Syllabus
for
Bachelor of Technology *(B-Tech.)* **Programme**
in

Biomedical Engineering
Effective from August, 2017

School of Technology,
North-Eastern Hill University, Mawkynroh,
Umshing, Shillong – 793 022

Contents

1. Acronyms used in subject coding

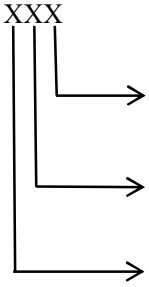
1.1 SUBJECT NOMENCLATURE AND CODING

BM – Biomedical Engineering
MA – Mathematics
PH – Physics
CH – Chemistry
HU – Humanities
ES – Environmental Science
EE – Electrical Engineering
CE – Civil Engineering
ME – Mechanical Engineering
EC – Electronics and Communication Engineering
IT – Information Technology

Subject Coding for *Core Paper*:

Three Digit Numeric Numbers Used in Subject Code (e.g.BM –XXX):

XXX



Subject Number (In case of Practical, this number stands for its corresponding theory subject number. However, where there is no corresponding theory paper, this number will start from6. For example, BM- 116)

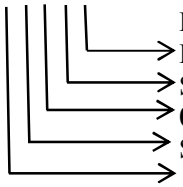
0 for Theory and 1 for Practical/Drawing/Design

Semester Number

Subject Coding for *Elective Paper*:

Five Digit Numeric Numbers Used in Subject Code (e.g. BM –XXXXX)

XXXXX



Elective Subject Number
Elective Number
Subject Number in the Semester
0 for Theory and **1** for Practical/Drawing/Design
Semester Number

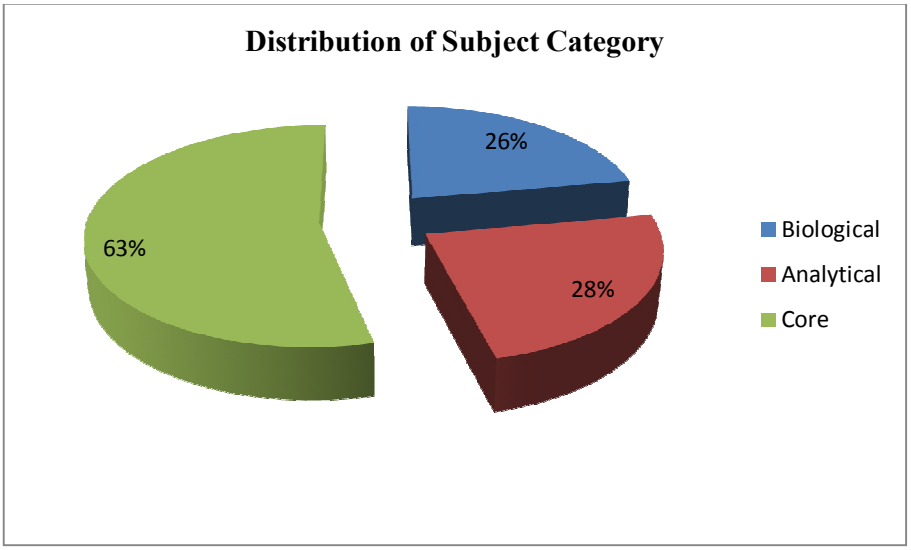
For example, BM – 70412: It is a Seventh (7) Semester First (1) Elective Theory (0) Paper. Paper serial number in the Seventh Semester Paper List is four (4) while elective serial number two (2) in the First Elective Paper List of the Semester.

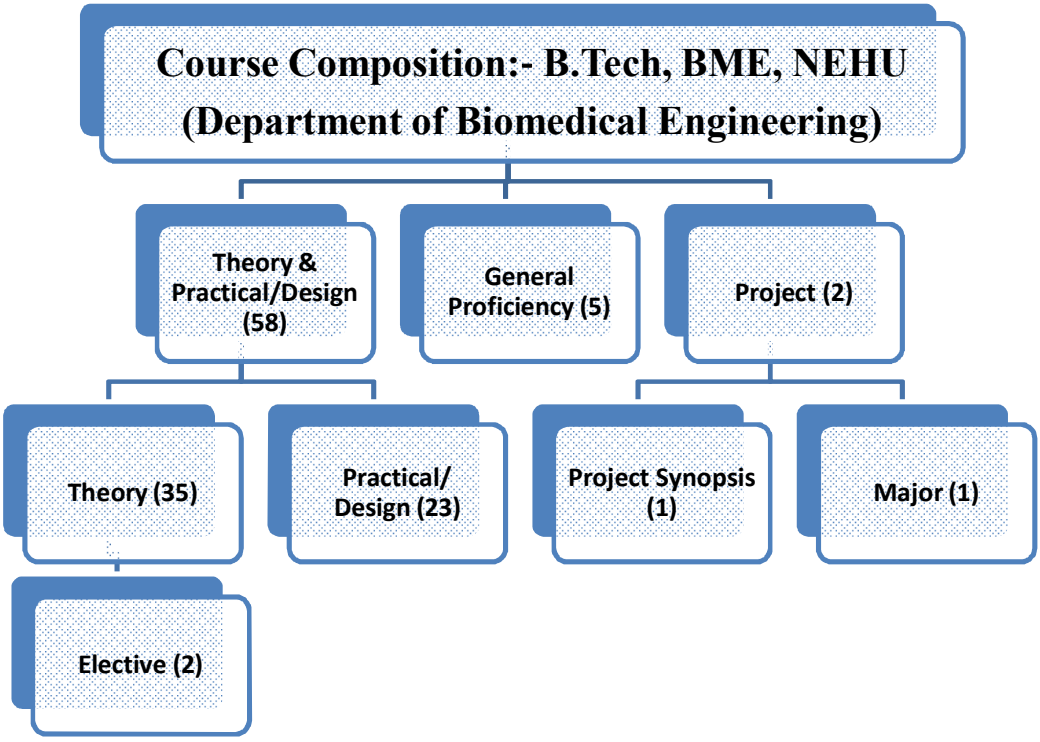
1.2 GENERAL PROFICIENCY:

GP I and II would be based on the industrial training the students would have undergone during Winter/ Semester Break after Second and Third year(s) of their B-Tech programme. The evaluation would be done by a committee comprising of the Head of the Department and three Department faculty members.

In GP – III, the students shall be evaluated based on skills acquired during their Project and interactions with industry/research institution/ hospital etc. The evaluation would be done through a committee constituted by the Head of Department, comprising of the Head of the Department, two faculty members and an outside expert in the field.

1.3 COURSE COMPOSITION AT A GLANCE





2.1 SCHEME OF FIRST SEMESTER

BRANCH: Biomedical Engineering YEAR: I GROUP A SEMESTER I

Sl. No	Subject Code	Subject Name	Evaluation Scheme (distribution of marks)					Credits
(THEORY)			Internal Works			ESE	SUBTOTAL	
			TA	CT	TOT			
1	MA – 101	Engineering Mathematics-I	20	20	40	60	100	**4**
2	CH –102	Engineering Chemistry	20	20	40	60	100	**4**
3	ME –103	Engineering Mechanics	15	15	30	45	75	**3**
4	PH – 104	Engineering Physics	20	20	40	60	100	**4**
5	BM-105	Introduction to Biomedical Engineering	15	15	30	45	75	**3**
(PRACTICAL)								
6	CH –112	Engineering Chemistry Laboratory	20	-	20	30	50	**2**
7	PH– 114	Engineering Physics Laboratory	20	-	20	30	50	**2**
		Total					**550**	**22**

Total Contact Hours: 24

L– Lecture **T –** Tutorial **P–** Practical **TA –** Teachers Assessment **Total Marks: 600**

CT– Class Test **TOT –** Total Internal Marks **ESE–** End Semester Examination **Total Credits: 22**

2.2 SCHEME OF SECOND- SEMESTER

BRANCH: Biomedical Engineering YEAR: I GROUP B SEMESTER II

Sl. No	Subject Code	Subject Name	Evaluation Scheme (distribution of marks)					Credits
(THEORY)			**Internal Works**			**ESE**	**SUB TOTAL**	
			TA	CT	TOT			
1	MA – 201	Engineering Mathematics - II	20	20	40	60	100	**4**
2	IT – 202	Computer Systems and Programming	20	20	40	60	100	**4**
3	ES – 203	Elements of Environmental Sciences	20	20	40	60	75	**3**
4	EE – 204	Basic Electrical Engineering	20	20	40	60	100	**4**
5	HU-205	Professional Communication Skills	15	15	30	45	75	**3**
(PRACTICAL)								
6	IT – 212	Computer Programming Laboratory	20	-	20	30	50	**2**
7	EE – 214	Basic Electrical Engineering Laboratory	20	-	20	30	50	**2**
							550	**22**

Total Contact Hours: 25

L– Lecture **T –** Tutorial **P–** Practical **TA –** Teachers Assessment **Total Marks: 550**

CT– Class Test **TOT –** Total Internal Marks **ESE–** End Semester Examination **Total Credits: 22**

2.3 SCHEME OF THIRD SEMESTER

BRANCH: Biomedical Engineering **YEAR: II** **SEMESTER III**

Sl. No	Subject Code	Subject Name	Evaluation Scheme (distribution of marks)						Credits
(THEORY)				Internal Works			ESE	SUB TOTAL	
				TA	CT	TOT			
1	BM-301	Bioelectronics		20	20	40	60	100	**4**
2	BM-302	Biomaterials		20	20	40	60	100	**4**
3	BM-303	Human Anatomy and Physiology		20	20	40	60	100	**4**
4	BM-304	Medical Microbiology and Biochemistry		20	20	40	60	100	**4**
(PRACTICAL)									
5	BM-311	Bioelectronics Laboratory	-	20	-	20	30	50	**2**
6	BM-313	Human Anatomy and Physiology Laboratory	-	20	-	20	30	50	**2**
7	BM- 314	Medical Microbiology and Biochemistry Laboratory	-	20	-	20	30	50	**2**
		Total	**12**					**550**	**22**

Total Contact Hours: 25

L– Lecture **T –** Tutorial **P–** Practical **TA –** Teachers Assessment **Total Marks:550**

CT– Class Test **TOT –** Total Internal Marks **ESE–** End Semester Examination **Total Credits: 22**

2.4 SCHEME OF FOURTH SEMESTER

BRANCH: Biomedical Engineering **YEAR: II** **SEMESTER IV**

Sl. No	Subject Code	Subject Name	Evaluation Scheme (distribution of marks)					Credits
(THEORY)			Internal Works			ESE	SUB TOTAL	
			TA	CT	TOT			
1	MA-401	Statistics and Random Processes	20	20	40	60	100	**4**
2	BM-402	Biomedical Instrumentation –I	20	20	40	60	100	**4**
3	BM-403	Tissue Engineering and Artificial Organs	20	20	40	60	100	**4**
4	BM-404	Biomedical Signals and Systems	20	20	40	60	100	**4**
(PRACTICAL)								
5	BM-412	Biomedical Instrumentation Laboratory –I	20	-	20	30	50	**2**
6	BM-414	Biomedical Signals and Systems Laboratory	20	-	20	30	50	**2**
7	GP-I	General Proficiency – I	-	-	50	-	50	**2**
		Total					**550**	**22**

Total Contact Hours: 22

L– Lecture **T –** Tutorial **P–** Practical **TA –** Teachers Assessment **Total Marks: 550**

CT– Class Test **TOT –** Total Internal Marks **ESE–** End Semester Examination **Total Credits: 22**

2.5 SCHEME OF FIFTH SEMESTER

BRANCH: Biomedical Engineering **YEAR: III** **SEMESTER V**

Sl. No	Subject Code	Subject Name	Evaluation Scheme (distribution of marks)					Credits
(THEORY)			Internal Works			ESE	SUB TOTAL	
			TA	CT	TOT			
1	BM-501	Bio-Transport Process	20	20	40	60	100	**4**
2	BM-502	Microprocessor and Microcontroller	20	20	40	60	100	**4**
3	BM-503	Biomedical Signal Processing	20	20	40	60	100	**4**
4	BM-504	Biomedical Instrumentation-II	20	20	40	60	100	**4**
(PRACTICAL)								
5	BM-512	Microprocessor and Microcontroller Laboratory	20	-	20	30	50	**2**
6	BM-513	Biomedical Signal Processing Laboratory	20	-	20	30	50	**2**
7	BM-514	Biomedical Instrumentation-II Laboratory	20	-	20	30	50	**2**
							550	**22**

Total Contact Hours: 25

L– Lecture **T –** Tutorial **P–** Practical **TA –** Teachers Assessment **Total Marks: 500**

CT– Class Test **TOT –** Total Internal Marks **ESE–** End Semester Examination **Total Credits: 20**

2.6 SCHEME OF SIXTH SEMESTER

BRANCH: Biomedical Engineering **YEAR: III** **SEMESTER VI**

Sl. No	Subject Code	Subject Name	Evaluation Scheme (distribution of marks)					Credits
(THEORY)			Internal Works			ESE	SUB TOTAL	
			TA	CT	TOT			
1	BM-601	Biomechanics and Rehabilitation Engineering	20	20	40	60	100	**4**
2	BM-602	Medical Imaging and Image Processing	20	20	40	60	100	**4**
3	BM-6031X	Elective I	20	20	40	60	100	**4**
4	HU-604	Professional Ethics and IPR	20	20	40	60	100	**4**
(PRACTICAL)								
5	BM-611	Biomechanics and Rehabilitation Engineering Laboratory	20	-	20	30	50	**2**
6	BM-612	Medical Image Processing Laboratory	20	-	20	30	50	**2**
7	GP-II	General Proficiency –II	-	-	50	-	50	**2**
		Total					**550**	**22**

Total Contact Hours: 22

L– Lecture **T –** Tutorial **P–** Practical **TA –** Teachers Assessment **Total Marks: 550**

CT– Class Test **TOT –** Total Internal Marks **ESE–** End Semester Examination **Total Credits: 22**

Elective-I:-

1) Nano medicine
2) Hospital Management
3) Virtual Instrumentation

2.7 SCHEME OF SEVENTH SEMESTER

BRANCH: Biomedical Engineering **YEAR: VI** **SEMESTER VII**

Sl. No	Subject Code	Subject Name	Evaluation Scheme (distribution of marks)					Credits
(THEORY)			Internal Works			ESE	SUB TOTAL	
			TA	CT	TOT			
1	BM-701	Medical Informatics and Telemedicine	20	20	40	60	100	**4**
2	BM-702	Biological Control System	20	20	40	60	100	**4**
3	BM-7032x	Elective-II* (Open Elective)	20	20	40	60	100	**4**
4	HU-704	Industrial Economics and Entrepreneurship	20	20	40	60	100	**4**
(PRACTICAL)								
5	BM-711	Biological Control System Laboratory	20	-	20	30	50	**2**
6	BM-715	Minor Project	40	-	40	60	100	**4**
		Total					**550**	**22**

Total Contact Hours: 25

L– Lecture **T –** Tutorial **P**– Practical **TA –** Teachers Assessment **Total Marks: 500**

CT– Class Test **TOT –** Total Internal Marks **ESE–** End Semester Examination **Total Credits: 20**

Elective-II (Open Elective):-

1) Artificial Intelligence in Biomedical Engineering
2) Laser and fibre optics
3) Fundamentals of Bio-MEMS

2.8 SCHEME OF EIGHTH SEMESTER

BRANCH: Biomedical Engineering **YEAR: IV** **SEMESTER VIII**

Sl. No	Subject Code	Subject Name	Evaluation Scheme (distribution of marks)					Credits
(THEORY)			Internal Works			ESE	SUB TOTAL	
			TA	CT	TOT			
(PRACTICAL)								
1	BM-815	Major Project*	80	80	160	240	400	**16**
2	BM-816	Seminar	-	-	100	-	100	**4**
3	GP – III	General Proficiency – III	-	-	50	-	50	**2**
		Total					**550**	**22**

Total Contact Hours: 20

L– Lecture **T** – Tutorial **P**– Practical **TA** – Teachers Assessment **Total Marks: 350**

CT– Class Test **TOT** – Total Internal Marks **ESE**– End Semester Examination **Total Credits: 14**

In the case of projects, TA = Assessment from the Guide(s), CT = Internal Seminar, and ESE = Seminar with External/Inter Departmental Expert

FIRST Semester Paper

MA-101 ENGINEERING MATHEMATICS -I 3-1-0 = 4

Subject Code: *MA – 101*
Subject Name: *Engineering Mathematics –I*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT-I
Differential Calculus of Single Variable: Functions, continuity and differentiability *(with emphasis on hyperbolic and inverse hyperbolic functions)***,** Properties of continuous functions on closed intervals, Intermediate value theorem and its applications, Successive differentiation; Taylor's and Maclaurin's series; L'Hospital rule (statements only with applications)

UNIT-II
Complex analysis*:* Analytic functions, Cauchy-Riemann equations, Cauchy's integral theorem, Cauchy's integral formula, Taylor series and Laurent series. Residue and its applications to evaluating real integrals (statements only with applications).

UNIT-III
Laplace and Fourier Transforms: Laplace transforms, Inverse transform, shifting on the ***s*** and ***t*** axes, convolutions, partial fractions, Fourier transforms, Solutions of ordinary differential equations by Laplace and Fourier transforms.

UNIT-IV
Linear Algebra: Vector space over the field of real and complex numbers, subspaces, bases and dimension; Matrices and Linear Transformation; Elementary row and column operations; echelon form; normal form; system of linear equations; Eigen values and Eigen vectors; Cayley-Hamilton theorem; diagonalization.

Text Books

1. E. Kreyszig, "Advance Engineering Mathematics", 8th Edition, J. Willey & Co, 1999.
2. Spiegel, "Fourier Analysis with application & Laplace Transforms", Tata McGraw Hill.
3. S. Pal and S. C. Bhunia, "Engineering Mathematics'', Oxford University Press, 2015.
4. B.S. Grewal, "Higher Engineering Mathematics", 42nd Edition, Khanna Publication.

Reference Books

1. Babu Ram, "Engineering Mathematics", Pearson.
2. Sastry, "Engineering Mathematics", PHI.
3. M. C. Potter, J. L Goldberg and E.F. Aboufadel, "Advance Engineering Mathematics" (Third Edition), Oxford University Press.

CH-102 ENGINEERING CHEMISTRY **3-1-0 = 4**

Subject Code: *CH - 102*
Subject Name: *Engineering Chemistry*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Unit – I
Chemical Thermodynamics: Second law of thermodynamics, entropy and its physical significance, entropy change of ideal gases, free energy, Maxwell's relations, Gibbs-Helmholtz equation, thermodynamic equilibrium, Van't Hoff equation, Clausius-Clapeyron equation, Nernst heat theorem, third law of thermodynamics.

UNIT – II
Organic Chemistry: Structures, functions and classification of biologically important molecules (Amino acids, Peptides, Proteins, Nucleic acids, Carbohydrates); Preparative methods of Amino acids and Peptides; Peptide sequencing; 3D Structure of Proteins; Reactions of monosaccharaides.
Polymers: Types of Polymerization; Classification and structures of polymers; Commercial uses of some important polymers (e.g. Nylons, Polyester, Polyurethane, Rubber, Teflon, Polycarbonate, Bakelite, Epoxy resin, Silicones, etc.).

UNIT - III
Electrochemistry: Electrochemical cells, EMF and applications of its measurement, commercially important cells, corrosion (its electrochemistry and remedial measures).
Chemical Kinetics: Reactions of different orders - general discussion, rate law with examples of zero, first and second order reactions, problems based on zero, first and second order reactions, pseudo-uniorder reaction, activation energy and role of catalyst in a reaction - collision theory and activation energy.

UNIT - IV
Water and its hazard in industry: Soft & Hard water and estimation of hardness of water, hazards of hard water in industry and treatment of industrial water (external and internal methods).
Fundamentals of Spectroscopy: Microwave, infra-red and UV-VIS spectroscopic techniques.

Text Books

1. Prakash, Tuli, Basu and Madan, "Advanced Inorganic Chemistry", Vol. I & II (Diamond Ed.), S. Chand, Reprinted, 2006.
2. Morrison and Boyd, "Organic Chemistry", 6th Edition, Prentice Hall of India, reprinted, 2006.
3. Jain and Jain, "Engineering Chemistry", Dhanpat Rai Publishing Co., 2008.

Reference Books

1. S. H. Pine "Organic Chemistry", 5th Edition (special Indian ed.), Tata McGraw Hill, 2007.
2. Banwell and McCash, "Fundamentals of Molecular Spectroscopy", 4th Edition, Tata Mc Graw Hill, 1962.

ME-103 ENGINEERING MECHANICS **2-1-0 = 3**

Subject Code: *ME - 103*
Subject Name: *Engineering Mechanics*
No. of Hours Per Week: *Lectures-2, Tutorial-1*
Marks Distribution: *Sessional Works = 30, End Semester Examination = 45.*
Questions to be set: *Six (Q.1 of 15 marks shall be compulsory for all students to attempt and will comprise of the questions from all the Units. The remaining questions shall be of 10 marks each and to be set at least one from each Unit).*
Questions to be answered: *Any four.*
Duration of End Semester Examination: *Two and half hours.*

UNIT-I
Force Systems: Moment of a force about a point and about an axis; couple moment; reduction of a force system to a force and a couple. Equilibrium: Free body diagram; equations of equilibrium; problems in two and three dimensions; plane frames and trusses.

UNIT–II
Friction: Laws of Coulomb friction, problems involving large and small contact surfaces; square threaded screws; belt friction; rolling resistance. *Properties of Areas*: Moments of inertia and product of inertia of areas, polar moment of inertia, principal axes and principal moments of inertia.

UNIT–III
Kinematics and Rigid Body Dynamics: Particle dynamics in rectangular coordinates cylindrical coordinates and in terms of path variables; central force motion. Relative velocity, Translation, Pure rotation and plane motion of rigid bodies, D'Alembert's principle, linear momentum, principle of conservation of momentum, impact of solid bodies, work, energy, power, principle of conservation of energy.

Text Books

1. R. K. Bansal, "A textbook of Engineering Mechanics", Laxmi Publication, 1992.
2. F. P. Beer and F. R. Johnston, "Mechanics for Engineering", TMH, 1987.
3. S. Ramamurtham, "Engineering Mechanics", Dhanpatrai Publishing Company, 2003.

Reference Books

1. Timoshenko and Young, "Engineering Mechanics", McGraw Hill Publications, 1956.
2. A. Nelson, "Engineering Mechanics-Statics & Dynamics", McGraw Hill Publications (reprint), 2010.

PH-104 ENGINEERING PHYSICS **3-1-0 = 4**

Subject Code: *PH - 104*
Subject Name: *Engineering Physics*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*
(Numerical problems are to be covered in every relevant topic in all units)

UNIT-I

Classical mechanics and General properties of matter: Co-ordinate system: Cartesian, plane polar and Spherical polar coordinate system, Relationship between the coordinate system, velocity and acceleration in plane polar and spherical polar coordinate systems. Dimension analysis. Theory of Errors. Moment of inertia: Theorems of parallel and perpendicular axes. Compound pendulum and its theory. Elasticity: Interrelation of elastic constants. Torsion of a cylinder.

UNIT-II

Optics: Interference: Concept of Interference, types of interference, Young's double slit experiment, Newton's ring experiment: Theory and application, Diffraction: Fraunhofer diffraction at a single slit, diffraction grating. Fresnel diffraction, zone plate. Polarization: Types of polarization. Nicol prism as polarizer and analyzer, half wave plate and quarter wave plate and applications.

Unit-III

Atomic, molecular and nuclear Physics: Rutherford model , Bohr model and Sommerfeld model of hydrogen atom. Vector atom model; Spectra of hydrogen atom. Concept of a molecule, molecular spectra, Raman effect. Nuclear binding energy. Nuclear reaction and Q-value, Nuclear fission, chain reaction, concept of a nuclear reactor, nuclear fusion and stellar energy.

Unit-IV

Electromagnetism: Electric field intensity and electric potential and the relation between them, Gauss law, Lorentz force, Biot-Savart law, Ampere's law, Faraday law, Maxwell's equation, Electromagnetic (e. m.) wave equation, solution of e. m. wave, transverse nature of e. m. wave

Text Books:

1. P K Chakrabarthy, Mechanics and General Properties of Matter, Books & Allied Ltd., 2001
2. B B Laud, Electromagnetics, 2/e, New age international, 1997
3. A Beiser, Concepts of Modern physics, Tata McGraw Hill, New Delhi, 1997
4. H K Malik and A K Singh, Engineering Physics, Tata McGraw Hill, New Delhi, 2010.

Reference Books:

1. F W Sears, M W Zemansky and H D Young, University Physics, Narosa Publishing House, 1982
2. G R Fowles and G L Cassiday, Analytical Mechanics, 7/e, Ceingage Learning, Indian Edition, 2005.
3. P V Naik, Principles of Physics, Prentice Hall of India Pvt. Ltd., 2000.
4. S G Lipson, H Lipson and D S Tannhauser, Optical Physics, Cambridge University Press, 1995 .

BM-105 INTRODUCTION TO BIOMEDICAL ENGINEERING 2-1-0 = 3

Subject Code: *BM - 105*
Subject Name: *Introduction to Biomedical Engineering*
No. of Hours Per Week: *Lectures-2, Tutorial-1*
Marks Distribution: *Sessional Works = 30, End Semester Examination = 45.*
Questions to be set: *Six (Q.1 of 15 marks shall be compulsory for all students to attempt and will comprise of the questions from all the Units. The remaining questions shall be of 10 marks each and to be set at least one from each Unit).*
Questions to be answered: *Any four.*
Duration of End Semester Examination: *Two and half hours.*

UNIT I

Introduction to Biomedical Engineering: Definition, Terminology, Different areas or fields of Biomedical Engineering with applications, Need and role of biomedical engineer in society, Computer applications in Biomedical Engineering.

UNIT II

Medical Physics: Introduction, X-rays, Photography and film image, Fluoroscopy and angiography, Infrared Imaging, Special imaging techniques, Radioactivity, Radiation effects, Nuclear medicine system.

UNIT III

Patient safety: Electrical and patient safety, medical devices classification and their safety standards in working environment, different types of safety circuits for medical equipment and measures to reduce shock hazards.

Text Books

1. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 4th Edition, Tata McGraw Hill, 2014.
2. R. Hendee and E.R.Ritenour, "Medical Physics", Cambridge University Press, 1992.
3. W Leslie Cromwell "Biomedical Instrumentation and Measurements", 2nd Edition, 2010, PHI.

Reference Books

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg. , Boston, 1986.
2. Brown, Smallwood, Barber, Lawford and Hose, "Medical Physics and Biomedical Engineering", Institute of Physics Publishing, Bristol, 1999.

CH-112 ENGINEERING CHEMISTRY LABORATORY 0-0-3 = 2

Subject Code: *CH - 112*
Subject Name: *Engineering Chemistry Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. Volumetric estimation of Mg^{2+} and Ca^{2+} ions by EDTA titration (Hardness of water).
2. Volumetric estimation of Fe^{2+} ions by permanganatometry.
3. Determination of composition of the given liquid mixture by viscosity measurement.
4. Determination of partition-coefficient of iodine between carbon tetrachloride and water.
5. Determination of integral heats of dilution of sulphuric acid solutions, and to determine the strength of the given unknown acid solution.
6. Standardization of strong base by conductometric titration method using a strong acid.
7. Experimental verification of Hasselbach-Henderson equation by pH measurement and to determine the dissociation constant of weak acid.
8. Determination of rate constant of the acid catalyzed hydrolysis of methyl acetate.
9. Verification of Beer-Lambert law with potassium permanganate and the estimation of potassium present in the given solution.
10. Systematic qualitative analysis of organic compound containing one functional group:
    a. Detection of element out of N, S, Cl, Br, I.
    b. Detection of a functional group out of – COOH, $-NO_2$, -OH (alcoholic or phenolic), >CO carbonyl, $-NH_2$ group.
11. Standardization of unknown HCl solution against standard sodium hydroxide solution, spectrophotometrically.

Text Books

1. Pandey, Bajpai and Giri, "Practical Chemistry", S. Chand & Co. Ltd., 2006.
2. Gurtu and Kapoor, "Advanced Experimental Chemistry", Vol. I & II, 4th Edition (reprinted), S. Chand & Co. Ltd., 1989.

Reference Books

1. Vogel's, "Textbook of Quantitative Chemical Analysis", 5th Edition, ELBS, 1991.
2. Vogel's, "Textbook of Practical Organic Chemistry", 5th Edition, ELBS, 1996.

PH -114 ENGINEERING PHYSICS LABORATORY **0-0-3 = 2**

Subject Code: *PH - 114*
Subject Name: *Engineering Physics Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
Question to be answered: *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. To determine the acceleration due to gravity by bar pendulum/Kater's pendulum.
2. To determine the Young's modulus of a wire by any method
3. To determine rigidity modulus of a wire by statical method/dynamical method.
4. To find the wavelength of monochromatic light by using Newton's ring method.
5. To determine the wavelength of sodium light by Michelson's interferometer.
6. To determine the specific rotation of sugar solution by Polarimeter.
7. To determine the magnetic moment of a bar magnet (M) and the earth's horizontal intensity at a place by deflection and vibration magnetometers
8. To determine the wavelength of laser light using diffraction grating
9. To determine the resistance per unit length of a meter bridge wire by Carey- Foster method.
10. To determine the time constant of the RC circuit.
11. To obtain the hysteresis curves (B-H) for a ferromagnetic material (thin rod or wire) on CRO using solenoid and to determine the related magnetic constants.
12. To study the Hall Effect and determine the Hall Coefficient of a given material.
13. To determine the Planck's constant by a Photocell.
14. To determine the value of e/m of an electron by any method.
15. To determine the refractive index of a prism by using spectrometer.
16. To determine the velocity of ultrasonic waves in liquids.
17. To calibrate the given ammeter and voltmeter by potentiometer.
18. To determine energy band gap of a given semiconductor material.

Text Books:

1. Samir Kumar Ghosh, *A Text book of Practical Physics*, New Central Book Agency, Kolkata, 2006.
2. Gupta and Kumar, *Practical Physics*, Progati Prakashan, Meerut, U.P., 2005.
3. Harnam Singh, *B.Sc. Practical Physics*, S Chand & Company, 2004.
4. C. L. Arora, *Advance B.Sc. Practical Physics*, S. Chand, 2004.

SECOND Semester Paper

MA-201 ENGINEERING MATHEMATICS -II 3-1-0 = 4

Subject Code: *MA - 201*
Subject Name: *Engineering Mathematics -II*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT - I
Calculus of several variables: Partial derivatives. Chain rule, Standard Jacobians for change of variables. Gradientand directional derivatives. Tangent and normal planes. Exact differentials. Euler's theorem on homogeneous functions. Repeated and multiple integrals, maxima and minima for several variables, method of Lagranges multipliers.

UNIT - II
Vector Calculus: Vector valued function of one or more variables (up to 3), derivatives ofsuch a function of one variable. Gradient of a scalar valued function. Geometrical properties of gradient. Divergence and Curl of vector valued functions. Line, surface, and volume integrals. Green's theorem, Gauss's divergence theorem and Stoke's theorem in Cartesian coordinates (statements only with applications).

UNIT – III
Numerical Methods: Bisection method, Newton-Rapson's and Secant methods for roots of nonlinear equations. Polynomial interpolation, divided differences. Numerical differentiaon and Numerical integration, trapezoidal and Simpson's rules..

UNIT-IV
Ordinary Differential Equations (ODE): Ordinary linear differential equations of nth order, solutions of homogeneous equations, Wronskian, Operator method (simple problems only with emphasis on second order homogeneous equations).Variation of Parameters for second order linear ODE with variable coefficients. Nonlinear equations and Clairaut's equations.

Text Books
1. E. Kreyszig, "Advance Engineering Mathematics", 8th Ed, J. Willey & Co, 1999.
2. S. Pal and S. C. Bhunia, "Engineering Mathematics'' , Oxford University Press, 2015.
4. B.S. Grewal, "Higher Engineering Mathematics", 42nd Edition, Khanna Publication.

Reference Books
1. Babu Ram, "Engineering Mathematics", Pearson.
2. Sastry, "Engineering Mathematics", PHI.
3. M. C. Potter, J. L Goldberg and E.F. Aboufadel, "Advance Engineering Mathematics" (Third Edition), Oxford University Press.

IT - 202 COMPUTER SYSTEMS AND PROGRAMMING 3-1-0 = 4

Subject Code: *IT - 202*
Subject Name: *Computer Systems and Programming*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT - I
Digital computer fundamentals and file management: Functional components of computer, Von Newman Architecture, Algorithm and flowcharts, Data representation, Programming languages, Function of system software. Introduction to File management, Opening and Closing a File, Input/output Operations on Files, Error Handling during I/O Operations, Random Access to Files, command line Arguments.

UNIT - II
Imperative programming (Using C): Overview of C, Constants, Variables and Data Types, Operators and Expressions, Input and Output Operations, Branching and looping operation.

UNIT - III
Functions: Defining a function, accessing a function, passing arguments to a function, Specifying argument data types, function prototypes and recursion, storage classes. *Arrays***:** Defining an array, processing an array, passing arrays to a function, multidimensional arrays, strings, string handling functions.

UNIT - IV
Structures and Unions: Defining and processing of structure and union, Array of structure, array within structure, passing of structure as argument. *Pointers***:** Fundamentals, pointer declarations, passing pointers to a function, pointer and one dimensional arrays, pointer as function arguments, Functions returning Pointer, Pointer to functions, pointers and structures. Searching and Sorting.

Text Books

1. V. Rajraman, "Fundamental of Computer", 4th Edition, PHI, 2006.
2. E. Balaguruswami, "Programming in ANSI C", 2nd Edition, Tata McGraw Hill, 2004.
3. Behrouz A. Forouzan and Richard F.Gilberg, "A structured programming Approach Using C.", 3rd Edition, Cengage learning, 2008.

Reference Books

1. Y. Kanetkar, "Let us C", BPB Publication, 2004.
2. A. Kelley and I. Pohl, "A Book on C", 4th Edition, Pearson Education, 1998.

ES-203 ELEMENTS OF ENVIRONMENTAL SCIENCES 2-1-0 = 3

Subject Code: *ES - 203*
Subject Name: *Elements of Environmental Sciences*
No. of Hours Per Week: *Lectures-2, Tutorial-1*
Marks Distribution: *Sessional Works = 30, End Semester Examination = 45.*
Questions to be set: *Six (Q.1 of 15 marks shall be compulsory for all students to attempt and will comprise of the questions from all the Units. The remaining questions shall be of 10 marks each and to be set at least one from each Unit).*
Questions to be answered: *Any four.*
Duration of End Semester Examination: *Two and half hours.*

UNIT - I
Environment, ecosystems and biodiversity: Concept of environment*:* components of environment and their interactions; abiotic and biotic factors; Ecosystems: characteristic feature and structure and function of forest, grassland, desert and aquatic ecosystem (Ponds, streams, lakes, rivers, oceans, estuaries); Ecological pyramid; energy flow and nutrient cycling; Biodiversity: value of biodiversity; loss and conservation of biodiversity.

UNIT - II
Environmental problems and issues: Environmental problems and issues: greenhouse effect, ozone depletion, acid rain; Renewable and non-renewable resources; natural resources, associated problem and its conservation: forest, water, mineral, food, energy and land resources; environmental impact assessment; environment protection act.

UNIT - III
Environmental pollution and management: Environmental pollution: sources and types of air, water, soil, radioactive and noise pollution; Industrial pollutants and their impact on environment and human health; Toxicants and toxicity; toxic chemicals: heavy metals and pesticides; Safety and prevention of industrial pollution; bio-transformation and bioremediation; Aerobic and anaerobic treatment of waste water; waste management and cleaner production.

Text Books

1. W. P. Cunningham, and W.B. Saigo, “Environmental Science”, McGraw Hill, New York, 1999.
2. E. P. Odum, and G. W. Barrett, “Fundamentals of Ecology”, Thomson Asia Pvt. Ltd.Singapore, 2005.
3. E. Bacci, “Contaminants in the Environment”, CRC Press, 1994.

Reference Books

1. N. J. Sell, “Industrial Pollution Control: Issues and Techniques”, Wiley Publication, 1992.
2. Venugopal Rao, “Textbook of Environmental Engineering”, PHI, 2003.
.

EE- 204 BASIC ELECTRICAL ENGINEERING **3-1-0 = 4**

Subject Code: *EE - 204*
Subject Name: *Basic Electrical Engineering*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT – I
Engineering Circuit Analysis: Circuit elements, Ohm's law, Kirchoff's law, Nodal Analysis, Mesh Analysis, Source transformations. Linearity and Superposition, Thevenin and Norton Theorems, Maximum power transfer theorem, Star-Delta and Delta-Star Conversion.

UNIT – II
Series and Parallel RLC Circuits: Simple RL and RC Circuits, Unit Step Forcing Function, source free RLC Circuits, Sinusoidal Forcing Function, Complex Forcing Function, Phasor Concept, Impedance and Admittance, Phasor diagrams, Response as a Function of, Instantaneous Power, Average Power, RMS values of Current and Voltage, Apparent Power and Power Factor, Complex Power, Introduction to Three Phase Circuits.

UNIT – III
DC Machines: Principle of DC Generator, Methods of excitation, Characteristics and Applications, Principle of DC Motor, Types, Speed – Torque Characteristic, Speed Control. Transformers: Working principle of Transformers, Equivalent Circuit, Transformer tests.

UNIT –IV
Three Phase: Induction Motor: Construction, Production of rotating field, Slip, Torque and Slip. Single Phase Induction Motor: Double field revolving theory, Shaded Pole single phase induction motor. Stepper Motors.

Text Books

1. W.H. Hayt, J.E. Kemmerly and S.M. Durbin, "Engineering Circuit Analysis", 6th Edition, TMH, 2006.
2. D.P. Kothari, I. J. Nagrath, "Theory and Problems of Basic Electrical Engineering", PHI, 2004.
3. B.L. Thereja and A.K. Thereja, "Electrical Technology", Vol-II, S. Chand, Reprint 2006.

Reference Books

1. Van Valkenburg, "Network Analysis", 3rd Edition, PHI, 2005.
2. D. Roy Choudhury, "Networks and Systems", New Age Publishers, 1998.

HU-205 PROFESSIONAL COMMUNICATION SKILLS 2-1-0 = 3

Subject Code: *HU - 205*
Subject Name: *Professional Communication Skills*
No. of Hours Per Week: *Lectures-2, Tutorial-1*
Marks Distribution: *Sessional Works = 30, End Semester Examination = 45.*
Questions to be set: *Six (Q.1 of 15 marks shall be compulsory for all students to attempt and will comprise of the questions from all the Units. The remaining questions shall be of 10 marks each and to be set at least one from each Unit).*
Questions to be answered: *Any four.*
Duration of End Semester Examination: *Two and half hours.*

UNIT I
General Principles of Communication and Oral Communication: The Process of Communication, Principles of Communication(communication barriers, levels of Communication, Communication network, verbal, non-verbal) and Professional Communication. The Speech Mechanism, IPA Symbols (vowel and consonant sounds), minimal pairs, word transcription, stress and intonation, active listening, types of listening, traits of a good listener, active versus passive listening.

UNIT II
Constituents of Effective Writing and Vocabulary: The sentence and its parts, articles, the verb phrase, tense and aspect, the active and passive, the adjective, interrogative and negative sentences, concord, preposition. Paragraph development, summary writing and reading, comprehension word formation processes: affixation, compounding, converting, use of words in different parts of speech, idioms and phrases.

UNIT III
Business Correspondence and Communication Strategies: Characteristics of Business Letters, Drafting: Bio-data/ Resume/Curriculum vitae (theory).
Report Writing: Structure, Types of Reports (theory). Presentation Skills, Public speaking and group discussion (theory) and Soft Skills (theory).

Text Books

1. Das, B. K., Samantray K., "An Introduction to Professional English and Soft Skills", CUP, New Delhi, 2009.
2. Sharma R.C, Mohan K., "Business correspondence and Report Writing", Tata McGraw Hill, New Delhi, 2002.
3. Doff A., Jones, C., "Language In Use, Upper- Intermediate Classroom Book", CUP, New Delhi, 2004.

Reference Books

1. O'Connor, J. D., "Better English Pronunciation", CUP, London, 2006.
2. Patnaik, P., "Group Discussion and Interview Skills", CUP, New Delhi, 2011.

IT-212 COMPUTER PROGRAMMING LABORATORY **0-0-3 = 2**

Subject Code: *IT - 212*
Subject Name: *Computer Programming Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Programs

1. Assignments on Operators and Expressions: At least three C programs using operators and expressions.
2. Assignments on Branching: At least five C programs using if, switch-case construct of C.
3. Assignments on Looping: At least three C programs (each), incorporating for loop, while loop and do-while loop.
4. Assignments on Array: At least three C programs using array (1D and 2D)
5. Assignments on String: string manipulation and use of standard library functions in C.
6. Assignments on Function: At least three C programs using function, Demonstration call by-value and call-by-address, passing array (1D and 2D) to a function, at least two C programs related to recursive function.
7. Assignments on Pointer: At least three C programs using pointer, function and array.
8. Assignments on Structure and Union: At least one C program using structure, demonstration of difference between structure and union.
9. Assignments on File handling and Commands line arguments: C programs involving opening, closing, reading/writing a file. Copy the content of one file to another file using commands line, arguments.

Text Books

1. B. S. Gotfried, Programming in C, Schuam Outline Series, TMH, 2005.
2. Behrouz A. Forouzan and Richard F.Gilberg, "A structured programming Approach Using C.", 3rd Edition, Cengage learning, 2008.

Reference Books

1. Y. Kanetkar, "Let us C", BPB Publication, 2004.
2. A. Kelley and I. Pohl, "A Book on C", 4th Edition, Pearson Education, 1998.

EE-214 BASIC ELECTRICAL ENGINEERING LABORATORY 0-0-3 = 2

Subject Code: *EE - 214*
Subject Name: *Basic Electrical Engineering Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. To verify Thevenin's theorem.
2. To verify Norton's theorem.
3. To verify Maximum Power Transfer theorem.
4. To verify that the phasor sum of currents at any junction in an A.C. circuit is zero.
5. To measure Power and power factor of the load by three ammeters method.
6. To measure Power and power factor of the load by three voltmeters method.
7. To perform Open circuit and Short Circuit Tests on a single phase transformer.
8. To determine the Open Circuit Characteristic of D.C. Generator
9. To measure and control the Speed of D.C. motors using Tachometer.
10. To calibrate an ammeter as voltmeter.

Text Books

1. W. H. Hayt, J. E. Kemmerly and S.M. Durbin, "Engineering Circuit Analysis", 6th Edition, TMH, 2006.
2. B. L. Thereja and A.K. Thereja, "Electrical Technology", Vol-II, S. Chand & Co., Reprint, 2006.

Reference Books

1. Van Valkenburg, "Network Analysis", 3rd Edition, PHI, 2005.
2. D. Roy Choudhury, "Networks and Systems", New Age Publishers, 1998.

THIRD Semester Paper

BM-301 BIO-ELECTRONICS **3-1-0 = 4**

Subject Code: *BM - 301*
Subject Name: *Bioelectronics*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I
Basic Electronics: Semiconductor Materials, chemical and physical bonds, Intrinsic and extrinsic semiconductors, carrier motion in semiconductors – Drift, Diffusion And Recombination – Generation process, Boltzmann Transport equation, P-N junction diode, Bipolar Junction Transistor (BJT), Field Effect Transistor (FET), Operational Amplifier (OPAMP).

UNIT II
Signal generator and filters: Sine-wave generators, Multivibrators and Triangular wave generator, Saw-tooth wave generator, ICL8038 function generator, Timer IC 555, IC Voltage regulators – Three terminal fixed and adjustable, voltage regulators. Filters: low pass, high pass, band pass and band stop filters with medical applications.

UNIT III
Electronic devices: Metal - Oxide - Semiconductor (MOS): MOS Structure, Modes of operation, Metal Oxide Semiconductor Field effect Transistor (MOSFET) with applications in BME. Electrolyte – Insulator – Semiconductor (EIS): EIS Structure, Site binding Theory, Electrical double layer theory.

UNIT IV
Biosensors and bio-amplifiers: Introduction, classification with applications. Need for bio-amplifier - single and differential bio-amplifier. Filtering, isolation amplifiers and optical isolation- isolated DC and AC amplifier, chopper amplifier and power line interference.

Text Books

1. Massimo Grattarola, Giuseppe Massobrio, "Bioelectronics Handbook, MOSFETs, Biosensors & Neurons", Tata McGraw Hill, 1988.
2. J C Nicholls, A. R. Martin, B G Wallace, "From Neuron to Brain", Sinauer Associates, 5th Edition, 2012.
3. Ramakant A. Gayakwad, "OP-AMP and Linear ICs", 4th Edition, Prentice Hall / Pearson Education, 2001.

Reference Books

1. Metin Akay, "Neural Engineering", 1st Edition Wiley /IEEE Press, 2007.
2. Chandran Karunakaran, Kalpana Bhargava, Robson Benjamin "Biosensors and Bioelectronics", ELSEVIER, 2015.

BM-302 BIOMATERIALS **3-1-0 = 4**

Subject Code: *BM - 302*
Subject Name: *Biomaterial*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I

Introduction: Definition of biomaterials, requirements of biomaterials, classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.

UNIT II

Metallic implant materials: Introduction to Metallic, Polymeric and Biopolymers, Nanocomposite Implants importance of stress-corrosion cracking. Host tissue reaction with biometals, corrosion behaviour and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopaedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Polymeric implant materials, Polyolefins, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetals. (Classification according to thermosets, thermoplastics and elastomers). Viscoelastic behaviour: creep-recovery, stress-relaxation, strain rate sensitivity. Synthetic polymeric membranes and their biological applications.

UNIT III

Ceramic and Composite implant materials: Definition of bio ceramics. Common types of bio ceramics: Aluminium oxides, Glass ceramics, Carbon based materials. Bioresorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction. Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with oestrogenic fillers (e.g. hydroxyapatite).

UNIT IV

Biocompatibility and toxicological screening of biomaterials as well as Testing of biomaterials/Implants: Biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situ implantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization, carcinogenicity, mutagenicity and special tests. ETO, Gamma radiation, autoclaving. Effects of sterilization on material properties. In vitro testing (Mechanical testing): tensile, compression, wears, fatigue, corrosion studies and fracture toughness. In-vivo testing (animals): biological performance of implants. Ex-vivo testing: in vitro testing simulating the in vivo conditions. Standards of implant materials.

Text Books

1. Buddy D**.** Ratner, "Biomaterials Science**:** An Introduction to Materials in Medicine"**,** Academic Press**,** San Diego**,** 1996**.**
2. Sujata V. Bhat, "Biomaterials", Narosa Publishing House, 2002.
3. J B Park, "Biomaterials - Science and Engineering", Plenum Press, 1984.

Reference Books

1. Lawrence Stark and Gyan Agarwal, "Biomaterials", Plenum Publishing Corporation, 1969.
2. L. Hench & E. C. Ethridge, "Biomaterials - An Interfacial approach" Volume 19, Issue 5, Willey India, 1985.

BM-303 HUMAN ANATOMY AND PHYSIOLOGY **3-1-0 = 4**

Subject Code: *BM - 303*
Subject Name: *Human Anatomy and Physiology*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT-I
Introduction to the Human Body: Structure and function of Cell & cellular components, Blood and its composition, Overview of Immune system, Human body planes and sections. Polarization and depolarization of cell.

UNIT-II
Cardiovascular, Respiratory and Nervous Systems: Heart, Conductive tissue of heart, Cardiac cycle, Heart valves, Systemic & pulmonary circulation, Transmission of cardiac impulse, Blood pressure. Respiratory system: Respiration external (ventilation), Exchange in gases in the alveoli, Artificial respiration. Nervous System: Structure, Biology of neuron, Synapses and action potential generation, Mirror neurons, functioning, Reflex action & reflex arc. Function of sympathetic nervous system, Nervous conduction & action potentials. Sense organs: Eye, Ear, Integumentary system: Structure, Type and functions of skin.

UNIT-III
Alimentary and Excretory Systems: Alimentary system: All organs of the digestive system, other secretions & main functions. Excretory system: Structure of Nephron, Formation of urine & function of kidneys, Urinary bladder, urethra, Internal/external sphincters.

UNIT-IV
Endocrine and Reproductive Systems: Endocrine system: All glands, Their secretions, Control of secretions. Reproductive system of male and female, Spermatogenesis and oogenesis.

Text Books

1. Ross and Wilson, "Anatomy and Physiology in Health and Illness", 12th Edition, ELBS Publishers, 1987.
2. Vander, J. Sherman and D. Luciano, "Human Physiology", 8th Edition, Mc Graw Hill Publishers, 2001.

Reference Books

1. Charles E Tobin, "Manual of Human Dissection", 4th Edition, Mc Graw Hill, 1961.
2. J Gibson, "Modern Physiology and Anatomy of Nerves", Black Well Publication, 1981.

BM-304 MEDICAL MICROBIOLOGY AND BIOCHEMISTRY 3-1-0 = 4

Subject Code: *BM - 304*
Subject Name: *Medical Microbiology and Biochemistry*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I
Basic of Microbiology: Introduction, Types of microbes, Structure of bacteria, Fungi, Virus. Infection due to microbes, Sterilization process.

UNIT II
Introduction to Biochemistry and Medicine: Proteins, Enzymes: General properties of enzymes, Spectrophotometric measurement of enzymes (proteins) isolation methods study of enzyme properties, Diagnostic enzymes, Urine chemistry: Chemical composition of urine under normal and abnormal conditions.

UNIT III
Instrumentation: Principles and applications of Differential Centrifugation, Photometry, spectrophotometry, Fluorometry, Nephalometry and turbidimetry, Biochemical analysis carried out in the estimation of blood constituents like glucose, Urea, Creatinine, Protein, Cholesterol, Bilirubin etc., Electrophoresis.

UNIT IV
Metabolism: Catabolic and anabolic pathways for biomolecules. Isotopes: Definitions, Units, radioactive isotopes, Applications of isotopes in life sciences and medicine.

Text Books

1. Jagmohan, "Organic Spectroscopy-Principles and applications", 2nd Edition, Narosa Publishing House, 2004.
2. A.V.S.S. Rama Rao, "A textbook of biochemistry", Ubs Publishers' Distributors Ltd, 2008.
3. Trenor Palmer, "Enzymes-Biochemistry, Biotechnology, Clinical chemistry", 2nd Edition, EWP, 2007.

Reference Books

1. Jagmohan, "Organic Analytical chemistry-Theory and Practice", 25th Edition, McGraw Hill, 2010.
2. J.L. Jain, Sanjay Jain, "Fundamentals of biochemistry", 1st Edition, S.Chand Publication, 2007.

BM-311 BIOELECTRONICS LABORATORY **0-0-3 = 2**

Subject Code: *BM - 313*
Subject Name: *Bioelectronics Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. To study designing of Instrumentation amplifier
2. To study designing of active filters – LPF, HPF and BPF
3. To design of regulated power supply and V/I and I/V converters.
4. To design of linearizing circuits and cold–junction compensation circuit for thermocouples.
5. To design signal conditioning circuit for strain gauge and RTD.
6. To study linear wave and non-linear wave shaping
7. To study Op-amp as a square wave generator
8. To study Op-amp as active integrator and differentiator
9. To study IC 555 timer as mono-stable, astable and bistable multivibrator
10. To study Schmitt trigger
11. To design voltage regulator of +/- 5V and +/- 12 V.
12. To study UJT as relaxation oscillator
13. To study boot strap time base generator

Text Books

1. Jacob Millman, Christos Halkias, Chetan Parikh, "Integrated Electronics: Analog and Digital Circuits and Systems", 2nd Edition, Pearson, 2004.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", 1st Edition, Tata McGraw Hill, 2002.

Reference Books

1. Metin Akay, "Neural Engineering", 1st Edition Wiley /IEEE Press, 2007.
2. Chandran Karunakaran, Kalpana Bhargava, Robson Benjamin "Biosensors and Bioelectronics", ELSEVIER, 2015.

BM-313 HUMAN ANATOMYAND PHYSIOLOGY LABORATORY 0-0-3 = 2

Subject Code: *BM - 313*
Subject Name: *Human Anatomy and Physiology Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

Introduction to Laboratory safety measures

List of Experiments

1. To study the
a) T.S. of Pancreas Gland.
b) T.S. of Liver Gland.
c) T.S. of Thyroid Gland.
d) T.S. of Adrenal Gland.
e) T.S. of Spinal cord.
2. To study the effects of various trends of solution on RBCs.
3. To determine Human Blood Group.
4. To study the clotting time and bleeding time.
5. To study estimation of erythrocyte sedimentation rate (ESR).
6. Estimation of haemoglobin percentage by haemometer.
7. To determine the total no. of RBCs and WBCs in Human blood.
8. To study human reflex action.
9. To measure eye pressure.
10. To study human hearing loss using Audiometer.

Text Books

1. Ross and Wilson, "Anatomy and physiology in health and illness", 12th Edition, ELBS Publishing, 2014.
2. A.G. Guyton, "Textbook of Medical Physiology", 12th Edition, Saunders, 2010.
3. Tortora and Grabowski, "Principles of Anatomy and Physiology", 7th Edition, Harper Collins publication, 1992.

Reference Books

1. Charles E Tobin, "Manual of Human Dissection", 4th Edition, Mc Graw Hill, 1961.
2. J Gibson, "Modern Physiology and Anatomy of Nerves", Black Well Publication, 1981.

BM-314 MEDICAL BIOCHEMISTRY LABORATORY **0-0-3 = 2**

Subject Code: *BM - 314*
Subject Name: *Medical Biochemistry Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. To perform estimation of blood glucose level by enzymatic method.
2. Proteins: Test for albumin and globulin, Test for Cysteine.
3. Estimation of Blood Urea.
4. Estimation of Blood Cholesterol.
5. To perform Liver function test (SGOT).
6. To perform Liver function test (SGPT).
7. To perform Alkaline phosphates test.
8. To study of abnormal urine content bile pigment salt.
9. Estimation of total serum bilirubin.
10. Estimation of gastric juices – pH and acidity test.
11. To estimate vitamin in biological sample.
12. To culture bacteria and fungi on petri plate.

Text Books

1. A.V.S.S. Rama Rao, "A textbook of biochemistry", 1st Edition, Ubs Publishers' Distributors Ltd, 2008.
2. Jagmohan, "Organic Spectroscopy-Principles and Applications", 2nd Edition, Narosa Publish House, 2004.

Reference Books

1. Jagmohan, "Organic Analytical chemistry-Theory and Practice", 25th Edition, McGraw Hill, 2010.
2. J.L. Jain, Sanjay Jain, "Fundamentals of biochemistry", 1st Edition, S.Chand Publication, 2007.

FOURTH Semester Paper

MA-401 STATISTICS AND RANDOM PROCESSES 3-1-0 = 4

Subject Code: *MA - 401*
Subject Name: *Statistics and Random Processes*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Unit I

Introduction to probability : Events, Set, set operations, classical and relative frequency based definitions of probability, axiomatic definition of probability, conditional probabilities, independence, total probability, Baye's rules and applications, Repeated trails. *Random variables* : Continuous and discrete random variables, cumulative distribution function (cdf), probability mass function(pmf), probability density functions(pdf) and properties.

Unit II

Some special distributions: Binomial and Poisson discrete distributions, Uniform, exponential, Gaussian and Raleigh continuous distributions.Expected value of a random variable(s), mean, variances and moments of random variables. Function of single random variable. Moment generating and characteristic functions and their applications.Chebyshev Inequality.

Unit III

Two dimensional random variables: joint distribution and density functions, marginal probability distribution, conditional probability distribution, independence. Functions of two random variables. Multivariate random variables, covariance and correlations, independence. Multivariate Gaussians distributions, vector- space representation of random variables. Inner product, Schwarz inequality.
Sequence of random variables: almost sure and mean square convergence, convergence in probability and distribution, law of large numbers, central limit theorem.

Unit IV

Random Proccess: Discrete and continuous time processes, probabilistic description of random process, mean, auto correlation and auto covariance functions. *Stationarity*: strict sense stationary (SSS), wide sense stationary (WSS) processes, auto correlation functions of a WSS process and its properties, Cross correlation functions. Power spectral densities and properties. Gaussian process, Poison process and Markov processes.

Text Books:

1. A, Papoulis and S.U. Pillai, "Probability, Random variables and Stochastic process", 4 ed, McGraw Hill, 2002.
2. H, Stark and J.W.Woods, Probability and Random Processes with applications to Signal Processing, Pearson Education, 2002

Reference Books

1. P.Z, Pebbles, "Probability, random variables and random signals principles", 4ed, McGraw Hill, 2000.
2. T, Veerarajan, "Probability, statistics and random processes",2ed, McGraw Hill, 2003.

BM-402 BIOMEDICAL INSTRUMENTATION -I **3-1-0 = 4**

Subject Code: *BM - 402*
Subject Name: *Biomedical instrumentation -I*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I
Bioelectric Amplifiers: Introduction, characteristics**,** Special features of bioelectric amplifiers, Safety requirements, Realization of bioelectric amplifiers, Carrier amplifiers, Chopper amplifiers, Phase sensitive detector, Isolation amplifiers, Instrumentation amplifiers.

UNIT II
Biomedical Transducers and Bio electrodes: Bio electrodes for ECG, EEG, EMG with the study of ECG/EEG/EMG in detail as sample case, Recording of ECG, EMG, EEG signal and their characteristics, Holter monitor and cardiac stress test. Transducers: Temperature, Pressure, Displacement, Position, Motion, Humidity, Moisture. Skin resistance measurements.

UNIT III
Patient Monitoring System: Different component of patient monitoring system, Foetal monitoring instrument, Multi parameter(s) patient monitor. Computer assisted patient monitoring, Blood pressure, heart sound, heart rate measurements and variability, sources of signal artifact and their implications.

UNIT IV
Analytical and Diagnostic Instruments: Common analytical equipment used in hospitals and Biochemistry laboratories, blood flow meters, cardiac output measurement, Pulmonary function analyzers, Different types of oximetry systems, , Blood cell counters. Patient safety, Computer aided biopsy.

Text Books

1. Carr and Brown, "Introduction to Biomedical Equipment Technology", 4th Edition Pearson Education, 2000.
2. W Leslie Cromwell "Biomedical Instrumentation and Measurements", 2nd Edition, 2010, PHI.
3. John G Webster, "Bioinstrumentation", Wiley and Sons, 2008.
4. R. B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", 2nd Edition, CRC Press, 2012.

Reference Books

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg, Boston, 1986.
2. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 3rd Edition, Tata McGraw Hill, 2014.

BM-403 TISSUE ENGINEERING AND ARTIFICIAL ORGANS 3-1-0 = 4

Subject Code: *BM - 403*
Subject Name: *Tissue Engineering and Artificial Organs*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I
Introduction: Basic principles and strategies of tissue engineering, Soft and hard tissue and its function, Vascularity and angiogenesis, Basic wound healing, Cell migration.

UNIT II
Cell culture: Different cell types, Progenitor cells and cell differentiations, Different kind of matrix, Cell-cell interaction. Aspect of cell culture: Sterilization, Cell expansion, Cell transfer, Cell storage and cell characterization, Bioreactors, Microfluidic in tissue engineering.

UNIT III
Molecular biology aspects: Cell signalling molecules, Growth factors, Hormone and growth factor signalling, Growth factor delivery in tissue engineering, Cell attachment: Differential cell adhesion, Receptor-ligand binding, Cell surface markers.

UNIT IV
Artificial Organ and scaffolds: Engineering biomaterials for Artificial Organ, Degradable materials (collagen, silk and polylactic acid), Porosity, Mechanical strength, 3-D architecture, Printing and cell incorporation. Engineering tissues for replacing bone, Cartilage, Tendons, Ligaments, Skin and liver. Basic transplant, Immunology, Stems cells: Introduction, Haematopoiesis.

Text Books

1. Clemens van Blitterswijk, "Tissue Engineering", Academic Press, 2008.
2. L Hench, J. Jones, "Biomaterials, Artificial Organs and Tissue Engineering", 1st Edition Woodhead Publishing, 2005.

Reference Books

1. J. Endarle and Joseph Bronzino, "Introduction to Biomedical Engineering", 3rd Edition, Academic press, 2011.
2. B. Palsson, J.A. Hubbell, R.Plonsey and J.D. Bronzino, "Tissue Engineering", CRC-Taylor and Francis, 2003.

BM-404 BIOMEDICAL SIGNALS AND SYSTEMS 3-1-0 = 4

Subject Code: *BM - 404*
Subject Name: *Biomedical Signals and Systems*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT– I
Introduction: Signals and systems, Examples of signals and systems; Signal types: Energy and power signals, Continuous and discrete time signals, Analog and digital signals, Deterministic and random signals; Signal properties: Symmetry, Periodicity, absolute integrability. Systems and system properties: Linearity, Shift-invariance, Causality, Stability, Realizability; Continuous time and discrete time linear shift-invariant (LSI) systems: The impulse response and step response; Response to arbitrary inputs: Convolution, Interconnections; Characterization of causality and stability of linear shift-invariant systems;

UNIT– II
Signal Representation: Signal space and orthogonal bases of signals, Fourier series representation; Fourier Transform and properties, Parseval's Theorem, Time-bandwidth product; Phase and group delays; Hilbert transform, pre- envelope. Spectral Analysis: Energy, Power, Parseval's theorem, Energy, Power Spectral density functions (PSDF), The Autocorrelation function, Cross correlation function, Relationship between PSD function and auto correlation function.

UNIT– III
Network Analysis:- Complex Frequency, Laplace Transforms, Shifting theorems, Initial value theorem, final value theorem, Effects of differentiation and integration in time domain. System transfer function, poles and zeroes, Impulse response convolution, Transient and steady state analysis (R-L-C circuit), Solution of linear differential equation.

UNIT– IV
Discrete Signals:-Introduction, z-transform and Inverse z-transforms, Relation between s–plane and z–plane. Shifting theorem. Initial value theorem and final value theorem, Transfer function of delay unit, Realization of z-domain transfer function, Unit sample response convolution. Solution of difference equations and its applications in biomedical domain.

Text Books

1. A.V. Opponheim, A.S. Willsky and Nawab, "Signals and Systems", 2nd Edition, PHI, 2006.
2. Robert A. Grabel and Richard A. Roberts, "Signals and Linear System", John Willey and Sons, 1987.

Reference Books

1. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems – Continuous and Discrete", 4th Edition, PHI, 2005.
2. I. J. Nagrath, S.N. Saran, R. Ranjan and S. Kumar, "Signals and Systems", TMH, 2001.

BM-412 BIOMEDICAL INSTRUMENTATION LABORATORY -I 0-0-3 = 2

Subject Code: *BM - 412*
Subject Name: *Biomedical Instrumentation Laboratory -I*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. Measurement of waveform, amplitude, durations and frequency using CRO, triggering of beam with an external signal.
2. Record the ECG signal, it characteristics and calculate heart rate of subject.
3. Study of EEG Signal, to measure the amplitude frequency with respect to external stimulus.
4. Study the EMG signal and its characteristics.
5. Non-invasive blood pressure measurement using aneroid and mercury sphygmomanometer.
6. Non-invasive blood pressure measurement using computer aided system.
7. Study of heart sound using computer aided microphone (or Electronic stethoscope) and characterise various heart sound.
8. Measurement of galvanic skin resistance and its characteristics.
9. Study of multipara meter patient monitor.

Text Books

1. Carr and Brown, "Introduction to Biomedical Equipment Technology", 4th Edition Pearson Education, 2000.
2. W Leslie Cromwell "Biomedical Instrumentation and Measurements", 2nd Edition, 2010, PHI.
3. John G Webster, "Bioinstrumentation", Wiley and Sons, 2008.

Reference Books

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg, Boston, 1986.
2. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 3rd Edition, Tata McGraw Hill, 2014.

BM-414 BIOMEDICAL SIGNALS AND SYSTEMS LABORATORY 0-0-3 = 2

Subject Code: *BM - 414*
Subject Name: *Biomedical Signals and Systems Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. To study important MATLAB/Sci Lab free software (linux) commands and their usage.
2. To develop an elementary signal function modules (m-files) for unit sample, unit step, exponential and unit ramp sequences.
3. To develop a program for discrete convolution and correlation.
4. To develop a program for computing inverse Z-transform
5. To develop a program for computing DFT and IDFT.
6. To develop a program for computing circular convolution.
7. To develop a program for designing IIR filter.
8. To develop a program for data compression techniques.

Text Books

1. A. P. Malvino, "Electronics Principles", 6TH Edition, TMH, 2005.
2. R. L. Boylestead and L. Nashelsky, "Electronic Devices and Circuit Theory", 9th Edition, PHI, 2006.

Reference Books

1. R.F. Ziemer, W.H. Tranter and D.R. Fannin, "Signals and Systems – Continuous and Discrete", 4th Edition, PHI, 2005.
2. I. J. Nagrath, S.N. Saran, R. Ranjan and S. Kumar, "Signals and Systems", TMH, 2001.

FIFTH Semester Paper

BM-501 BIO-TRANSPORT PROCESS **3-1-0 = 4**

Subject Code: *BM - 501*
Subject Name: *Bio-Transport Process*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I
Heat and Mass Transfer: Introduction to fluid mechanics, heat and mass transfer. Heat Transport: Heat production in humans, Loss of heat to the environment, heat transfer within the body.

UNIT II
Blood and gaseous transport: Transport through cell membranes, Membrane structure, composition and permeability, Osmosis, Passive diffusion, Pressure diffusion, Facilitated transport, Facilitated diffusion of oxygen in haemoglobin solutions and its mathematical modelling, Active transport, Pinocytosis.

UNIT III
Compartment modelling: Pharmacokinetic models, one-compartment and two compartment open models. Structure and gross operational features of the respiratory system, Gas transport mechanisms in the lungs.

UNIT IV
Structure and operation of kidney: Transport mechanisms in the kidney tubules, Pore models of the glomerular tuft, Counter current mechanism of urine formation, Models of nephron function, Analytical model for Henle's loop. Haemodialysis: Types and methods

Text Books

1. David O. Cooney, "An introduction to fluid, heat & mass transport process-Principles", Vol.1, Marcel Dekker Inc., New York, 1976.
2. Edwin N. Lightfoot, "Transport phenomena and living systems – Biomedical aspects of momentum and mass transport", John Wiley, 1974.

Reference Books

1. Ronald L. Fournier, "Basic transport phenomena in Biomedical Engineering", Taylor Francis, 1998.

BM-502 MICROPROCESSOR AND MICROCONTROLLER 3-1-0 = 4

Subject Code: *BM - 502*
Subject Name: *Microprocessor and Microcontroller*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I
8086/8088 Architecture addressing modes and instructions: instruction sets, addressing mode. Assembler directives and Advanced programming. Min and Max mode of operation. 8086 Programming, Interrupts and DOS interrupt 21H functions.

UNIT II
8155-Programmable I/O: 8255-Programmable Peripheral Interface; 8355-ROM; 8253 – Timer; 8251 – USART; 8257 – DMAC, 8259 – PIC.

UNIT III
8051 Architecture: Addressing modes and instructions, Programming of 8051. Applications of Microcontroller. Interfacing A/D converters with 8051 and 8086, data acquisition. Interfacing D/A converters, Waveform generation. Introduction to AVR.

UNIT IV
8085 Programming: Stacks and subroutines, Counters, Time delays, Interrupts, Instruction cycle, Machine cycle, Timing diagrams. Memory Interfacing with 8085, Interfacing I/O, Memory mapped I/O and I/O mapped I/O. Interfacing A/D and D/A converters. Stepper motor interface with 8085.

Text Books

1. Ramesh S. Gaonkar, "Microprocessor architecture, Programming and Applications with 8085", 5th Edition, Penram International Publishing (India) Pvt. Ltd., 2002.
2. B. Ram, "Fundamentals of microprocessors and microcomputers", 3rd Edition, Dhanpat Rai Publication, 1989.
3. Douglas V.Hall, "Microprocessor and interfacing", 2nd Edition, McGraw Hill International, 2006.

Reference Books

1. Intel Corp., "The 8080/8085 Microprocessor Book: Intel marketing communications", Wiley Inter Science Publications, 1980.
2. Triebel and Singh, "The 8088 and 8086 Microprocessors", 4th Edition, Pearson Education, 2003.

BM-503 BIOMEDICAL SIGNAL PROCESSING **3-1-0 = 4**

Subject Code: *BM - 503*
Subject Name: *Biomedical Signal Processing*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I
Discrete – Time Signals and Systems: Sampling of Analogue signals, Aliasing, Standard discrete time signals, Classification, Discrete time system, Linear time invariant stable casual discrete time systems, Classification methods, Linear and circular convolution, Difference equation representation, DFS, DTFT, DFT, FFT computations using DIT and DIF algorithms.

UNIT II
Infinite Impulse Response Digital Filters: Review of design of analogue Butterworth and Chebyshev Filters, Frequency transformation in analogue domain, Design of IIR digital filters using impulse invariance technique, Design of digital filters using bilinear transform, Pre warping, Frequency transformation in digital domain, Realization using direct, Cascade and parallel forms

UNIT III
Finite Impulse Response Digital Filters: Symmetric and antisymmetric FIR filters, Linear phase FIR filters , Design using Frequency sampling technique, Window design using Hamming, Hanning and Blackmann Windows, Concept of optimum equiripple approximation, Realization of FIR filters , Transversal, Linear phase and polyphase realization structures.

UNIT IV
Analysis of Bio –Signals and Special Topics in BSP
Removal of artifacts-ECG, Event detection, ECG, P wave, QRS Complex, T wave, correlation analysis of ECG signals, Averaging of signals, PCG,ECG and EMG. Heart rate variability analysis. Analysis of PCG signals, Analysis of Time variant systems, fixed segmentation, STFT, ACF, SEM and GLR.

Text Books

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing, Algorithms and Applications", 3rd Edition PHI of India Ltd., New Delhi, , 2000.
2. Rangaraj M. Rangayyan, "Biomedical signal processing: A Case Study", IEEE Press, 2002.

References Books

1. Sanjit K. Mitra, "Digital Signal Processing: A Computer Based Approach", Tata McGraw-Hill, New Delhi, 1998.
2. A.V. Opponheim, A.S. Willsky and Nawab, "Signals and Systems", 2nd Edition, PHI, 2006.

BM-504 BIOMEDICAL INSTRUMENTATIONS-II 3-1-0 = 4

Subject Code: *BM – 504*
Subject Name: *Biomedical Instrumentations -II*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I

Cardiac Pacemakers and Defibrillators: Introduction, effects of electric field on cardiac muscles and laws of stimulation. External, Internal and Programmable pacemakers. Pulse generator- sensing, Output and timing circuits. Power sources, Electrodes and leads system, Pacing system analyzers. Defibrillators- basic principle and comparison of output wave forms of different DC defibrillator, Energy requirements, Synchronous operation, Implantable defibrillators, defibrillator safety and analyzers, Treatment for arrhythmias.

UNIT-II

Ventilators and Anesthesia System: Basic principles of ventilators, Different generators, Inspiratory phase and expiratory phase, Different ventilator adjuncts, Neonatal ventilators, p based ventilator, Ventilator testing. Anesthesia: Need of anesthesia, Gas used and their sources, Gas blending and vaporizers, Anesthesia delivery system, Breathing circuits.

UNIT-III

Physiotherapy Equipment's: Electrical stimulators: Strength-duration curve, Types of stimulators, Electrodiagnostic / therapeutic Stimulator. Nerve-muscle stimulator: Peripheral nerve stimulator, Ultrasonic stimulators, Stimulators for pain and relief.
Diathermy: IR diathermy, UV diathermy, Short wave diathermy, Microwave diathermy, Ultrasonic diathermy, Surgical Diathermy.

UNIT-IV

Therapeutic Equipment: Physics and engineering of lithotripters. Principle and Biomedical application of LASER, Hemodialysis machine, Heart Lung machine, LINAC and Automated drug delivery system, Baby Incubator, Laparoscopy. Calibration

Text Books

1. Carr and Brown, "Introduction to Biomedical Equipment Technology", 4th Edition Pearson Education, 2000.
2. John G Webster, "Bioinstrumentation", Wiley and Sons, 2008.
3. Leslie Cromwell, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education, 1990.

Reference Books

1. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg, Boston, 1986.
2. R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 3rd Edition, Tata McGraw Hill, 2014.

BM-512 MICROPROCESSOR AND MICROCONTROLLER LABORATORY

0-0-3 = 2

Subject Code: *BM - 512*
Subject Name: *Microprocessor and Microcontroller Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. Write an 8085 ALP to perform Binary /BCD addition between two bytes stored in consecutive / different location (Generated Carry).
2. Write an 8085 ALP to perform Binary / BCD subtraction between two bytes stored in consecutive / different locations with sign of the result taken into account.
3. Write an 8085 ALP to generate of Fibonacci Series.
4. Write an 8085 ALP to reverse a string .The string is either a binary byte or a bunch of data bytes stored in consecutive locations.
5. Write an 8085 ALP to arrange the bytes (stored in consecutive locations) in sorted order either ascending or descending order.
6. Write an 8085 ALP to verify the incoming and outgoing data using LEDS and a PPI chip.
7. Write an 8085 ALP to generate a square wave of a certain frequency using PPI chip and a CRO display.
8. Write an 8086 ALP to find the largest number from an array of 16 bit numbers stored sequentially in memory location.
9. Write an 8086 ALP to convert a given word into its decimal equivalent.
10. Write an 8086 ALP to find out whether a given byte is present in the string or not.
11. Write a 8086 ALP program to open a new file kmb.dat in the current directory and drive if it is successfully opened. Write 200H Bytes of data into it from a data block named BLOCK. Display a message if the file is not opened successfully.
12. Employ 8051 as controller for monitoring devices.
13. Employ 8051 to perform Boolean operations.
14. Write an ALP to interface a keyboard with 8086 microprocessor using PPI chips.
15. Write an ALP to interface a stepper motor with 8085 microprocessor using PPI chips.

Text Books

1. Ramesh S. Gaonkar, "Microprocessor architecture, programming and applications with 8085", 5th Edition, Penram International Publishing (India) Pvt. Ltd., 2002.
2. B. Ram, "Fundamentals of microprocessors and microcomputers", 3rd Edition, Dhanpat Rai Publication, 1989.

Reference Books

1. Triebel and Singh, "The 8088 and 8086 Microprocessors", 4th Edition, Pearson Education, 2003.
2. Douglas V.Hall, "Microprocessor and interfacing", 2nd Edition, McGraw Hill International, 2006.

BM-513 BIOMEDICAL SIGNAL PROCESSING LABORATORY 0-0-3 = 2

Subject Code: *BM - 513*
Subject Name: *Biomedical Signal Processing Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. Sine wave generation using C.
2. Designing an FIR filter using MATLAB and DSP Kit.
3. Designing an IIR filter using MATLAB and DSP Kit.
4. Fourier analysis of periodic signal.
5. Time frequency domain properties of different windows using MATLAB.
6. Implementation of the Double-Precision Complex FFT for ECG signal.
7. Design of Notch filter for elimination of 50Hz from ECG signal.
8. EMG processing using MATLAB –Rectification and Signal Averaging.
9. Heart rate variability analysis employing ECG
10. Artifacts removal from ECG/EEG/EMG bio-signals.

Text Books

1. John G. Proakis and Dimitris G.Manolakis, "Digital Signal Processing, Algorithms and Applications", PHI of India Ltd., New Delhi, 3rd Edition, 2000.
2. Rangaraj.M.Rangayyan, "Biomedical signal processing: A Case Study", IEEE press 2002.

References Books

1. Sanjit K. Mitra, "Digital Signal Processing: A Computer Based Approach", Tata McGraw-Hill, New Delhi, 1998.
2. A.V. Opponheim, A.S. Willsky and Nawab, "Signals and Systems", 2nd Edition, PHI, 2006.

BM-514 BIOMEDICAL INSTRUMENTATION LABORATORY-II 0-0-3 = 2

Subject Code: *BM - 514*
Subject Name: *Biomedical Instrumentation Laboratory -II*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. To study about operation of Pacemaker Circuits.
2. To study about operation of Defibrillators.
3. To study about operation of Holter monitor.
4. To study about operation of Ventilators.
5. To study about operation of Treadmill, design a protocol for cardiac stress test.
6. Demonstration of operation and trouble shooting of Heart lung machine.
7. Study of Audiometer.
8. Study of spirometry and various lung volume and capacities.
9. Study of lithotripter.
10. Visit to Hospital/Medical Institute for Exposure**.**

Text Books

1. John G Webster, "Bioinstrumentation", Wiley and Sons, 2008.
2. Carr and Brown, "Introduction to Biomedical Equipment Technology", 4th Edition Pearson Education, 2000.

Reference Books

1. R. S. Khandpur, "Handbook of Bio-Medical Instrumentation", 3rd Edition, Tata McGraw Hill, 2014.
2. Joseph Bronzino, "Biomedical Engineering and Instrumentation", PWS Engg, Boston, 1986.

SIXTH Semester Paper

BM-601 BIOMECHANICS AND REHABILIATION ENGINEERING 3-1-0 = 4

Subject Code: *BM - 601*
Subject Name: *Biomechanics and Rehabilitation Engineering*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Unit I
Biomechanics: Introduction to biomechanics**,** kinesiology, basic mechanical concepts**,** types of motion**,** different types of body and joint movement. Basic kinematics concepts**,** vectors and trigonometry, position of anatomical axis and corresponding movements of the body part.

Unit II
Tissue Biomechanics: Solids and Structures: Biological Materials Properties, Viscoelasticity, Simple Structure, Hydrostatic Structure, Structural Systems, Biomechanical characteristic of bone and the soft tissue structure: tendons, ligaments, muscles, function and physiological factors.

Unit III
Movement Biomechanics: Human Gait, its measurement and analysis, body and limbs: mass and motion characteristics actions, forces transmitted by joints. Joints forces results in the normal and disable human body, normal and fast gait on the level platform. Patterns: Push/Throw Continuum Biomechanics of push - like motions, Biomechanics of throw - like motions.

Unit IV
Rehabilitation Engineering: Impairments, disabilities and handicaps. Measurement and assessment, prosthetics and orthotics: definition, role, classification and applications. Principles of three-point pressure, total constant and partial weight relieving, Design considerations for orthosis and prosthesis. Spinal orthosis, recent developments in prosthetics and orthosis designing and usage. Rehabilitation device for locomotion, visual, speech and hearing impaired persons. Study of manual and powered wheelchair with their applications.

Text Books

1. Sean P. Flanagan, Flanagan, “Biomechanics: A case based Approach”, Jones and Bartlett Publishers, 2013.
2. Y. C. Fung, Yuan-Cheng Fung, “Biomechanics: mechanical Property of living Tissue”, Springer, 1996.
3. Carol A. Oatis, “The Mechanics and Pathomechanics of Human Movement”, Lippincott Williams and Wilkins, 2010.
4. D. Bhatia, “Stroke Rehabilitation”, 2016, ABS Publishers, Delhi

Reference Books

1. Prof. Ghista, “Biomechanics”, Private Publication UAF, 2009.
2. White and Puyator, “Biomechanics”, Private publication UAF, 2010.

BM-602 MEDICAL IMAGING AND IMAGE PROCESSING 3-1-0 = 4

Subject Code: *BM - 602*
Subject Name: *Medical Imaging and Image Processing*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I

X-ray and Computed Tomography: Principles and production of soft X- rays and hard x rays**,** X-Ray Detectors, details of radiographic and fluoroscopic images in X-Ray systems. Principles of CT, evolution of CT machines – CT image formation, Artefacts in CT imaging, PET and SPECT imaging.

UNIT II

Ultrasonic and Magnetic Resonance Imaging: Principle of MRI/NMR, Image acquisition in magnetic resonance imaging – T1, T2, Proton density weighted images, spin-echo technique and spin relaxation technique.
Ultrasonic –Physics of ultrasound – Principles of image formation – Capture and display, principles of A-Mode, B-Mode, M-Mode. Scan converters, frame grabbers. Single line and multi-line monitoring of ultrasound displays, MR Angiography-Techniques and Principles Hardware.

UNIT III

Digital Image Processing: Image acquisition storage, processing, communication display. Visual perception: Structure of Human Eye, Image formation in human eye, brightness and contrast, adaptation and discrimination, Uniform and non-uniform sampling, quantization, Image enhancement: Image smoothing, point operators, contrast manipulation, histogram modification, noise clipping image sharpening, spatial operators, frequency domain method, low pass and high pass filtering, holomorphic filtering, median filtering.

UNIT IV

Image Transforms: DFT, Properties of 2D Fourier Transforms, Sine and Cosine Transforms, Hadamass Transforms. Image Restoration: Degradation Model, A prior knowledge required in restoration, Inverse filtering, Weiner Filtering, Interactive restoration. Image Segmentation: Detection of discontinuity, point line and edge detection and boundary detection, Thresholding, Image interpretation.

Text Books

1. R. C. Gonsalez, R.E. Woods, Steven L. Eddins, “Digital Image Processing ”, 1st Edition, Dorling Kindersley Pvt Ltd, 2006.
2. Anil Kr. Jain, “Fundamental of Image Processing”, Prentice Hall, 1988.

Reference Books

1. William K. Pratt, “Digital Image Processing”, John Wiley, NJ, 1987.
2. Albert Macouski, “Medical Imaging systems”, Prentice Hall, New Jersey, 1983.

BM-60311 NANOMEDICINE **3-1-0 = 4**

Subject Code: *BM - 60311*
Subject Name: *Nanomedicine*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Work = 40, End Semester Examination = 60.*
Questions to be set: *Eight (one from each unit and remaining four from the combination of more than one unit).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

Unit I
Introduction to Bio Nanotechnology: Cellular nanostructures, Self-assembly of colloidal nanostructures of biological relevance.

Unit II
Nanoparticles for Drug Delivery (including solid lipid nanoparticles, Synthetic and biopolymeric nanoparticles): Carbon nanotubes, Polymeric nanofibers, Implications in neuroscience, Tissue engineering and cancer therapy, Environmental and safety aspects of bio-nanotechnology.

Unit III
Multilayer Thin Film: Polyelectrolyte multilayers, coated colloids, Smart capsules, LBL self-assembly.

Unit IV
Nano engineered Biosensors: Fibre Optic Nano-sensors in medical care, Semiconductor and Metal Nanoparticles: Synthesis and Applications, Nanotechnology in Tissue Engineering, Micro emulsions and drug delivery.

Texts Books

1. Gero Decher, Joseph B. Schlenoff, "Multilayer Thin Films", Wiley-VCH Verlag GmbH & Co., 2003.
2. David S. Goodsell, "Bionanotechnology: Lessons from Nature", Wiley-Liss, 2004.

Reference Book

1. Kenneth J. Klabunde, "Nanoscale Materials in Chemistry", John Wiley and Sons, Inc., 2001.

BM-60312 HOSPITAL MANAGEMENT **3-1-0 = 4**

Subject Code: *BM - 60312*
Subject Name: *Hospital Management*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I

Organisation and Planning of the Hospital: Organisational structure: Governance, Duties and responsibilities of the governing board, Management structure: Duties, responsibilities and functions of the CEO, Hospital information System: Benefits, Organisation, Layout, Survey, Financial planning, Equipment planning.

UNIT II

Medical, Auxiliary Services and Nursing Services: Emergency services, Clinical laboratories, Radiological services, Diagnostic radiology, Radiation therapy department, Nuclear Medicine, Surgical Department, Physical Medicine and Rehabilitation, CATH lab, OT: Design and related equipment. General nursing unit, Central Nurse Station, Paediatric nursing unit, Isolation rooms, Intensive Care Unit(ICU), Coronary Care Unit(CCU), New-born nurseries. Electrical system, Air conditioning services, Centralised gas system, Communication systems, Transportation, CSSD, MEDICAL.

UNIT III

Engineering and Biomedical Engineering Department: Engineering department: Functions, Location, Design, Organization, Maintenance management. Biomedical Engineering department: Functions, Designs, Space facilities, Utilities, Hospital wiring system.

UNIT IV

Safety and Security in the Hospital: Hospital safety rules, Security and loss prevention, Fire safety, Bomb threat, Alarm systems, Disaster and Disaster preparedness plan, Safety codes for electrical and medical equipments, Medical standards for hospitals and equipment.

Text Books

1. G.B. Kunder and Gopinath, “Hospital Planning, Design and Management”, Tata McGraw Hill, 2004.
2. S. L. Goel and R.Kumar, “Principles of Hospital Administration and Planning”, Deep and Deep Publications, 2002.
3. John Webster and Albert Cook, “Clinical Engineering Principles and Practices”, Prentice Hall, 1979.

Reference Books

1. Carl W. Nelson, “Operations Management in the Health Services; Planning Restructuring and Control” Elsevier Science Ltd, 1983.
2. Rakich, J. S. Darr, “Hospital Organisation and Management”, S.P. Medical and Science Book Publication, 1983.

BM-60313 VIRTUAL INSTRUMENTATION **3-1-0 = 4**

Subject Code: *BM - 60313*
Subject Name: *Virtual Instrumentation*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT 1
Review of Virtual Instrumentation: Historical perspective, Need of VI, Advantages of VI, Define VI, block diagram & architecture of VI, data flow techniques, graphical programming in data flow, comparison with conventional programming. Programming Techniques, VIS and Sub VIS, loops & charts, arrays, clusters, graphs, case & sequence structures, formula modes, local and global variable, string & file input.

UNIT II
Fundamentals of Virtual Instrumentation: Data Acquisition basics, ADC, DAC, DIO, Counters & timers, PC Hardware structure, timing, interrupts, DMA, Software and Hardware Installation.

UNIT III
Cluster of Instruments in VI System: Common Instrument Interfaces for Current loop, RS 232C/Rs 485, GPIB, System basics, interface basics: USB, PCMCIA, VXI, SCXI, PXI etc, networking basics for office & industrial application VISA & IVI, image acquisition & processing, Motion Control.

UNIT IV
Analysis Tools and Simple Applications in VI: Use of Analysis Tools, Fourier transforms Power spectrum, Correlation methods, windowing & flittering. Application of VI: Application in Process Control Designing of equipments like Oscilloscope, Digital Multimeter using Lab view Software, Study of Data Acquisition & control using Lab view Virtual instrumentation for an Innovative Thermal Conductivity Apparatus to measure the Thermal Conductivity Apparatus- to measure the conductivity of non-Newtonian fluids white they are subjected to sharing force.

Text Books

1. Sanjay Gupta, "Virtual Instrumentation Using Labview", Tata McGraw Hill Publishing, 2006.
2. Jovitha Jerome, "Virtual Instrumentation Using Labview", PHI, 2010.
3. Marco Schwartz, Oliver Manickum, "Programming Arduino with Labview", Packt Publishing, 2015.

Reference Books

1. Gary Johnson, "Labview Graphical Programming", 2nd Edition, McGraw Hill, Newyork, 1997.
2. Lisa K. Wells and Jettrey Travis, "Labview for everyone", Prentice Hall, New Jersey, 1997.

HU-604 PROFESSIONAL ETHICS AND IPR **3-1-0 = 4**

Subject Code: *HU - 604*
Subject Name: *Professional Ethics and IPR*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT – I
Engineering as a Profession: Historical and Social Context, Ethics in Engineering, Codes of Engineering Ethics, History and Purpose, Consequentialism and Utilitarianism, Deontological Approaches, Duties, Rights and Respect for a Person, Responsibility, Virtue Ethics, Honesty, Moral Autonomy, Obligations of Engineering Profession and Moral Propriety.

UNIT-II
Engineer's Moral Responsibility for Safety and Human Right: Risk assessment and communication, Product liability, Development ethics, Engineers and employer relationship, Whistle blowing and its moral justifications. Computer Ethics: Social impact of computers, Privacy, Cybercrime, Ethical use of software.

UNIT- III
IPR I: Intellectual property, definition, types, rights and functions, patents, trademark, software design, industrial designs, semi-conductor and integrated circuits layout design, grant of patent in India, authority and procedure, patent forms, surrender and revocation of patents and compulsory licensing, acquisition of inventions by the Government.

UNIT- IV
IPR II: Contents of draft application for patents, Drafting patent specification and claims, WTO and drafting patent specification and claims, IPR infringement and piracy under Indian Laws.

Text Books

1. Vinod V. Sople, "Managing Intellectual Property: The Strategic Imperative", PHI, 2006.
2. Charles, Harri Michael, S Pritchard and Michael J Robins, "Engineering Ethics: Concepts and cases", Wordsworth/ Thompson Learning, Belmont Calif, 2000.
3. Dr. B. L. Wadehra, "Law Relating to Intellectual Property", Universal Law Publishing, 2009.

Reference Books

1. Huff and Finholt, "Social Issues in Computing: Putting Computing in Place", McGraw Hill, 1994.
2. Govindarajan, Natarajan and Senthil Kumar, "Engineering Ethics", PHI, 2004.

BM-611 BIOMECHANICS AND REHABILITATION LABORATORY 0-0-3 = 2

Subject Code: *BM - 611*
Subject Name: *Biomechanics and Rehabilitation Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Work = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. Study of BIOPAC MP-150 system and Acq Knowledge software tool.
2. Identification of different upper and lower extremity muscles in humans.
3. EMG acquisition and analysis of lower limb muscles.
4. Angle measurement using goniometer for upper extremity movements.
5. Angle measurement using goniometer for lower extremity movements.
6. Study and analysis of Sit-to Stand movement from stationary chair employing EMG and Force plate.
7. Study and analysis of Stand-to Sit movement on a stationary chair employing EMG and Force plate
8. Force and torque measurement using BIOPAC MP-150 system.
9. Study of human gait cycle.
10. Inverse dynamics of human gait

Text Books

1. Sean P. Flanagan, Flanagan, "Biomechanics: A case based Approach", Jones &and Bartlett Publishers, 2013.
2. Susan J Hall, "Basic Biomechanics", 6th Edition, McGraw Hill, 2012.
3. D. Bhatia, "Stroke Rehabilitation", 2016, ABS Publishers, Delhi

Reference Books

1. Prof. Ghista, "Biomechanics", Private Publication UAF, 2009.
2. White and Puyator, "Biomechanics", Private publication UAE, 2010.

BM-612 MEDICAL IMAGE PROCESSING LABORATORY 0-0-3 = 2

Subject Code: *BM - 612*
Subject Name: *Medical Image Processing Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. Study of different images for different imaging modality like Ultrasound, X-ray, Computed Tomography and Magnetic resonance imaging.
2. Write a program in MATLAB/Sci Lab
    a) To draw white rectangle (200pixel X 100pixels) inside the black square (400 square pixels).
    b) To draw a black circle which have a diameter 200 pixels inside a 400 square pixel white box.
    c) To draw a English alphabet H.
    d) To draw three squares (300 pixel X 300pixel) cascaded color of red, green and blue.
3. Write a program to draw the histogram of provided image and on the basis of histogram perform threshold operation.
4. Write a program for histogram equalization and apply on given image.
5. Write a program for the edge detection using Roberts, prewitt, sobel edge detectors.
6. Write a program to convert RGB color model into HSV color model apply onn given image.
7. Write a program to calculate different morphological features (Area, perimeter, major axis, minor axis) of an object in a given image.
8. Write a program to add salt and paper noise than apply median filter and comment on result.
9. Design a GUI and add following functionality
    a) A button for load an image
    b) A brightness adjustment bar
    c) A contrast adjustment bar
10. Write a program to count number of objects in given image and level objects
11. Segment vertebra column using MIMICS software and label different nodes.
12. Segment Liver using MIMICS software and write the appropriate strategy.

Text Books

1. R. C. Gonsalez, R.E. Woods, Steven L. Eddins, "Digital Image Processing using MATLAB", 1st Edition, Dorling Kindersley Pvt Ltd, 2006.
2. Anil Kr. Jain, "Fundamental of Image Processing", Prentice Hall, 1988.

Reference Books

1. William K. Pratt, "Digital Image Processing", John Wiley, NJ, 1987.
2. Albert Macouski, "Medical Imaging systems", Prentice Hall, New Jersey.1983.

SEVENTH Semester Paper

BM-701 MEDICAL INFORMATICS AND TELEMEDICINE 3-1-0 = 4

Subject Code: *BM - 701*
Subject Name: *Medical Informatics and Telemedicine*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I
Introduction - Structure of Medical Informatics –Internet and Medicine, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, CIS, e-health services, Health Informatics – Medical Informatics, Bioinformatics.

UNIT II
Data Compression and Safety- Introduction, Classification of data, Database Management System (DBMS), History taking by computer, Dialogue with the computer, Components and functionality of EPR and CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients, Security issues and its prevention.

UNIT III
Computers in medical imaging: Computers in medical decision making, Expert system-General model of CMD, Neurocomputers and Artificial Neural Networks with applications, Computer assisted surgery v/s Robotic Surgery with applications, IOT in medical field and remote surgery.

UNIT IV
Telemedicine and Artificial Intelligence: Fundamental concepts, Significance, Principle, functional blocks of Telemetry and Telecontrol system, Methods of telemetry, State of art-Telemetry standards., Medical Peripheral devices, Introduction to Artificial neuron and neural networks (ANN), types of learning, Introduction and foundation of Fuzzy systems, Application of AI in biomedical engineering.

Text Books

1. R. D. Lele, “Computers in medicine progress in medical informatics”, Tata McGraw Hill Publishing computers Ltd, New Delhi, 2005.
2. D. Bhatia, “Medical Informatics”, Prentice Hall of India Publication, 2015.

Reference Books

1. Mohan Bansal, “Medical informatics”, Tata McGraw Hill Publishing Ltd, 2003 New Delhi, 2003.

BM -702 BIOLOGICAL CONTROL SYSTEM **3-1-0 = 4**

Subject Code: *BM - 702*
Subject Name: *Biological Control System*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I
Modeling of Systems: Terminology and basic structure of control system, Example of a closed loop system, Transfer functions, Modeling of electrical systems, Translational and rotational mechanical systems, and electro mechanical systems, Block diagram and signal flow graph representation of systems, Conversion of block diagram to signal flow graph, Reduction of block diagram and signal flow graph.

UNIT- II
Time Response and Stability Analysis: Step and impulse responses of first order and second order systems, Determination of time domain specifications of first and second order systems from its output responses, Definition of steady state error constants and its computations. Definition of stability, Routh- Hurwitz criteria of stability, Root locus technique, Construction of root locus and study of stability, Definition of dominant poles and relative stability.

UNIT - III
Frequency Response Analysis: Frequency response, Nyquist stability criterion, Nyquist plot and determination of closed loop stability, Definition of gain margin and phase margin, Bode plot, Determination of gain margin and phase margin using Bode plot, Use of Nichol's chart to compute response frequency and bandwidth.

UNIT- IV
Physiological Control System: Example of physiological control system, Difference between engineering and physiological control systems, Generalized system properties, Models with combination of system elements, Linear models of physiological systems-Examples, Introduction to simulation

Text Books

1. Michael C K Khoo, "Physiological Control Systems", IEEE Press, Prentice Hall of India, 2001.
2. M. Gopal "Control Systems Principles and Design", Tata McGraw Hill, 2002.
3. John Enderle Susan Blanchard, Joseph Bronzino "Introduction to Biomedical Engineering", second edition, Academic Press, 2005.

Reference Books

1. Richard C. Dorf, Robert H. Bishop, "Modern control systems", Pearson, 2004.
2. L. Stark, "Neurological Control System", Plenum Press, 1968.

BM- 70321 ARTIFICIAL INTELLIGENCE IN BIOMEDICAL ENGINEERING

3-1-0 = 4

Subject Code: *BM - 70321*
Subject Name: *Artificial Intelligence in Biomedical Engineering*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT-I

Introduction to Artificial Neuron and Neural Networks: Feature selection. Types of learning, Supervised and unsupervised learning, Supervised learning decision surfaces, two category separation, Linearly separable sets, Multiple category classification problems. Relationship to neural network models, Comparison of methods, Applications.

UNIT-II

Unsupervised Learning: Clustering, Kohonen network and competitive learning, Hebbian learning, Adaptive Resonance Theory (ART), Applications.

UNIT III

Introduction & foundation of Fuzzy system: Fuzzy system at work; Fuzzy system design, Crips v/s Fuzzy sets, Fuzzy sets to fuzzy even, Fuzzy logic, Practical fuzzy measures, Fuzzy set operation, Properties of fuzzy sets, Fuzzification techniques, Relational inference, Compositional inference, Linguistic variable and logic operation, Inference using fuzzy variable, fuzzy Implications.

UNIT IV

Fuzzy system and Algorithms: Defuzzification, Adaptive fuzzy system algorithm, Expert system v/s fuzzy inference engines, Basic fuzzy inference algorithm. Evaluating antecedent fuzzy variables, Left hand side computation, Right hand side computation. Introduction to Genetic algorithm, Application of AI in biomedical engineering

Text Books

1. Donna L., Hudson and Maurice E. Cohen, "Neural Networks and Artificial Intelligence for Biomedical Engineering", Prentice Hall of India. Pvt., Ltd., New Delhi, 2011.
2. Riza C, Berkan and Sheldon L. Trubatch., "Fuzzy System Design Principles", Standard Publishers and distributors, Delhi, 1997.

Reference Books

1. J.S.R Jang, C.T. Sun and E Mizutani, "Neuro, Fuzzy and soft computing", Prentice Hall of India. Pvt., Ltd., New Delhi, 2010.

BM-70322 LASER AND FIBER OPTICS

3-1-0 = 4

Subject Code: *BM - 70322*
Subject Name: *Laser and fiber optics*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I

Introduction to Fiber Optics: Basic fiber link, Applications, Principles of light: Introduction, EM spectrum, internal & external reflections, Snell' slaw, Optical fiber numerical aperture, Fresnel reflection.

UNIT II

Optic Fiber and its Properties: Introduction, Basic fiber construction, Propagation of light, Modes of operation, Refractive index profile, Types of fibers, Dispersion, Data rate and bandwidth, Attenuation, losses. Connectors, Splices & Couplers: Introduction, splices: Mechanical, fusion, Protection of splice, Connectors: SMA, STC, Bionic etc. Coupling: Passive, Stan, TEE types. Optical sources & Photo Detectors: Introduction: Creation of photons, LED, ILD.

UNIT III

Modulation Scheme for Fiber Optics Transmission: Introduction, Digital modulation, Analog modulation schemes, Multiplexing. Laser Systems: Introduction, Types of lasers: Solid state lasers, Gas lasers, Dye lasers, Lasers used in medical practice: Ruby laser, CO2 laser, Nd-YAG laser and related solid state laser

UNIT IV

Photo Detectors: Introduction, PIN photodiode, Avalanche photodiode, Photodiode parameters, Detector noise, Speed of response, SNR Laser -Tissue Interaction: Terminology: spectral band designations, Energy & power, Irradiant & radiant exposure, Fluency, Thermal diffi1sion fibers & contact tips, Types of laser-tissue interactions. Laser application in medical therapy.

Text Books

1. G. David Baxter, "Therapeutic Lasers -Theory and practice", 1st Edition, Churchill Livingstone publications, 2000.
2. David H Shiney, Stephen and L. Trokel, "Medical Lasers and Their Safe Use", 1st Edition, Springer-Verlag publications, 1993.
3. S. K. Venkata Ram, "Biomedical Electronics & Instrumentation", Galgotia Publications, 2008.

Reference Books

1. Katzer and Abraham, "Laser and Optical Fibers in Medicine", Academic Press Publications, 2012.
2. A. M. Cherin, "An Introduction to Optical Fibers", McGraw Hill Publications, 1982.

BM-70323 FUNDAMENTAL OF BIO-MEMS **3-1-0 = 4**

Subject Code: *BM - 70323*
Subject Name: *Fundamental of Bio-MEMS*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I
MEMS and Microsystems: Photolithography: Mask design; Wet and dry etching; Thin film deposition and growth, Electroplating, Moulding, LIGA, Bonding and sacrificial processes, Polymer processing and rapid prototyping.

UNIT II
MEMS AND Microfluidic System: Biomaterials and Biocompatibility Issues: Microfluidics, Micro total analysis system (μTAS): Fluid control components, μ-TAS: Sample handling, μ-TAS: Separation components, μ-TAS: Detection.

UNIT III
Cell Handling and Characterization: Systems for PCR, Polynucleotide arrays and genetic screening.

UNIT IV
Microsensors and Microactuators: Miniature Biosensors, Biosensors arrays and implantable devices, Neural interfaces,microsurgical tools, Micro needles, and drug delivery, Miniature bioreactors and Microsystems for tissue engineering, Tissue scaffolds, Optical biosensors, MEMS metrology, MEMS packaging.

Text Books
1. Manz and H. Becker, "Microsystem Technology in Chemistry and Life Sciences", Spronger-Verlag, New York, 1999.
2. Albert Folch, "Introduction to BioMEMS", 1st Edition, CRC Press, 2012.

Reference Books
1. Cooney David, "Biomedical Engineering Principles", Volume 1, Marcel Decker, 1976.
2. Dane E Karne & Michael C Raymer, "Fundamental concepts of Bioinformatics", Pearsons Education, 2006.

HU-704 INDUSTRIAL ECONOMICS AND ENTREPRENEURSHIP 3-1-0 = 4

Subject Code: *HU - 704*
Subject Name: *Industrial Economics and Entrepreneurship*
No. of Hours Per Week: *Lectures-3, Tutorial-1*
Marks Distribution: *Sessional Works = 40, End Semester Examination = 60.*
Questions to be set: *Eight (At least one question from each Unit will be set while the remaining questions may be from more than two Units. Each question will be of 12 marks).*
Questions to be answered: *Any five.*
Duration of End Semester Examination: *Three Hours.*

UNIT I
Market structures: Concept of demand and supply, Elasticity of demand, Types of market structure, Firm and industry, Business cycle, Input and out analysis, Plant location decision, Types of cost.

UNIT II
Production Process: Types of production, Plant layout, Production planning and control processes, Human resource functions, Emotional intelligence, Inventory control techniques, Work and method study, Productivity concept.

UNIT III
Management Principles and Functions: Managerial skills, Decision making process, Types of organization structures, Maslow's hierarchy of needs, Types of communication, Leadership styles.

UNIT IV
Marketing Concept: Factors affecting consumer behaviour, Types of market segments, Product life cycle, Pricing methods, Distribution channels, Advertising and sales promotion, Value engineering.

Text Books

1. R.R. Barthwal, "Industrial Economics: An Introductory Text Book", New Age, 2010.
2. Ahuja, H, L., "Managerial Economics:, S. Chand and Company Ltd., New Delhi, 2007.
3. Aswathapa, K, "Human Resource and Personnel Management", 4th Edition, TMH, New Delhi, 2005.

Reference Books

1. Kotler, Keller, Koshy, Jha, "Marketing Management-A South Asian Perspective", Pearson Ltd., 2009.
2. Luthans, Fred, "Organizational Behaviour", TMH, New Delhi, 2003.

BM-711 BIOLOGICAL CONTROL SYSTEM LABORATORY 0-0-3 = 2

Subject Code: *BM - 711*
Subject Name: *Biological Control System Laboratory*
No. of Hours Per Week: *Practicals-3*
Marks Distribution: *Sessional Works = 20, End Semester Examination = 30.*
Minimum number of Experiments to be carried out: *Eight.*
***Question to be answered*:** *One experiment will be allotted to a student on lottery basis.*
Duration of End Semester Examination: *Four Hours.*

List of Experiments

1. Experimental Study of Adaptation of Postural Control and after-effects to Postural Control Adaptation.
2. To obtain a transfer function from given poles and zeroes using MATLAB
3. To obtain the step and impulse response of a transfer function of the given system using MATLAB
4. Estimate the impulse response by use of correlation analysis and plot the step response.
5. To obtain the time response of a given second order system with its damping frequency
6. Verify an RTD temperature sensor and thermistor circuit.
7. Verify the behavior of a closed-loop system under the presence of disturbances
8. To obtain bode plot for a givan transfer function of the system using MATLAB.
9. To obtain the transfer function from the state model.
10. To obtain a state model from given poles and zeros using MATLAB.
11. To find out the transfer function using system identification toolbox
12. To obtain the Nyquist plot for a given transfer function of the system.
13. To design lag-lead compensator using closed loop system.
14. To control the closed loop system using PID controller.

Text Books

1. T. R. Bewley, "Flow Control: New Challenges for a New Renaissance, *Progress in Aerospace Science"*, Vol. 37, 2001.
2. : Narciso F. Macia George J. Thaler, "Modeling & Control of Dynamic Systems" Thomson Publishers.
3. R. Johansson, "System Modeling and Identification", Prentice Hall, 1993.

Reference Books

1. B. C. Kuo "Automatic Control Systems", 8th Edition, John Wiley and Son's, 2003.
2. I. J. Nagrath and M. Gopal, "Control Systems Engineering" New Age International (P) Limited, Publishers, 2nd edition, 2005.

BM-715 MINOR PROJECT **0-0-6=4**

Minor project: Students need to carry out their projects in the department under the supervision of atleast one faculty member from the Department. They can also opt to carry out their projects during the 8th Semester outside NEHU with the collaboration of other National Institutes/ National laboratories/ Industries/ Hospitals within India or abroad, in that case student needs to take a co-supervisor from the department and also needs to take permission from the department supervisor as well as from the Head of the Department. In exceptional cases or based on requirements of host organization the permission may be granted from the Head of the Institution.

Selection of the supervisor(s) and topic of interest needs to be finalised at the end of 6th semester and submitted to the Department. Students need to submit a project synopsis on their respective area of work at the beginning of the 7th semester. During the minor project, students need to deliver presentation covering their work undertaken during that period. The evaluation of the Minor project would be done through a committee constituted by the Head of Department, comprising of the Head of the Department, respective supervisor, department faculty members and an outside expert in the field.

EIGHT Semester Papers

BM- 815 MAJOR PROJECT **0-0-20=20**

Major projects: Students can carry out their major projects in the department under the supervision of at least one teacher. They can also opt to carry out their projects outside NEHU with the collaboration of other National Institutes/ National laboratories/ Industries/ Hospitals within India or abroad, in that case student needs to take a co-supervisor from the department and also needs to take permission from the department supervisor as well as from the Head of the Department. In exceptional cases or based on requirements of host organization the permission may be granted from the Head of the Institution.
Selection of the supervisor(s) and topic of interest needs to be finalised at the end of 6^{th} semester and submitted to the Department. Students need to submit a project synopsis on their respective area of work at the beginning of the 7^{th} semester. At the end of project, students need to submit their project reports and deliver presentation covering their work undertaken. The evaluation of the Major project would be done through a committee constituted by the Head of Department, comprising of the Head of the Department, respective supervisor, department faculty members and an outside expert in the field.

BM-816 SEMINAR **0-0-0=4**

In Seminar, students would submit their topic of seminar at beginning of 8th semester. The topic chosen should be related to the field of Biomedical Engineering highlighting recent developments in the field. If required they can decide the topic of presentation in consultation with the departmental faculty members/ field experts etc. and prepare a presentation of not more than 25-30 slides. At the end of the 8th Semester, each student will deliver presentation for 15-20 minutes followed by question and answer session for 5-10 minutes.

Within 15 days of presentation of their Seminar, they should submit 3 copies hard bounded report in approved format. The evaluation of the Seminar would be done through a committee constituted by the Head of Department, comprising of the Head of the Department, department faculty members and an outside expert in the field. If the performance is found to be unsatisfactory, they will be asked for resubmission/ repeat presentation.