of organizational objectives.
5	To learn about the reasons for organizational change and its development.
<b>Pre-Requisite:</b> Technical English (HMHU301), Basic knowledge of Management	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to Management &amp; Organization:</b> Definition of management, evolution of management, human relations, system and contingency approaches, types of managers, role of managers, manager vs. entrepreneur, organizational structure, centralization and decentralization, selection and recruitment, training and development, current trends and issues in management.	8
2	<b>Planning &amp; Directing:</b> Nature and purpose of planning, planning process, types of plans, objectives, managing by objective strategies, types of strategies, policies, decision making, types of decision, decision making process, rational decision making, market planning, Marketing Mix, advertising and brand management, creativity and innovation, motivation and satisfaction, motivation theories, leadership styles, leadership theories, CSR.	12
3	<b>Controlling &amp; Quality Management:</b> Process of controlling, types of control, managing productivity, cost control, financial statements and ratio analysis, maintenance control, quality control with control charts, TQM, Kaizen and six sigma, MIS.	14
4	<b>Organizational Behaviour:</b> Definition, importance, fundamental concepts of OB, challenges and opportunities for OB, meaning of personality, development of personality, determinants of personality, application of personality in the organizational level, communication, concept of group dynamic, types of group, group behaviour, group decisions and techniques to improve group decision, merits and demerits of group decisions.	10
5	<b>Organizational Change:</b> Meaning and nature of organizational change, factors of organizational change, resistance to change, factors in resistance, overcoming resistance to change, organizational development-concept, objectives and process of organization development.	8

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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Recognize the fundamentals of management thoughts that are vital for the development of conceptual framework of management as a discipline.
2. Demonstrate knowledge of organizational structure, organizational conflict, negotiation, politics and change.
3. Apply the principles of decision making through planning, organizing, directing and controlling.
4. Implement effective communication skills to handle group behavior and monitor human resources through effective leadership.
5. Relate knowledge of ethics in the context of corporate social responsibility and advertising, brand management and product positioning across cultural diversities.
6. Create a congenial and cohesive ambience within the framework of organizational structure in achieving the organizational goals.

**Text/Reference Books:**

1. Premvir Kapoor, "Principles of Management", Khanna Publishing House.
2. Bhat, A. Kumar, "Management: Principles, Processes & Practices" OUP.
3. Charles W.L.Hill, Steven L. McShane, "Principles of Management" McGraw Hill Education, Special Indian edition, 2007
4. Previr Kapoor, "Principles of Management" Khanna Publishing House, New Delhi.
5. Koontz, "Essentials of Management" Revised Edition, Tata McGraw Hill.
6. Arun Kumar, N. Meenaskshi, "Organisational Behaviour" Vikas Publishing House, 2009.
7. S. P. Robbins, T.A. Judge, "Organizational Behavior", Pearson Education, 15th Edn.
8. Luthans, Fred, "Organizational Behavior", McGraw Hill, 12th Edn.
9. Shukla, Madhukar, "Understanding Organizations-Organizational Theory & Practice in India", PHI
10. R. Fincham, P. Rhodes, "Principles of Organizational Behaviour", OUP, 4th Edn.
11. Hersey, P., Blanchard, K.H., Johnson, D.E.- Management of Organizational Behavior Leading Human Resources, PHI, 10th Edn.

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<b>Name of the Course</b>	<b>MEDICAL IMAGE PROCESSING</b>
<b>Course Code: PC-BME701</b>	<b>Semester: Seventh</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To introduce students about the fundamental concepts of medical image processing.
2	To discuss the transform with respect to basic functions, properties and applications.
3	To understand the basic medical image enhancement, segmentation, compression, representation techniques and algorithms.
4	To provide students with an overview of the computational and mathematical methods in medical image processing.
<b>Pre-Requisite:</b> Biomedical Digital Signal Processing (PCBME601), Medical Imaging Techniques.	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Digital Image Fundamentals &amp; Transforms:</b> Basic idea of medical images, digital image representation, steps in digital image processing, sampling and quantization, relationships between pixels, colour image fundamentals-RGB, image transforms: discrete transform, fast Fourier transform, 2-D Fourier transform and inverse Fourier transform.	8
2	<b>Image Enhancement:</b> Spatial domain method, frequency domain method, contrast enhancement, histogram processing, image smoothing, image averaging, masking, image sharpening, removing of blur caused by uniform linear motion, enhancement in the frequency domain: low pass, high pass, mean and band-pass filtering, high boost filtering, homomorphic filtering, special examples using US and CT images.	9
3	<b>Image Segmentation:</b> point detection, line detection, edge detection, thresholding, region growing, region splitting and merging, morphological processing, erosion and dilation, segmentation by morphological watersheds.	8
4	<b>Image Compression:</b> Need of medical image compression, fidelity criteria, image compression models, lossy and lossless compression techniques, image compression standards.	6
5	<b>Image Restoration &amp; Reconstruction of Medical Images:</b> Degradation models, algebraic approach to restoration, inverse filtering, Wiener filtering, image reconstruction from back projections, Radon transforms, filter back projection reconstruction of CT images, Fourier reconstruction of MRI images.	9

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the concepts and techniques in digital image processing.
2. Analyze the performance of various medical image processing techniques.
3. Perform image compression using lossy and lossless techniques.
4. Implement image enhancement techniques in spatial and frequency domain.
5. Perform image segmentation and image restoration.
6. Design and implement algorithm(s) for medical image processing applications.

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**Text/Reference Books:**

1. R.C. Gonzalez, R.E. Woods, "Digital Image Processing", Pearson Education 3rd edition, 2010.
2. Anil K Jain, "Fundamentals of Digital Image Processing", Pearson, 2002.
3. Chanda&Majumdar, "Digital image processing and analysis", PHI
4. Sinha& Patel, "MedicalImage Processing-Conceptand Application"
5. G Dougherty, "DigitalImage ProcessingforMedicalApplications"
6. R.C. Gonzalez, R.E. Woods, SEddins, "Digital Image Processing using MATLAB", Pearson Education Inc 2011
7. Kenneth R Castleman, "Digital Image Processing", Pearson, 2006.

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<b>Name of the Course</b>	<b>HOSPITAL ENGINEERING &amp; MANAGEMENT</b>
<b>Course Code: PE-BME701</b>	<b>Semester: Seventh</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand the fundamentals of hospital engineering, management system and organization.
2	To study about various medical services and quality and safety aspects in hospital.
3	To impart knowledge regarding clinical engineering, biomedical engineering, safety technology and hospital information system.
<b>Pre-Requisite:</b> Biomedical Instrumentation (PCBME402), Basic knowledge of Management.	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Healthcare System:</b> Roles of hospital in healthcare, health organization of the country, Indian hospitals-challenges and strategies, introduction to hospital engineering system, management concept and organization, modern techniques of hospital management.	4
2	<b>Hospital Organization &amp; Medical Services:</b> Classification of hospitals, role of hospital in healthcare, location and environment of hospital, wards and departments, outpatient services, inpatient services, emergency services, clinical laboratories, radiology services, OT services, pharmacy, line services, supportive services and auxiliary services, role of biomedical engineers in hospital.	12
3	<b>Engineering Services &amp; Safety:</b> Engineering departments, maintenance department, preventive maintenance of equipment, power supply system, air conditioning system, water supply and sanitary system, centralized gas supply system, central sterilization system, communication system, electrical safety, fire safety and alarm system, waste disposal system.	12
4	<b>Hospital Management &amp; Information System:</b> Hospital management system, MRO, role of HMIS, functional areas, modules forming HMIS, HMIS and internet, RIS, centralized data records system, computerized patient record system, health information system, disaster management.	8
5	<b>Regulation &amp; Safety Protocols:</b> FDA regulation, ISO certification, NABH, NABL, clinical laboratory standards to infection control, healthcare worker safety, fire protection standard.	4

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Classify hospitals, different units and their functions in hospital.
2. Demonstrate knowledge of strategic planning and decision making in the healthcare.
3. Assess and prioritize various medical and engineering services in hospital.
4. Implement information system for effective and improved healthcare delivery.
5. Apply skills for improving safety and the quality of care in hospital.
6. Practice professional ethics and legal issues in hospital engineering and healthcare system management.

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**Text/Reference Books:**

1. R.C. Goyal, "Handbook of Hospital Personal Management", Prentice Hall of India, 1993.
2. Hans Pfeiff, Vera Dammann (Ed.), "Hospital Engineering in Developing Countries", Zreport Eschbom, 1986.
3. Antony Kelly, "Maintenance planning and control", Butterworths, London.
4. Cesar A. Caceres and Albert Zara, "The practice of clinical engineering", Academic Press, 1977.
5. Webster, J. Gand Albert M. Cook, "Clinical Engineering Principles and Practices", Prentice Hall Inc. Englewood Cliffs, 1979.
6. Jacob Kline, "Handbook of Bio Medical Engineering", Academic Press, San Diego 1988.
7. Sanjiv Singh, Sakthikumar Gupta, Sunil Kant, "Hospital infection control guidelines, principles and practice", Jaypee Brothers Medical Publishers Pvt Limited, First edition, 2012.

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<b>Name of the Course</b>	<b>HOSPITAL SAFETY &amp; MANAGEMENT</b>
<b>Course Code: PE-BME702</b>	<b>Semester: Seventh</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To impart adequate information on hazards, safety and precautionary measures in health care system.
2	To provide basic knowledge on the concept of healthcare quality management towards continuous improvement of patient care.
3	To make the students aware of the role of biomedical engineer in hospitals, especially in the management of electrical supply, maintenance of electrical safety, etc.
4	To understand the policies, safety standards in compliance with regulatory requirements and within engineering limits.
<b>Pre-Requisite:</b> Biomedical Instrumentation (PCBME402), Basic knowledge of Management.	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Hospital Safety:</b> Security and safety of hospital-property, staff and patients, radiations safety, safety precautions, hazardous effects of radiation, allowed levels of radiation, ICRP regulations for radiations safety, disposal of biological waste.	6
2	<b>Electrical &amp; Fire Safety:</b> Electrical hazards, causes of electrical shock, effect of shocks, macro and micro shocks-hazards, monitoring and interrupting the operation from leakage current, safety precautions for electrical hazards, elements of fire, causes of fire, action to be taken in case of fire in a hospital.	8
3	<b>LASER &amp; Ultraviolet Radiation Safety:</b> Classification of UV radiation, sources of UV, biological effects of UV, hazards associated with UV radiation, UV control measures, safety management of UV, classification of LASER and its radiation hazards, control measures, emergencies and incident procedures.	8
4	<b>Assessing Quality &amp; Regulatory Requirement for Healthcare:</b> Patients safety, organization-Governmental and independent, measuring quality care, evaluation of hospital services, six sigma way, quality assurance in hospitals, patient orientation for total patient satisfaction, 5S techniques, FDA regulations, accreditation for hospitals-JCI, NABH and NABL, other regulatory codes.	10
5	<b>Standardization of Quality Medical Care in Hospitals:</b> Define quality, need for standardization and quality management, TQM in healthcare organization, quality assurance methods, QA in (Medical Imaging & Nuclear medicine) diagnostic services, classification of equipment, medical device safety and risk management, effectiveness/performance of medical devices, role of each participant/stakeholder, shared responsibility for medical device safety and performance.	8

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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the types of hazards, planning, organization and training needed to work safely with hazardous materials.
2. Recognize and evaluate safety and health hazards and select appropriate control methodologies based on the hierarchy of controls.
3. Utilize regulatory standards as a guide to apply policies, procedures, standards and occupational safety and health principles.
4. Design, implement and monitor quality and safety initiatives in the health services.
5. Practice due diligence and employ managerial responsibility in creating and maintaining a culture of regulatory compliance in healthcare, including the management of accreditation processes.
6. Evaluate and apply quality, safety and management competencies to improve and assure healthcare standards.

**Text/Reference Books:**

1. Khandpur R.S, "Hand book of Biomedical instrumentation", TMH
2. Carr & Brown, "Introduction to Biomedical Equipment", PHI
3. Webster J. G and Albert M. Cook, "Clinical Engg, Principles & Practices", Prentice Hall Inc., Engle wood Cliffs, New Jersey, 1979.
4. Cesar A. Cacere & Albert Zana, "The Practice of Clinical Engg.", Academic press, New York, 1977.
5. B.M. Sakharkar, "Principles of Hospital administration and Planning", JAYPEE Brothers, Medical Publishers (P) Ltd.
6. K. Shridhara Bhat, "Quality Management", Himalaya Publishing House.
7. Karen Parsley, Karen Parsley Philomena Corrigan, "Quality improvement in Healthcare", 2nd edition, Nelson Thornes Pub, 2002
8. Sharon Myers, "Patient Safety & Hospital Accreditation - A Model for Ensuring Success" Springer Publishers 2012
9. Joseph F Dyro, "Clinical Engineering Handbook" Elsevier Publishers, 2004

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<b>Name of the Course</b>	<b>SPORTS MANAGEMENT</b>
<b>Course Code: PE-BME703</b>	<b>Semester: Seventh</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To provide knowledge of the medical field related to physical activity and sports.
2	To learn basic medical skills and science of injury prevention, treatment and rehabilitation as it relates to sports management.
3	To gain the basic knowledge to evaluate, diagnose and manage common disorders seen in sports medicine.
<b>Pre-Requisite:</b> Engineering Physiology & Anatomy (PCBME302), Biophysics & Biochemistry (PCBME303), Biomechanics & Rehabilitation Engineering.	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to Sports Medicine:</b> Meaning and concept of sports medicine, scope of sports medicine, history of sports medicine in India, prevention of sports injuries, role of physical educators and coaches in the prevention of sports injuries, pre-conditioning injury prevention exercises and drives static stretching exercises, therapeutic exercise and their classification.	9
2	<b>Sports Injuries:</b> Terminology and classification of common sports soft tissue injuries, pathological changes in sprains, strain and contusion and their management, regional injuries and their management-injuries of head, ears, eyes, nose, back, shoulders, elbows, hand, abdomen, thighs, knee, leg and ankle.	8
3	<b>Rehabilitation Procedures:</b> Principles of rehabilitation of injuries, therapeutic modalities-cryotherapy, hydrotherapy, electrotherapy and lesser therapy, massage and its techniques.	5
4	<b>Physiology of Exercise:</b> Short and long term effects of exercise on muscular tissues, physiological principles of development of strength, endurance, speed and flexibility, heart role and exercise, threshold for training effects on heart, cardiac reserve capacity, blood pressure and exercise, lungs ventilation during rest and exercise, change in lungs diffusions during muscular activities.	9
5	<b>Socio Psychological Factors:</b> Stress and sports competitions, socio psychological stress and human performance in sports, Seley's theory of stress and its implications, psychology and physiology of stress, measurement of stress, over training stress syndrome, psycho-physiological training for stress and psycho-somatic fitness, yoga therapy for psycho-physiological ailments, yoga and psycho-physiological training of games and sports.	9

### **COURSE OUTCOMES**

At the end of the course, students should able to:

1. Apply concepts, skills and techniques necessary for improving sports activities.
2. Demonstrate mechanical, biological and physiological implications involved in sports.
3. Correlate physical conditioning for the prevention of injuries and counsel mental health.
4. Diagnose and evaluate injuries using suitable methods and techniques.
5. Propose appropriate therapeutic modalities for rehabilitation of injuries.
6. Integrate other professionals within the allied health profession and medical field.

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**Text/Reference Books:**

1. Armstrong, Tuckler, "Injuries in Sports", London, Staples Press, 1964.
2. J.P.Bolan,P.J.Rasch,"Treatment and Prevention of Athletic Injuries", Inter-state Printers and Publishers, 1967.
3. L.E.Morehouse, P.J.Rasch,"Sports Medicine for Trainers", Philadephia, W.B. Saunder CO.1963.
4. Ryans Allan, "Medical Care of the Athlete", McGraw Hill.
5. Morchouse, Miller : Physiology of Exercise
6. Falls : Exercise Physiology
7. Karpovitch : Physiology of Muscular activity
8. Pande, P.K. "Know How Sports Medicine?" AP Publications, Jalandhar

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<b>Name of the Course</b>	<b>BIOLOGICAL CONTROL SYSTEMS &amp; MODELLING</b>
<b>Course Code: OE-BME701</b>	<b>Semester: Seventh</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To impart knowledge about various regulatory processes in designing a bio-control system.
2	To understand the basic ideas related to modelling and different modeling techniques for analysis and synthesis of dynamic physiological systems.
3	To understand methods and techniques to analyze and synthesize dynamic models.
4	To equip the students with necessary knowledge on analysis and design parameters of biological control system.
<b>Pre-Requisite:</b> Engineering Physiology & Anatomy (PCBME302), Biophysics & Biochemistry (PCBME303), Signals & Systems in Biomedical Engineering (PCBME301), Physics, Higher Engineering Mathematics.	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction:</b> Technological control system, mathematical approaches, system stability, biocontrol system, differences and similarities between biological and engineering control system, mathematical modeling of physiological system, technique of mathematical modeling, classification of models-black box and building block, characteristics of models, linearization of nonlinear models, Time invariant and time varying systems for physiological modeling.	12
2	<b>Bioprocess Regulation:</b> Acid-base balance, extra-cellular water and electrolyte, interstitial fluid volume, blood pressure, blood glucose, CO <sub>2</sub> , thermal regulatory system.	6
3	<b>Biological Control Mechanism:</b> Cardiac rate, respiratory rate, mass balancing of lungs, oxygen uptake by RBC and pulmonary capillaries, oxygen and carbon dioxide transport in blood and tissues, urine formation and control, Pupil control systems, skeletal muscle servomechanism and semicircular canal, endocrine control system.	8
4	<b>Physiological Modeling:</b> Purposes of physiological modeling, Hodgkin and Huxley's model of action potential, model of the whole neuron, Huxley model of isotonic muscle contraction, modeling of EMG, modeling of ECG, electrical analog of blood vessels, model of systematic blood flow, model of coronary circulation, transfer of solutes between physiological compartments by fluid flow, counter current model of urine formation, model of Henle's loop, linearized models: immune response, pulmonary mechanics and thermoregulation.	14

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the regulation and control mechanism of various physiological processes / biological systems.

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2. Simulates \_\_\_\_\_ and \_\_\_\_\_ analyze physiological systems in time and frequency domain and to understand the concept of system stability.
3. Interpret the biological significance of linear and nonlinear control systems.
4. Apply principles of mathematical modeling in understanding the various biological systems.
5. Formulate methods and techniques for analysis and synthesis of dynamic models.
6. Create mathematical \_\_\_\_\_ and \_\_\_\_\_ computational models in \_\_\_\_\_ the analysis of physiological process/biological systems \_\_\_\_\_ as well as implement and \_\_\_\_\_ evaluate \_\_\_\_\_ it to meet desired needs in healthcare.

### Text/Reference Books:

1. Ogata Katsuhika, "Modern control engineering", 2<sup>nd</sup> ed, Prentice Hall of India.
2. Ibrell and Guyton, "Regulation and control in physiological system",
3. Milsum John H., "Biological control systems analysis", Tata McGraw-Hill.
4. Milhorn T.H. Saunder, "Application of control theory to physiological systems",
5. Suresh.R. Devasahayam, "Signals and \_\_\_\_\_ Systems in Biomedical Engineering", Kluwer Academic/Plenum Publishers.
6. V.Z. Marmarelis, "Advanced methods of physiological modeling", Plenum Press.
7. J. Candy, "Signal Processing: The Model Based approach", Mc.Graw Hill.
8. Enderle, Blanchard & Bronzino, "Introduction to Biomedical Engineering", Academic press.

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<b>Name of the Course</b>	<b>BIOMEDICAL MEMS &amp; NANOTECHNOLOGY</b>
<b>Course Code: OE-BME702</b>	<b>Semester: Seventh</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand the working principle of MEMS and Microsystems.
2	To learn various MEMS fabrication techniques and application of BioMEMS in healthcare.
3	To study about nanotechnology and its application in medical field.
4	To know about electro kinetic phenomena, micro sensors, micro actuators and drug delivery systems.
<b>Pre-Requisite:</b> Human Physiology, Biophysics & Biochemistry, Basic Knowledge of Mathematics, Biology, Electronics, Mechanics and Basics of Sensors	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>MEMS &amp; Microsystems:</b> Introduction to MEMS and microelectronics, MOEMS, microsystems and miniaturization, principles of microsystems, micro-sensors, micro-actuation, micro-accelerators, application of microsystems in healthcare industry.	7
2	<b>MEMS Materials &amp; Fabrication:</b> Materials for MEMS, active substrate materials, silicon and its compounds, silicon piezoresistors, gallium arsenide, quartz, polymers, photolithography, thin film deposition, doping, etching, bulk micromachining, wafer bonding, LIGA.	9
3	<b>BioMEMS:</b> Introduction to BioMEMS, BioMEMS for clinical monitoring, lab on a chip, DNA Sensors, E-Nose, E-Tongue, microsystem approaches to PCR, MEMS based implantable drug delivery system, emerging BioMEMS technology.	8
4	<b>Nanoscience &amp; Nanotechnology:</b> Nanoscience and nanotechnology in biology and medicine- an overview, nanomaterials, quantum well, wire, dot, carbon nanotubes, carbon nanotube biosensors.	6
5	<b>Nanomedicine:</b> Carbon nanotubes for monitoring antibody-antigen reaction, drug delivery and monitoring drug interaction using nanotubes and nanowires, quantum dots for drug discovery and imaging, quantum dots and gold nanoparticles for cancer treatment, nanoparticle mediated gene therapy, growth of neurons on nanomaterials, nanomaterials for brain protection and repair, DNA biochips, nanorobotics for surgery	10

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the working principles of MEMS and Microsystem and their application in medical field.
2. Explain and evaluate various MEMS fabrication techniques.
3. Design and develop miniaturized biomedical sensors and BioMEMS for practical applications.

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4. Demonstrate a detailed understanding of the fundamental principles of nanotechnology and their application to biomedical engineering.
5. Analyse nanosensors and nanodevices for diagnostics and therapeutic purposes.
6. Apply knowledge of nanotechnology to identify how they can be exploited for new applications.

### Text/Reference Books:

1. Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002. (Unit I, II, III & IV).
2. Wanjun Wang, Stephen A. Soper, "BioMEMS: Technologies and Applications", CRC Press, New York, 2007 (Unit V)
3. Mark J. Schulz, Vesselin N. Shanov, Yeoheung Yun, "Nanomedicine Design of Particles, Sensors, Motors, Implants", Artech House, 2009.
4. Neelina H. Malsch, "Biomedical Nanotechnology", CRC Press, 2005.
5. Chang Liu, "Foundations of MEMS", Pearson Education International, New Jersey, USA, 2006.
6. Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, First Edition 2002
7. Abraham P. Lee and James L. Lee, "BioMEMS and Biomedical Nanotechnology", Volume I, Springer, First Edition 2006.
8. Steven S. Saliterman, "Fundamentals of BioMEMS and Medical Microdevices", International Society for Optical Engineering, First Edition 2006

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<b>Name of the Course</b>	<b>MEDICAL ROBOTICS &amp; AUTOMATION</b>
<b>Course Code: OE-BME703</b>	<b>Semester: Seventh</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To introduce fundamental concepts in robotics, robot structure and workspace.
2	To expose to a broad range of topics in robotics with emphasis on basics of actuators, grippers, manipulators, kinematics and sensors system.
3	To provide the basic knowledge on design, analysis, control and working principle of robotics in medical field.
<b>Pre-Requisite:</b> Basic Knowledge of Electronics, Sensors, Mechanics	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction of Robotics:</b> Introduction to robots, robot subsystems and classification, degrees of freedom, configurations and concept of workspace, automation, mechanisms and movements, dynamic stabilization, applications of robotics in medicine.	8
2	<b>Actuators &amp; Grippers:</b> Pneumatic and hydraulic actuators, stepper motor control circuits, end effectors, various types of grippers, design consideration in vacuum and other methods of gripping, PD and PID feedback actuator models.	8
3	<b>Manipulators &amp; Basic Kinematics:</b> Construction of manipulators, manipulator dynamic and force control, electronic and pneumatic manipulator, forward kinematic problems, inverse kinematic problems, solutions of inverse kinematic problems.	8
4	<b>Power Sources &amp; Sensors:</b> Sensors and controllers, internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder, variable speed arrangements, path determination, machinery vision, ranging, laser, acoustic, magnetic, fiberoptic and tactile sensor.	9
5	<b>Robotics in Medicine:</b> Biologically inspired robots, Da Vinci surgical system, image-guided surgical robotic systems, robotic tele-surgical system, bionic arm, clinical and surgical-cardiology, gynaecology, orthopaedics and neurology.	7

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the state of the art medical robots and their operational workspace characteristics.
2. Select and identify suitable automation hardware for given application.
3. Analyze and design the motion for articulated systems.
4. Identify and describe different types of medical robots and their potential applications.
5. Simulate the basic concepts in kinematics, dynamics and control relevant to medical robotics.
6. Design and implement robotic assistance for both minimally invasive surgery and image-guided interventions.

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**Text/Reference Books:**

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, First edition, 2003.
2. Spong and Vidyasagar, "Robot Dynamics and Control", John Wiley and Sons, First edition, 2008.
3. Fu, K. S., Gonzalez, R. C., Lee, C. S. G., "Robotics, control", sensing, Vision and Intelligence, Tata McGraw Hill International, First edition, 2008.
4. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thrun, "Principles of Robot Motion: Theory, Algorithms, and Implementations", Prentice Hall of India, First edition, 2005.
5. Philippe Coiffet, Michel Chirouze, "An Introduction to Robot Technology", Tata McGraw-Hill, First Edition, 1983.
6. Jacob Rosen, Blake Hannaford & Richard M Satava, "Surgical Robotics: System Applications & Visions", Springer 2011.
7. [http://www.lapsurg.com.br/arquivos/books/medical\\_robotics12402am020100000000.pdf](http://www.lapsurg.com.br/arquivos/books/medical_robotics12402am020100000000.pdf)
8. Barbara Webb and Thomas R Consi, "Bio Robotics: Methods & Applications", Barbara Webb and Thomas R Consi, AAAI Press/MIT Press, First Edition, 2001.

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<b>Name of the Course</b>	<b>INDIAN CONSTITUTION</b>
<b>Course Code: MC-HU701</b>	<b>Semester: Seventh</b>
<b>L-T-P-C: 2-0-0-0</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To have basic knowledge about Indian Constitution.
2	To understand the structure and functioning of union, state and local self-government.
3	To understand the structure, jurisdiction and function of Indian judiciary.
<b>Pre-Requisite: NIL</b>	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to Constitution of India:</b> Sources of Constitutional history, Preamble and its Salient Features, Citizenship, Fundamental Rights and Duties, Directive Principles of State Policy.	3
2	<b>Union Government &amp; its Administration:</b> Structure of the Indian Union- Federalism, Centre-State relationship, President - Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha.	6
3	<b>State Government &amp; its Administration:</b> Governor - Role and Position, CM and Council of ministers, State Secretariat - Organization, Structure and Functions.	3
4	<b>The Judiciary:</b> The Supreme Court - Organization, Procedure, Jurisdiction and Power, Chief Justice and other Judges High Court/s - Organization, Procedure, Jurisdiction and Power Chief Justice and other Judges, Subordinate Courts - Structure, Jurisdiction and Procedure, Lok Adalats, PIL - Scope, Principle and Features	8
5	<b>Local Administration &amp; Election Commission:</b> Municipalities, Municipal Corporations, Town Area, Notified Area, Mayor - Role and Function, Zilla Parishad, Aanchal Parishad and Gram Panchayats, Powers, Functions and Key Functionaries, Chief Election Commissioner and Election Commissioners - Role and Functioning, State Election Commission: Role and Functioning..	6

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Describe the features of Indian Constitution.
2. Describe the power and functioning of union, state and local self-government.
3. Workings of the various legislative, executive and judicial bodies in the country.
4. Appreciate the democratic workings at the grassroots level.
5. Illustrate the jurisdiction and procedures of Indian Courts.
6. Identify authority to redress a problem in the profession and in the society.

### **Text/Reference Books:**

1. 'Indian Polity' by Laxmikanth, Mcgraw Hill Publications, 5th Edition.
2. 'Indian Administration' by Subhash Kashyap
3. 'Indian Administration' by Avasti and Avasti
4. Introduction to the Constitution of India, D Basu, Lexis Publications of India, 21<sup>st</sup> Edition.

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<b>Name of the Course</b>	<b>MEDICAL IMAGE PROCESSING LABORATORY</b>
<b>Course Code: PC-BME791</b>	<b>Semester: Seventh</b>
<b>L-T-P-C: 0-0-2-1</b>	<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>	
1	To learn fundamental image processing techniques and characteristics of different types of medical images.
2	To understand the basic medical image enhancement, transforms, segmentation, compression, representation techniques and algorithms for quality improvement of an image.
3	To practice the basic image processing techniques and application of different classical image processing techniques for different types of medical images.

**LIST OF EXPERIMENTS:**

1. Image characterization and digital image fundamentals
2. LP, HP, Mean and Median filtering of medical images
3. Image transformation technique of medical images
4. Image enhancement by histogram
5. Image smoothing technique of medical images
6. Image sharpening technique of medical images
7. Point, line and edge detection algorithms
8. Image segmentation technique of medical images
9. Image compression technique of medical images
10. Morphological image processing
11. Reconstruction of CT images
12. Fourier reconstruction of MRI images
13. A mini project based on medical image processing

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Employ image processing and analysis techniques appropriate to medical imaging.
2. Perform different operations to improve the quality of medical images.
3. Design and implement algorithm(s) for a medical image processing application.
4. Apply image processing technique to solve real health care problems.

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<b>Name of the Course</b>		<b>INDUSTRIAL / HOSPITAL TRAINING EVALUATION</b>
<b>Course Code: PROJ-BME792</b>		<b>Semester: Seventh</b>
<b>L-T-P-C: 0-0-2-1</b>		<b>Contact: 2 hrs/week</b>
<b>Objectives:</b>		
1	To	visualizetherealworkingenvironmentandget acquaintedwiththeorganizationstructure,businessoperationsandadministrative functions.
2	To observe medical professionals at work and the roles of allied health professionals.	
3	To provide hands-on experience atsite where biomedical equipment are manufactured or utilized (hospitals).	
4	To use theknowledge ofone'sown role and thoseof otherprofessionstoaddressthehealthcare needsofpopulations and patientserved.	

**GUIDELINES:**

- Complete training in any leading multi-speciality hospital /medical industry for duration of 2-4 weeks.
- Prepare an extensive report as per the standard format and submit to the concerned course in-charge during the session.
- Evaluation should be based on the presentation, viva-voce and final report.

**COURSE OUTCOMES**

At the end of the course, students should able to:

1. Communicatewith other health professionalsand practice professional ethics and legal issues in workplace.
2. Recognize theimportance ofinter-professional collaborationin healthcare.
3. Analyzereal-timeproblemsandadvocate an appropriateproblemsolvingmethodology.
4. Propose apatient-centered inter-professional health improvementplanbaseduponthepatient'sperceivedneeds.

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<b>Name of the Course</b>	<b>PROJECT-I</b>
<b>Course Code: PROJ-BME793</b>	<b>Semester: Seventh</b>
<b>L-T-P-C: 0-0-12-6</b>	<b>Contact: 12 hrs/week</b>
<b>Objectives:</b>	
1	To enable the students to come up with their own innovative ideas and realize it.
2	To develop skills to formulate a technical project.
3	To gain experience in organization and implementation of a small project and thus acquire the necessary confidence to carry out main project.
4	To provide guidelines to prepare technical report of the project.

**GUIDELINES:**

- Project should be carried out by a group of 3 or 4 and not more than 4 in a group.
- Project may be a hardware or combination of hardware and software.
- PCB soldering and testing.
- Documentation in the form of project report is to be submitted at the end of the semester.
- Evaluation should be based on the demonstration, viva-voce and final report.

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Express the technical ideas, strategies and methodologies.
1. Convert ideas of interest into a conceptual model.
2. Work in a group in a collaborative and productive manner.
3. Prepare technical report and present theoretical demonstrations.

**Special Remarks:**

The above mentioned outcomes are not limited. Institute may redefine course outcomes based on their Program Educational Objectives (PEOs).

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**SEMESTER-VIII**

<b>Name of the Course</b>	<b>HOME MEDICARE TECHNOLOGY</b>
<b>Course Code: PE-BME801</b>	<b>Semester: Eighth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To provide basic knowledge of home medicare system and various clinical application.
2	To understand the various aspects that influence safety, quality and effective home medicare.
3	To gain in-depth knowledge about the advances in healthcare technologies and wireless technology related to healthcare system.
<b>Pre-Requisite:</b> Engineering Physiology & Anatomy (PCBME302), Biomedical Instrumentation (PCBME402), Telehealth Technology (PEBME501)/Communication Engineering & Bio-Telemetry (PEBME502).	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to Home Medicare:</b> Home healthcare, purpose, legal and ethical aspects, organization of home care system, historical development of home care, environmental influences on home care, home care organization, home care nursing practice, role of home care nurse and orientation strategies, infection control in home, patient education in home.	8
2	<b>Working with Clients:</b> Basic human needs, communication and interpersonal skills, caregiver observation, recording and reporting, confidentiality, working with elderly-aging and body systems, working with children-need for home care, mobility-transfers and ambulation, range of motion exercises, skin care and comfort measures.	8
3	<b>Home Medical Devices:</b> Medical devices at home, user centered design and implementation, co-design with old users, device types, user issues, ethical and legal issues, infant monitors, medical alert services, activity monitors.	7
4	<b>Advancement in Medical Technologies:</b> Advances and trends in health care technologies, driver impacting the growth of medical technologies, impact of Moore's law of medical imaging, e-health and personal healthcare, defining the future of health technology, inventing the future, tools for self-health, future of nano-fabrication molecular scale devices, future of telemedicine, future of medical computing.	10
5	<b>Wireless Technology:</b> Wireless communication basics, types of wireless network, body area network, emergency rescue, remote recovery, general health assessment technology in medical information processing, future trends in healthcare technology.	7

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the understanding about basics of home medicare system.
2. Identify the critical elements for providing effective integrated health care at home.
3. Evaluate home medicare devices and their clinical applications.

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4. Illustrate the various aspects that influence safety, quality and effective home medicare.
5. Anticipate advances in healthcare technologies and wireless technology related to healthcare system.
6. Plan and design cost effective quality home care devices with proper patent safety.

**Text/Reference Books:**

1. Robyn Rice, "Home care nursing practice: Concepts and Application", 4th edition, Elsevier, 2006.
2. LodewijkBos, "Handbook of Digital Homecare: Successes and Failures", Springer, 2011.
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph D. Bronzino, "Clinical Engineering", CRC Press, 2010.
4. Kenneth J. Turner, "Advances in Home Care Technologies: Results of the match Project", Springer, 2011.

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<b>Name of the Course</b>	<b>BIOMEDICAL HAZARDS &amp; SAFETY</b>
<b>Course Code: PE-BME802</b>	<b>Semester: Eighth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand the hazardous materials used in hospital and its impact on health.
2	To know various waste disposal procedures and management.
3	To impart sufficient information on the various hazards, medical wastes and relevant precautionary control measures for patient safety in healthcare system.
<b>Pre-Requisite:</b> Biomedical Instrumentation (PCBME402), Hospital Engineering & Management (PEBME701)/Hospital Safety & Management (PEBME702).	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Hazardous Materials:</b> Hazardous Substances, OSHA hazard communication standard, DOT hazardous material regulations, healthcare hazardous materials, medical gas systems, hazardous waste operations and emergency response standard, respiratory protection.	6
2	<b>Healthcare Hazard Control:</b> Introduction, hazard control, hazard control management, hazard control responsibilities, addressing behaviors, hazard control practice, hazard analysis, hazard control and correction, personal protective equipment, hazard control committees, hazard control evaluation, systems safety, ergonomics, understanding accidents: accident causation theories, human factors, accident deviation models, accident reporting, accident investigations, accident analysis, accident prevention, workers' compensation, orientation, education and training.	10
3	<b>Biomedical Waste Management:</b> Types of wastes, major and minor sources of biomedical waste, categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling, collection, storage and transportation, treatment and disposal.	8
4	<b>Infection Control, Prevention &amp; Patient Safety:</b> Healthcare immunizations, centers for disease control and prevention, disinfectants, sterilants, and antiseptics, OSHA bloodborne pathogens standard, tuberculosis, healthcare opportunistic infections, patient safety: organizational function, errors and adverse events, safety cultures, quality improvement tools and strategies.	8
5	<b>Facility Safety:</b> Introduction, administrative areas safety, slip, trip, and fall prevention, safety signs, colors and marking requirements, scaffolding, fall protection, machine guarding, compressed air safety, electrical safety, control of hazardous energy, OSHA hearing conservation standard, ventilating and air-conditioning systems, assessing IAQ, landscape and grounds maintenance, fleet and vehicle safety.	8

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### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the types of hazards, planning, organization and training needed to work safely with hazardous materials.
2. Explain the different types of hazardous exposure and its biological effects, exposure guidelines and basic workplace monitoring.
3. Analyze various hazards, infection, accidents and its control.
4. Categorize biowastes and design efficient waste disposal procedures.
5. Design different safety facility and control measures in hospitals.
6. Propose and adopt mandatory regulations and safety norms for improving healthcare delivery.

### **Text/Reference Books:**

1. Tweedy, James T., "Healthcare Hazard Control and Safety Management", CRC Press\_Taylor and Francis (2014).
2. Anantpreet Singh, Sukhjit Kaur, "Biomedical Waste Disposal", Jaypee Brothers Medical Publishers (P) Ltd (2012).
3. R.C. Goyal, "Hospital Administration and Human Resource Management", PHI, Fourth Edition, 2006
4. V.J. Landrum, "Medical Waste Management and Disposal", Elsevier, 1991

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<b>Name of the Course</b>	<b>BIOINFORMATICS &amp; EXPERT SYSTEM</b>
<b>Course Code: PE-BME803</b>	<b>Semester: Eighth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To get introduced to the basic concepts of bioinformatics and its significance in biological data analysis.
2	To acquaint with bioinformatics tools, biological database and recent advances in genomics technology.
3	To trained in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, and prediction of protein function.
4	To impart concepts of expert systems and its application in medical field.
<b>Pre-Requisite:</b> Knowledge of Biochemistry, Mathematics, Statistics, Computational theory, Analysis and Algorithm Design.	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to Bioinformatics:</b> Definition and history, applications of bioinformatics, internet resources, various databases and bioinformatics tools, organization of databases.	2
2	<b>Sequence Alignment:</b> Sequence analysis: protein and nucleic acids, analysis tools for sequences, data bank, pairwise and multiple sequence alignment, secondary structure predictions, fold recognition, FASTA-BLAST-amino acid substitution matrices.	8
3	<b>Projects &amp; Databases:</b> Structural comparisons, genome projects, biological information, database location and organization, access to database, software, database searching, locating specific entries, identity searches, similarity searches.	8
4	<b>Information Theory &amp; Biology:</b> Entropy, Shannon's formula, divergences from equiprobability and independence, Markov chains, ergodic processes, redundancy, application to DNA and protein sequences.	8
5	<b>DNA Mapping &amp; Sequencing:</b> Map alignment, large scale sequencing and alignment, shotgun-DNA sequencing, sequence assembly, gene predictions and molecular predictions with DNA strings.	8
6	<b>Experts Systems:</b> Overview of an expert system, structure of an expert systems, different types of expert systems-rule based, model based, case based and hybrid expert systems, knowledge acquisition and validation techniques, a case study: MYCIN.	6

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Demonstrate the most important bioinformatics databases, perform text and sequence-based searches, and analyze the results.
2. Carry out gene and protein expression patterns and modeling cellular interactions and processes.
3. Apply bioinformatics and biological databases to solve in real research problems.

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4. Choose biological data, submission and retrieval it from databases and design databases to store the information.
5. Illustrate the impact of bioinformatics in a global, economic, environmental, and societal context.
6. Design and develop expert system for real world problems.

### **Text/Reference Books:**

1. Sillince JA, Sillince M, "Molecular databases for protein sequence and structure studies", Springer Verlag, 1991.
2. M. Gribskov, J. Devereux, "Sequence Analysis primer" Stockton Press, 1989.
3. S.L. Seizberg, DB Searls, S. Kasif, "Computational Methods in Mol. Biol./Now Comprehensive Biochemistry", Vol.32. Elsevier 1998.
4. R.F. Doolittle, "Computer methods for macromolecular analysis-Methods in Enzymology", Vol.266, Academic Press 1996.
5. L.I. Garfield, "Information theory & living systems" Columbia University Press, 1992.
6. Dan Gusfield, "Algorithms on Strings Trees and Sequences", Cambridge University Press, 1997.
7. P. Baldi, S. Brunak, Bioinformatics; "A Machine Learning Approach", MIT Press, 1998.

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<b>Name of the Course</b>	<b>QUALITY CONTROL &amp; REGULATORY ASPECTS OF MEDICAL DEVICES</b>
<b>Course Code: OE-BME801</b>	<b>Semester: Eighth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To know the various quality standards and regulatory guidance used in healthcare.
2	To impart the fundamental knowledge on the medical devices and in vitro diagnostics, basis of classification and product life cycle of medical devices.
3	To make them understand the regulations of Food and Drug Administration.
4	To give sufficient knowledge about the legal and regulatory requirements for medical devices.
5	To know the regulatory requirements for approval of medical devices in regulated countries.
<b>Pre-Requisite:</b> Biomedical Instrumentation, Analytical & Diagnostic Equipment, Therapeutic Equipment & Implants, Imaging Instruments, Principles of management.	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Quality Management &amp; Assurance System:</b> Need for ISO 9000 and other quality systems, ISO 9000:2000 quality system elements, implementation of quality system, quality auditing, need for accreditation of hospitals, NABH, NABL.	6
2	<b>Classification of Medical Devices:</b> Introduction, definition, risk based classification and essential principles of medical devices and IVDs, differentiating medical devices IVDs and combination products from that of pharmaceuticals, product lifecycle of medical devices and classification of medical devices.	7
3	<b>Regulation of Medical Devices:</b> FDA regulations, history of medical device regulation, regulatory approval process for medical devices (Medical Device Directive, Active Implantable Medical Device Directive) and in-vitro diagnostics (In Vitro Diagnostics Directive), CE certification process, basics of in-vitro diagnostics, classification and approval process.	8
4	<b>Quality System Regulation &amp; Ethics:</b> Quality system regulations of medical devices: ISO 13485, quality risk management of medical devices: ISO 14971, validation and verification of medical device, adverse event reporting of medical device, clinical investigation of medical devices, clinical investigation plan for medical devices, good clinical practice for clinical investigation of medical devices (ISO 14155:2011).	9
5	<b>Regulation in Emerging Market &amp; Regulated Market:</b> Applicable regulations, regulatory registration procedure, guidelines and standards for regulatory filing of medical devices, data requirement for market authorization, advertising, labeling and packaging.	4
6	<b>IMDRF/GHTF:</b> Introduction, organizational structure, purpose and functions, regulatory guidelines, working groups, summary technical document (STED),	6

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	global medical device nomenclature (GMDN).	
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**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Examine the broad scope of the medical device industry and its quality assurance practices.
2. Explain the basics of medical devices and process of development.
3. Demonstrate the regulatory requirements for approval of medical devices.
4. Harmonize the initiatives for quality and ethical considerations for medical devices.
5. Conduct clinical evaluation and investigation for medical devices.
6. Propose procedures for approval and marketing of medical devices.

**Text/Reference Books:**

1. Douglas J. Pisano, David Mantus, "FDA regulatory affairs: a guide for prescription drugs, medical devices, and biologics".
2. Jonathan S. Kahan, "Medical Device Development: A Regulatory Overview".
3. John J. Tobin, Gary Walsh, "Medical Product Regulatory Affairs: Pharmaceuticals, Diagnostics, and Medical Devices".
4. Carmen Medina, "Compliance Handbook for Pharmaceuticals, Medical Devices and Biologics".
5. Webster J.G, Albert M. Cook, "Clinical Engineering, Principles & Practices", Prentice Hall Inc., Englewoodcliffs, New Jersey, 1979.
6. S. Amato, B. Ezzell, "Regulatory Affairs for Biomaterials and Medical Devices", Woodhead Publishing
7. Shayne C. Gad, "Safety Evaluation of Pharmaceuticals and Medical Devices: International Regulatory Guidelines", Springer.
8. Country Specific Guidelines from official websites.

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<b>Name of the Course</b>	<b>DESIGN CONCEPT &amp; MAINTENANCE OF BIOMEDICAL INSTRUMENTS</b>
<b>Course Code: OE-BME802</b>	<b>Semester: Eighth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To understand about basic design processes of medical device.
2	To introduce with basics of design, construction and development devices.
3	To familiarize with the application and troubleshooting, maintenance and repairing of medical instruments.
<b>Pre-Requisite:</b> Biomedical Instrumentation, Medical Equipment & Imaging Instruments, Knowledge of biomaterials and Management.	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to Design Process:</b> Needs finding, problem identification, prior art searches, strategy and concept generation, estimation, sketching, sketch modeling, machine elements, ergonomics and prototyping.	4
2	<b>Design of Medical Devices &amp; System:</b> Medical device classification, bioethics and privacy, biocompatibility and sterilization techniques, design of clinical trials, design control and regulatory requirements, introduction to specific medical technologies: biopotentials measurement (EMG, EOG, ECG, EEG), medical diagnostics (In-vitro diagnostics), medical diagnostics (Imaging), minimally invasive devices, surgical tools and implants.	10
3	<b>Medical Instruments Troubleshooting &amp; Testing:</b> AC, DC power supply, grounding, shielding, guarding, insulation testing, insulation resistance measurement, testing of electronic components, troubleshooting of PCB boards, calibration of analog and digital sensor probe, display interface, safe electrical practice, cables and standard, fuse, transformer testing, CT and PT, Panel wiring, troubleshooting of X-ray machines, troubleshooting of ECG recorders.,	10
4	<b>Maintenance of Medical Instruments:</b> BP apparatus, suction machine, microscope, ECG machines, pulse oximeter, patient monitor, X-ray machine, ultrasound machine, ventilator, dialyser, heart lung machine, surgical lights, incubator, baby warmer, infusion pumps, annual maintenance, contract requirements, vendor services, quality and safety standards.	10
5	<b>Maintenance of PC Based Medical Instruments:</b> Introduction to PC based medical instruments, system configuration and BIOS, identification and troubleshooting of PC components: motherboard, HDD, FDD, CD-ROM, monitor, printers, modems, ports etc.	6

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Perform needs finding and generate design requirements for medical instruments.
2. Utilize fundamental design principles, machine elements, manufacturing and assembly techniques.
3. Perform risk assessment for prototyping and countermeasure development.
4. Appreciate the need for grounding aspects, maintenance and troubleshooting.

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5. Identify the reasons for equipment failure and formulate solution.
6. Conduct investigation and analyze the data sheets for performance measurement of biomedical instruments.

### **Text/Reference Books:**

1. Paul H. King, Richard C. Fries, Arthur T. Johnson, "Design of Biomedical Devices and Systems", Third Edition, ISBN 9781466569133.
2. John G. Webster (ed), "Medical Instrumentation: Application and Design", 2007.
3. Peter J. Ogradnik, "Medical Device Design: Innovation from Concept to Market", Academic Press Inc; 1 edition (2012), ISBN-10: 0123919428.
4. Stefanos Zenios, Josh Makower, Paul Yock, Todd J. Brinton, Uday N. Kumar, Lyn Denend, Thomas M. Krummel, "Biodesign: The Process of Innovating Medical Technologies", Cambridge University Press; 1 edition (2009), ISBN-10: 0521517427.
5. Medical Equipment Maintenance Manual, Ministry of Health and Family Welfare, New Delhi, 2010.
6. Shakti Chatterjee, Aubert Miller, "Biomedical Equipment Repair", Cengage Learning Technology & Engineering, 2010.
7. David Herres, "Troubleshooting and Repairing Commercial Electrical Equipment", McGrawHill, Professional edition, 2013.
8. L. Nokes, B. Turton, D. Jennings, T. Flint, "Introduction to Medical Electronics Applications", A Butterworth Heinemann Title. 1995.
9. Joseph F. Dyro, "Clinical engineering handbook, Elsevier Academic Press, 2004.

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<b>Name of the Course</b>	<b>VIRTUAL INSTRUMENTATION DESIGN FOR MEDICAL SYSTEM</b>
<b>Course Code: OE-BME803</b>	<b>Semester: Eighth</b>
<b>L-T-P-C: 3-0-0-3</b>	<b>Contact: 3 hrs/week</b>
<b>Objectives:</b>	
1	To impart knowledge on the concepts of virtual instrumentation (VI).
2	To understand the programming concepts of VI and insight to various Common Instrument Interface.
3	To familiarize with the data acquisition system and analyzing tools for medical applications.
<b>Pre-Requisite:</b> Engineering Physiology & Anatomy (PC-BME302), Mathematics-III (BS-M301), Biomedical Instrumentation (PC-BME402)	

<b>M #</b>	<b>Content</b>	<b>Hrs</b>
1	<b>Introduction to Virtual Instrumentation (VI):</b> Historical perspective of VI, architecture and block diagram, comparison of VI with traditional instruments, need of VI, advantages, data flow techniques, graphical programming in data flow, comparison between graphical programming and conventional programming.	6
2	<b>Programming Techniques:</b> VIS and sub-VIS, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, strings, tables, file I/O functions, 2D and 3D plots, instrument drivers, publishing measurement data in the web.	9
3	<b>Data Acquisition Basics:</b> Introduction to data acquisition on PC, sampling fundamentals, I/O techniques and buses. ADC, DAC, digital I/O, counters and timers, DMA, software and hardware installation, calibration, resolution, data acquisition interface requirements.	9
4	<b>Common Instrument Interface:</b> Common instrument interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, Firewire, PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI.	9
5	<b>Analysis Tools and Designing for Medical Applications:</b> Fourier transform, power spectrum, correlation, windowing, filtering, oscilloscope, waveform generator, Multi-channel data acquisition using LABVIEW, Medical applications: ECG, EMG, Air Flow and Lung Volume, HR variability analysis, noninvasive BP measurement.	7

### **COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Explain applications of mathematical modelling for designing virtual instrument.
2. Relate fundamental physiological properties with virtual biomedical instruments.
3. Demonstrate advanced analysis capabilities that explore potential research topics.
4. Demonstrate clinical utilization of virtual biomedical instrumentation.
5. Categorise functions related to medical device development and tests.
6. Design and implement data acquisition system with PC interfacing.

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**Text/Reference Books:**

1. Stephan Bennett, Emagic Logic Virtual Instruments, PC Publishing 2003.
2. Anand M M S, Electronic Instruments and Instrumentation Technology, PHI Publishers, 2007.
3. Gary Jonson, "Labview Graphical Programming", McGraw Hill, New York, Fourth edition 2006.
4. Lisa K. Wells, Jeffrey Travis, "Labview for everyone", Prentice Hall Inc., New Jersey; First edition 1997.
5. Gupta S, Gupta J P, "PC interfacing for Data Acquisition & Process Control", Instrument Society of America, Second Edition, 1994
6. K. James, PC Interfacing and Data Acquisition: Techniques for Measurement Instrumentation and Control, Newness, 2000.
7. Sokoloff, Basic Concepts of Labview, Prentice Hall, New Jersey.
8. Technical Manuals for DAS Modules of Advantech and National Instruments

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<b>Name of the Course</b>	<b>DESIGN LAB / INDUSTRIAL PROBLEM RELATED PRACTICAL TRAINING</b>
<b>Course Code: PROJ-BME891</b>	<b>Semester: Eighth</b>
<b>L-T-P-C: 0-0-4-2</b>	<b>Contact: 4 hrs/week</b>
<b>Objectives:</b>	
1	To understand requirement of engineering for new product development and convert them in to design specification.
2	To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics.
3	To conceptualize, prototype and develop product management plan for a new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems.
4	To understand the global trends and development methodologies of various types of products and services.

**GUIDELINES:**

- Carry out a comprehensive work on the chosen topic which will stand them in good stead as they face real life situation.
- Convert innovative ideas into working models /systems using all the concepts learnt and use suitable modern tools.
- Take up any challenging practical problems and find solution by formulating proper methodology.
- Expected to exert on design, development and testing of the proposed work.
- Industry related problems are highly encouraged and assess its impact.

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Develop a model or simulation or prototype using industry best practices and tools.
2. Design a medical electronic circuits starting with a given specifications.
3. Solve a specific problem right from its identification till the successful solution of the same.
4. Formulate a real world problem, identify the requirement and develop the design solutions.

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<b>Name of the Course</b>	<b>PROJECT-II</b>
<b>Course Code: PROJ-BME892</b>	<b>Semester: Eighth</b>
<b>L-T-P-C: 0-0-12-6</b>	<b>Contact: 12 hrs/week</b>
<b>Objectives:</b>	
1	To estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model.
2	To teach use of new tools, algorithms and techniques required to carry out the projects.
3	To give guidance on the various procedures for validation of the product and analyze the cost effectiveness.
4	To train the students in preparing project reports and to face reviews and viva voce examination.

**GUIDELINES:**

- The project topics are decided in Phase-1 and the project work is to be carried out in group of 3 or 4.
- Industry projects are encouraged and promoted.
- Submit a report showing the design and implementation along with the literature survey.
- project work is evaluated based on oral presentation and the project report jointly by external and internal examiners

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Prepare a comprehensive technical project report and communicate with engineers and the community at large.
2. Utilize the new tools, algorithms, techniques that contribute to obtain the solution of the project.
3. Test and validate through conformance of the developed prototype and analyze the cost effectiveness.
4. Work independently as well as in teams and manage a project from start to finish.

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<b>Name of the Course</b>	<b>GRAND VIVA-VOCE</b>
<b>Course Code: BME881</b>	<b>Semester: Eighth</b>
<b>L-T-P-C: 0-0-0-1</b>	<b>Contact: NIL</b>
<b>Objectives:</b>	
1	To assess comprehensive knowledge on all courses in under graduate program in Biomedical Engineering.
2	To judge the basic concepts of core courses and techniques applicable to their own area of professional practice.
3	To evaluate knowledge and ideas gained in real world problems and issues relevant to the field.
4	To prepare the students to face interview both at the academic and the industrial sector.

**GUIDELINES:**

- Viva voce will be conducted at the end of the programme.
- Involvement of external experts is highly appreciated.
- Assessment should be in cognitive, affective and psychomotor domain of learning.

**COURSE OUTCOMES**

At the end of the course, students should be able to:

1. Explore their field of knowledge, which includes a critical awareness of current problems and/or new insights at the forefront of that field.
2. Demonstrate confidence and versatility in answering the varieties of questions posed by a group of faculty members in a moderately short duration.
3. Demonstrate self-direction and originality in tackling and solving problems, and act autonomously in planning and implementing tasks at a professional or equivalent level.
4. Demonstrate originality in the application of knowledge, together with a practical understanding of how established techniques professional enquiries are used to create and interpret knowledge in their discipline.

**Special Remarks:**

The above mentioned outcomes are not limited. Institute may redefine course outcomes based on their Program Educational Objectives (PEOs).