M.Tech (BME)
Two Year (Four Semesters)
Scheme of Instruction and Syllabus
(Choice Based Credit System)

(With effect from 2015-2016 admitted batches onwards)

Department of Electronics and Communication Engineering
AU College of Engineering (Autonomous)
Visakhapatnam -530003
2015-2016

CENTRE FOR BIO – MEDICAL ENGINEERING

Dept. of Electronics and Communication Engineering
AU College of Engineering (Autonomous)
Visakhapatnam – 530 003.

Credit Based Grading System

Scheme and Syllabi for M.Tech (Bio – Medical Engg.)
2 years (4 Semester) Programme
Valid with effect from 20015-16 Admitted Batch

SEMESTER – I

Subject Code	Subject Title	Credits	Pds / week		Sessionals	Univ. Exam Marks	Total
			Theory	Lab			
MTBM – 1.1	Anatomy & Physiology	4	4	-	30	70	100
MTBM –1. 2	Electronics Devices & Circuits	4	4	-	30	70	100
MTBM – 1.3	Elective –I a) EMI/EMC b) Elctrocardiography Signal Analysis c) Mathematical Methods for Engineers	4	4	-	30	70	100
MTBM –1. 4	Medical Image Processing	4	4	-	30	70	100
MTBM – 1.5	Elective – II a) Orthopedics & Rehabilitation b) Bio-Medical Signal Processing c) Bio-Mechanics	4	4	-	30	70	100
MTBM –1. 6	Bio-Medical Instrumentation – I	4	4	-	30	70	100
MTBM – 1.7	Digital Signal and Image Processing Lab	2	-	3	100	-	100
MTBM –1. 8	Seminar	2	-	3	100	-	100
	Total	28	24	6	380	420	800

SEMESTER – II

Subject Code	Subject Title	Credits	Pds / week		Sessionals	Univ. Exam Marks	Total
			Theory	Lab			
MTBM –2.1	Bio – Medical Instrumentation – II	4	4	-	30	70	100
MTBM –2.2	Principles of Radiology	4	4	-	30	70	100
MTBM – 2.3	Hospital Management & Support Services	4	4	-	30	70	100
MTBM – 2.4	Elective-III a) Clinical Medicine b) Biological Effects of Radition c) Biomems and Bio-Sensors	4	4	-	30	70	100
MTBM – 2.5	Principles of Electrotherapy	4	4	-	30	70	100
MTBM – 2.6	Elective – IV a) Nano-Technology and Applications b) Robotics and Artificial Intelligence c) Bio – Materials and artificial organs	4	4	-	30	70	100
MTBM – 2.7	Bio – Instrumentation Lab	2	-	3	100	-	100
MTBM – 2.8	Seminar	2	-	3	100	-	100
	Total	28	24	6	380	420	800

SEMESTER – III

Subject code	Subject title	Credits	Scheme of Examination	Total
MTBM-3.1	Thesis(Preliminary)	10	Viva -Voice	100

SEMESTER – IV

Subject code	Subject title	Credits	Scheme of Examination		Total
			Sessionals	Uni-Exam Marks	
MTBM-4.1	Thesis(Final)	14	30	70	100

1. **The 3rd and 4th semesters are allocated for the project work.**
2. **At the end of 3rd semester, a project review is conducted by HOD with the committee consisting of the HOD, Chair person of BOS and the Guide. In the affiliated colleges, Project (preliminary) will be evaluated by concerned HOD and thesis Guide of their respective Colleges.**
3. **At the end of 4th semester there will be a final viva voce for the project work conducted by the HOD with the committee consisting of HOD, Chair person of BOS, the Guide and an external examiner nominated by the University.**
4. **The Students need to complete 80 credits (in all the semesters put together) to be qualified for getting M-Tech degree.**

M.Tech (Bio-Medical Engineering)
I-Semester

Syllabus for
ANATOMY AND PHYSIOLOGY

Credits: 4

Subject Code: MTBM – 1.1 **Max. Marks:** 70
Sessionals : 30

1. Introduction
   - Cell and its constituents,
   - Functional characteristics of cell organelles,
   - Cell division : Mitosis and Meiosis,
   - Tissue structure and overview of organ systems
2. Nervous System
   - Structure of brain, spinal cord
   - Neuromuscular junction
   - Motor pathways : Pyramidal and extra pyramidal
   - Sensory pathway
   - Sensory end organs
   - Special sensors
     - Auditory pathway
     - Visual pathway
     - Olfactory pathway
     - Gustatory pathway
3. Energy balance, metabolism and nutrition
   - Energy metabolism
   - Intermediary metabolism
   - Nutrition
4. Respiratory System
   - Anatomy of lungs
   - Properties of gases
   - Gas exchange in the lungs
   - Mechanics of respiration
   - Hypoxia, effect of exercise
5. Kidney
   - Functional anatomy
   - Glomerular filtration
   - Tubular function
   - Effects of disordered renal function
6. Muscular System
   - Anatomy and structure of skeletal and smooth muscle
   - Process of contraction of skeletal and smooth muscle
   - Exercise physiology

Reference Books:

1. R.J. Last: Human anatomy: Associated East West Press
2. Ross & Wilson: Anatomy and Physiology
3. Ganeny Phyidogy

M.Tech (Bio-Medical Engineering)

I-Semester

Syllabus for

ELECTRONICS DEVICES AND CIRCUITS

Credits: 4

Subject Code: MTBM – 1.2 **Max. Marks:** 70

Sessionals : 30

1. Diode Characteristics and Applications

Diode working, Basic applications of PN diode, Diode specifications, Diode equivalent circuits, Characteristics of a PN diode, Volt-ampere characteristics of PN diode, Diode resistances, Diode testing, Varactor diode, Zener diode, Tunnel diode Light Emitting Diode, Photo diode, Solar cells,

2. Rectifier Circuits

Half-wave rectifier, Full-wave rectifier, Bridge rectifier, Comparative characteristics of rectifier circuits, Filter circuits

3. Transistor Characteristics and Applications

Operation of the transistor, Transistor configurations, Current amplification factor, β, Differences among the parameters of CE, CB and CC transistor configurations, The transistor equivalent circuits, The specification parameters correspondent to maximum ratings of BJT, Applications of transistors, Testing of transistors,

4. Biasing and Stability of Transistors

Biasing of amplifiers, Definition of operating point, Stability factors, Self-bias or emitter bias, Diode compensation, Thermister compensation, Sensistor compensation, Thermal runway, Thermal resistance, T_R, Thermal stability

5. Field Effect Transistors

Classification of field effect transistors, Junction field effect transistors (JFET), The salient features of JFET, Comparative characteristics of JFET and BJT, Merits of JFET

Demerits of JFET, Construction of JFET, JFET characteristics, JFET parameters, Transfer characteristics, Drain characteristics, Applications of JFETs, Metal oxide semiconductor field effect transistor (MOSFET), Enhancement type MOSFET, Depletion type MOSFET, Salient features of enhancement and depletion type of MOSFET

6. Feedback Amplifiers

Expression gain with feedback, First classification of feedback amplifiers, Negative feedback amplifier, Positive feedback, Second classification of feedback amplifiers, Characteristics of negative feedback amplifier, Characteristics of positive feedback, Effect of negative feedback on gain stability, Effect of negative feedback on bandwidth, Effect of negative feedback on distortion, Effect of negative feedback on non-linear distortion, Effect of negative feedback on noise, Voltage-series feedback, Voltage-shunt feedback, Current-series feedback, Current-shunt feedback amplifier, The net effects of feedback circuits, Applications of negative feedback.

7. Oscillators

Definition of oscillator, Definition of generator, Conditions for oscillators, Bharkhausen criteria, The characteristics of oscillators, Classification of oscillators, Sinusoidal oscillators, Relaxation oscillators, RC phase shift oscillator, Salient features of RC phase oscillator, Wein bridge oscillator, Colpitts oscillator, Hartley oscillator, The crystal oscillator

8. Operational Amplifiers and Applications

Introduction to integrated circuits, Salient features of op-amps, Symbol of op-amp, Classification of integrated circuits, Differences between linear and digital ICs, Characteristics of an ideal op-amp, Applications of operational amplifiers, The equivalent circuit of op-amp, The circuits inside an op-amp, Definitions of op-amp parameters, Frequency sensitive parameters of op-amp, Temperature sensitive parameters, Applications of linear ICs, Typical op-amps, Salient features of op-amp 741 series, Specifications of μA 741, Virtual ground concept, Applications of op-amp, Typical pin designations of op-amp

Textbook

1. G.S.N. Raju, "Electronic Devices and Circuits," IK International Publishing House Pvt. Ltd., 2006.

2. Boylestad, "Electronic Devices and Circuit Theory", Pearson Education Pvt. Ltd., 2006.

M.Tech (Bio-Medical Engineering)
I – Semester
Syllabus for
Elective-I (a): EMI/EMC

Credits: 4

Subject Code: MTBM – 1.3 **Max. Marks:** 70
Sessionals: 30

Common with M.Tech (Radar and Microwave Engineering), EMI/EMC (MTRM-5), M.Tech (Communication Systems) EMI / EMC (MTCS-6a) and M.E. (Electronic Instrumentation) EMI/EMC (MEI-6a)

1. Introduction, Natural and Nuclear sources of EMI / EMC:
   Electromagnetic environment, History, Concepts, Practical experiences and concerns, frequency spectrum conservations. An overview of EMI / EMC, Natural and Nuclear sources of EMI.
2. EMI from apparatus, circuits and open area test sites:
   Electromagnetic emissions, noise from relays and switches, non-linearities in circuits, passive intermodulation, cross talk in transmission lines, transients in power supply lines, electromagnetic interference (EMI). Open area test sites and measurements.
3. Radiated and conducted interference measurements and ESD:
   Anechoic chamber, TEM cell, GH TEM Cell, characterization of conduction currents / voltages, conducted EM noise on power lines, conducted EMI from equipment, Immunity to conducted EMI detectors and measurements. ESD, Electrical fast transients / bursts, electrical surges.
4. Grounding, shielding, bonding and EMI filters:
   Principles and types of grounding, shielding and bonding, characterization of filters, power lines filter design.
5. Cables, connectors, components and EMC standards:
   EMI suppression cables, EMC connectors, EMC gaskets, Isolation transformers, optoisolators, National / International EMC standards.

Text Books:

1. Engineering Electromagnetic Compatibility by Dr. V.P. Kodali, IEEE Publication, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.
2. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi, Modules 1 – 9.

References:

1. Introduction to Electromagnetic Compatibility, Ny, John Wiley, 1992, by C.R. Pal.

M.Tech (Bio-Medical Engineering)

I – Semester

Syllabus for

Elective-I (b): ELECTROCARDIOGRAPHY SIGNAL ANALYSIS

Credits: 4

Subject Code: MTBM – 1.3 **Max. Marks:** 70

Sessionals: 30

1. Projections of the cardiac vector on planes (vectorcardiographic loops) and lines (usually the standard 12 leads), and relates the waves, intervals and segments, corresponding phases of the cardiac contraction cycle, usefulness of the systematic approach to clinical ECG analysis

2. Techniques of ECG acquisition, instrumentation amplifier, 50 and 60 Hz notch filters, storage formats for the ECG, MIT-BIH database for QRS detection algorithms, false positive and false negative beats in an ECG recording.

3. ECG statistics, noise, artifacts, and missing data, standard clinical features of the ECG-parameters of the QRS complex, RR interval length, PR and QT intervals.,QT hysteresis, models for ECG and RR interval processes

4. linear and nonlinear filtering methods, Numerous techniques are presented: Wiener and Wavelet Filtering, Principal Component Analysis, Neural Networks, Lyapunov Exponents, Entropy, presentation of the T-wave alternans phenomenon, measurement techniques,

5. Techniques for estimating the respiratory frequency in ECG, ST analysis. Probabilistic Modeling Approach to interpretation of the ECG.

TEXT BOOKS:

1. Advanced Methods and Tools for ECG Data Analysis", by Gari D. Clifford, Francisco Azuaje and Patrick E. McSharry (Editors).

2. ECG Signal Processing, Classification and Interpretation: A Comprehensive Framework of Computational Intelligence, Adam Gacek, Witold Pedrycz

M.Tech (Bio-Medical Engineering)
I – Semester
Syllabus for
Elective-I (c): MATHEMATICAL METHODS FOR ENGINEERS

Credits: 4

Subject Code: MTBM – 1.3 **Max. Marks:** 70

Sessionals : 30

1. Mathematical modeling and solution of biomedical problems namely respiratory

Rate, blood flow, cardiac output and impedance diffusion, ultra filtration etc.

2.Operational research applied to the description of physiological systems and

Signals processing by interfacing instrumentation

3. Biomedical variability and probabilistic solution to medical decision making,

Population dynamics perturbation technique in dealing with the problems of thermodynamics.

Stochastic process. Finite- Difference method.

TEXTBOOKS:

1. Numerical Methods in Biomedical Engineering, By Stanley Dunn, Alkis Constantinides, Prabhas V. Moghe
2. Mathematical Models in Engineering,By Joesph M Powers,Mihir Sen.

M.Tech (Bio-Medical Engineering)
I-Semester

Syllabus for
MEDICAL IMAGE PROCESSING

Credits: 4

Subject Code: MTBM – 1.4 **Max. Marks:** 70

Sessionals : 30

1. Imaging In medicine – CT scan principle – reconstruction from projection – Fourier slice theorem -
2. Parallel and fan beam projection algorithm –
3. Uniqueness and resolution – X – ray - ultrasound – microwave tomography-
4. Positron Emission Tomography
5. MRI systems – T1 and T2 based imaging
6. Image processing in medicine – digital image processing –
7. Contrast enhancement – edge shaping –
8. Digital image compression for transmission – Safety consideration in medical imaging.

Reference Books:

1. Albert Kacovasaki : Medical imaging systems
2. Gonzalves : Digital Image processing
3. Rosenfield & A.C. Kak : Image processing Vol. 1,2

M.Tech (Bio-Medical Engineering)

I-Semester

Syllabus for
Elective II(a) : ORTHOPAEDICS AND REHABILITATION

Credits : 4

Subject Code : MTBM – 1.5 **Max. Marks :** 70

Sessionals : 30

1. Basics of orthopedics

2. Physiology of bones

a) Calcium and phosphorous metabolism
b) Bone physiology
c) Vitamin 'D' metabolism
d) Effects of hormones and humoral agents on calcium metabolism

3. Skeletal System

Organization
Bone formation and growth
Fracture healing
Bio-mechanism of joints

4. General Orthopedics

a) Gait
b) amputations
c) Prosthesis and Research work

5. Rehabilitation

Diagnostic aids in orthopedics

a) Radiological
b) Electrophysiological
c) Bone densitometry
d) Arthroscopy

Reference Books :

1. Textbook of Orthopaedics by Prakash P. Kotwal, mayilvahanan Natarajan, Elsevier Publications, 2005.
2. Essentials of Rehabilitation for orthopaedic surgeons by John Ebnezar, Jaypee Brothers Medical Publishers Pvt, Ltd., 2006.
3. Principles and practice of Orthopedics by Dr. C. Vyagreswarude, Andhra University press 1993.

M.Tech (Bio-Medical Engineering)

I-Semester

Syllabus for
Elective II(b) : BIO-MEDICAL SIGNAL PROCESSING

Credits : 4

Subject Code : MTBM – 1.5 **Max. Marks :** 70

Sessionals : 30

1. Discrete-time Signals and Systems

Characterization, classification and time-domain representation of discrete-time signals, Typical sequences and their representation, Classification of sequences, Basic operations on sequences, Discrete-time systems.

2. The Discrete Fourier Transform

The discrete-time Fourier transform (DTFT), The discrete Fourier Transform (DFT), Computation of the DFT

3. Theory of Z-Transform

Mathematical derivation of the unilateral z-transform, Properties of the z-transform, the inverse-z-transform, The bilateral z-transform, Power series, Region of convergence (RoC) and its impedance

4. Neurological Signal Processing

The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics, EEG analysis, Linear prediction theory,

5. Neurological Signal Processing

The autoregressive (AR) method, Recursive estimation of AR parameters, Spectral error measure, Adaptive segmentation, Transient detection and elimination – the case of epileptic patients, Overall performance.

6. Cardiological Signal Processing

Basic electrocardiography, ECG data acquisition, ECG lead system, ECG parameters and their estimation,

7. Cardiological Signal Processing

The use of multi-scale analysis for parameters estimation of ECG waveforms, Arrhythmia analysis monitoring, Long-term continuous ECG recording.

8. ECG Data Reduction Techniques

Direct data compression techniques, Direct ECG data compression techniques, Transformation compression technique, Other data compression techniques, The PRD index

Textbook

1. Biomedical Signal Processing, Principles and Techniques by D.C. Reddy, Tata McGraw Hill, 2005.

M.Tech (Bio-Medical Engineering)

I-Semester

Syllabus for
Elective II(c) : BIO-MECHANICS

Credits : 4

Subject Code : MTBM – 1.5 **Max. Marks :** 70

Sessionals : 30

1. BIO FLUID MECHANICS:Introduction: Newton's laws, Stress, Strain, Non Viscous fluid, Newtonian Viscous fluid, Viscoelasticity, Blood Characteristics, Mechanical Interaction of Red blood cells with solid wall, Thrombous formation and dissolution, Medical applications of blood rhelogy

2. BONE & ITS PROPERTIES:Bone structure and Composition, Blood Circulation in Bone, Viscoelastic properties of Bone, Electrical Properties of Bone, Fracture Mechanism and Crack Propagation in bones, Kinetics and Kinematics of Joints.

3. CARDIAC MECHANICS:Cardio vascular system, Mechanical properties of blood vessels-Arteries, Arterioles, Capillaries, Veins, Blood flow- Laminar & turbulent , Prosthetic Heart Valves & replacement.

4. BIOMECHANICS OF SPINE AND LOWER EXTREMITY:Biomechanics of Spine-Structure, Movements, Loads on Spine, Exoskeletal system for Paraplegics, Structure of Hip-Movements, Loads on Hip, Total Hip Prosthesis , Structure of Knee- Movements , loads on knee, Knee prosthesis , Powered wheel chair, Crutches and canes.

5. GAIT ANALYSIS:Human Locomotion- Gait Analysis, Foot Pressure measurements-Pedobarograph , Mechanics of Foot-Arthritis, Biomechanical treatment.

TEXT BOOKS

Y.C. Fung, *Biomechanics-Circulation Springer Verlang*, 2nd Edition, 1997.
Basic Biomechanics , By Susan J. Hall

REFERENCE BOOKS:

1. Alexander.R. Mc.Neill, *Biomechanics* , Chapman and Hall, 1975.
2. D.N.Ghista, *Biomechanics of Medical Devices*, Macel Dekker, 1982.
3. *An Introduction to Biomechanics*, By Jay D. Humphrey & Sherry L. Delance
4. *Fundamentals of Biomechanics* , By Duane Knudson.
5. VC Mow and W C Hayes, Basic *Orthopedic Biomechanics*, Lippineott – Raven Publishers.

M.Tech (Bio-Medical Engineering)
I-Semester

Syllabus for
BIO-MEDICAL INSTRUMENTATION – I

Credits : 4

Subject Code : MTBM – 1.6 **Max. Marks :** 70

Sessionals : 30

1. Introduction to Biomedical Instrumentation

The age of biomedical engineering, Development of biomedical instrumentation, Biometrics, Introduction to the man-instrument system, Components of the man-instrument system, Physiological Systems of the body, Problems encountered in measuring a living system

2. Basic Transducer Principles

The transducer and transduction principles, Active transducers, Passive transducers, Transducers for biomedical applications

3. Sources of Bioelectric Potentials

Resting and action potentials, Propagation of action potentials, The bioelectric potentials.

4. Electrodes

Electrode theory, Biopotential electrodes, Biochemical transducers

5. The Cardiovascular System

The heart and cardiovascular system, The heart, Blood pressure, Characteristics of blood flow, Heart sounds.

6. Cardiovascular Measurements

Electrocardiography, Measurement of blood pressure, Measurement of blood flow and cardiac output, Plethysmography, Measurement of heart sounds.

7. Patient Care and Monitoring

The elements of intensive-care monitoring, Diagnosis, Calibration and repairability of patient-monitoring equipment, Other instrumentation for monitoring patients, The organization of the hospital for patient-care monitoring, Pacemakers, Defibrillators.

8. Measurements in the Respiratory System

The physiology of the respiratory system, Tests and instrumentation for the mechanics of breathing, Gas exchange and distribution, Respiratory therapy equipment.

TEXT BOOK :

Biomedical Instrumentation and Measurements – C. Cromwell, F.J. Weibell, E.A. Pfeiffer – Pearson education.

Reference Book

Bio-Medical Instrumentation – Dr. M. Arumugam, Anuradha Agencies, 2005.

M.Tech (Bio-Medical Engineering)

I-Semester

Syllabus for
DIGITAL SIGNAL AND IMAGE PROCESSING LAB

Credits : 4

Subject Code : MTBM – 1.7 **Max. Marks :** 70

Sessionals : 30

1. Digitization of ECG using IBM PC and A/D connector cords

2. Digitization of EEG and EMG signals using IBM PC and A/D connector cords.

3. Digital smoothing using averaging filter

4. Digital filtering to eliminate 50Hz pick up and limiting bandwidth (notch filters and low pass filters)

5. Digital signal compression for biotelemetry applications

6. Image processing for contract enhancement and sharping the edges

7. MR image processing

8. Digital image compression

M.Tech (Bio-Medical Engineering)

II – Semester

Syllabus for

BIO-MEDICAL INSTRUMENTATION – II

Credits : 4

Subject Code : MTBM –2.1 **Max. Marks :** 70

Sessionals : 30

Chapter – I : Sources of Bioelectric potentials and Electrodes

Resisting and Action Potentials, Propagation of Action Potentials, The Bioelectric Potentials

Electrode theory, Bio Potential Electrodes, Biochemical Transducers

Chapter – II : The Cardiovascular System and Cardiovascular Measurements,

The Heart and Cardiovascular System, The Heart, Blood Pressure, Characteristics of Blood Flow, Heart Sounds

Electrocardiography, Measurement of Blood Pressure, Measurement of Blood Flow and Cardiac output, Plethysmography, Measurement of Heart Sounds,

Chapter – III : Patient Care & Monitory and Measurements in Respiratory System

The elements of Intensive Care Monitory, Diagnosis, Calibration and repairability of Patient Monitoring equipment, other instrumentation for monitoring patients, pace makers, defibrillators

The Physiology of respiratory system, tests and instrumentation for mechanics of breathing, respiratory theory equipment

Chapter – IV : Bio telemetry and Instrumentation for the clinical laboratory Introduction to biotelemetry, physiological parameters adaptable to biotelemetry, the components of biotelemetry system, implantable units, applications of telemetry in patient care

The blood, tests on blood cells, chemical test, automation of chemical tests

Chapter – V : X – ray and radioisotope instrumentation and electrical safety of medical equipment.

Generation of Ionizing radiation, instrumentation for diagnostic X – rays, special techniques, instrumentation for the medical use of radioisotopes, radiation therapy.

Physiological effects of electrical current, shock Hazards from electrical equipment, Methods of accident prevention

TEXT BOOK :

Biomedical Instrumentation and Measurements – C. Cromwell, F.J. Weibell, E.A. Pfeiffer – Pearson education.

M.Tech (Bio-Medical Engineering)
II – Semester
Syllabus for
PRINCIPLES OF RADIOLOGY

Credits : 4

Subject Code : MTBM – 2.2 **Max. Marks :** 70

Sessionals : 30

1. GI Tract
   Liver
   Gallbladder
   Pancreas
   Kidney
   Urinary Bladder
2. Female Genital Tract
   Chest
   Orthopaedics
   Nervous System
   Breast
   Thyroid
3. Helical CT Technique and Protocols
   Common Acute Abdominal Pathologies
   CT in Bowel Obstruction
   CT in the Evaluation of Intestinal Volvulus
   Abdominal Wall Hernias and Role of CT
4. CT in Inflammatory Bowel Diseases and Infectious Colitis
   Ischemic Bowel Disease
   Acute Intra-abdominal Vascular Emergencies and Hemorrhage
   Miscellaneous
5. Basic Principles
   Instrumentation
   MR Safety
   MR Contrast Media
   Principles of Interpretation : Neuroimaging
   Principles of Interpretation : Body Imaging
   MR Angiography
   Cardiac MRI

Textbooks

1. Radiology Interpretation Made Easy by G. Balachandiran, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, 2007.
2. Step by Step Emergency Radiology by Arjun Kalyanpur and Jagdish Singh, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, 2006.
3. MRI Made Easy by Govind B Chavhan, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, 2006.

M.Tech (Bio-Medical Engineering)

II-Semester

Syllabus for

HOSPITAL MANAGEMENT AND SUPPORT SERVICES

Credits : 4

Subject Code : MTBM – 2.3 **Max. Marks :** 70

Sessionals : 30

1. Evolution of hospitals
   Hospital Administration
   Outpatient Department (OPD)
   Inpatient (IP) Services
2. Operation Theatre Complex (OT Complex)
   Delivery Suite
   Pharmacy
   Laboratory Services (LAB)
3. Radiology Department (X-ray Department)
   Central Sterile Supply Department (CSSD)
   Medical Records Department (MRD)
4. Medico-legal Sciences
   Professional Ethics
   Labor Laws
5. Building Requirements
   Laboratory Services
   Blood Bank, Drug and Cosmetic Rules for regulation of blood banks, Drug and Cosmetic Rules
   Radiological and Imaging Services
6. Material Management
   Hospital Dietary Services
   Ambulance Services
7. Hospital Environmental Control
   Hospital Waste Management, Bio-Medical Waste (Management & Handling), Rules
8. Autopsy and Mortuary Management
   Fire Prevention, Communication and Workshop
   Transplantation of Human Organs Act

Textbooks

1. The Hospital Administrator by M.A. George, Jaypee Publications, 2005.
2. Essentials for Hospital Support Services and Physical Infrastructure by Madhuri Sharma, Jaypee Publications,

M.Tech (Bio-Medical Engineering)

II – Semester

Syllabus for

Elective III(a): CLINICAL MEDICINE

Credits : 4

Subject Code : MTBM – 2.4 **Max. Marks :** 70

Sessionals : 30

1. Evaluation of Headache
   Evaluating Chronic Cough
   An Approach to Interpret Arterial Blood Gases
   Pre-operative Medical Evaluation

2. Adult Immunisation
   Newer Developments in Management of Hypertension
   Exercise Testing in Diagnosis and Prognosis of Heart Disease : An Overview
   Cardiovascular Risk Assessment
   Management of Valvular Heart Disease

3. Update on Management of Type 2 Diabetes Mellitus
   Postprandial Hyperglycaemia : A Real Challenge in Diabetes Mellitus
   Vascular Complications in diabetes – Clinical Evaluation and Screening
   Antithyroid Drugs
   Viral Hepatitis

4. Iron Deficiency Anaemia
   Typhoid Fever
   Millary Tuberculosis
   Multidrug-resistant Tuberculosis (MDR-TB)
   Diagnostic Approach to Malaria

5. Preventive Strategies in Acute Renal Failure
   Management of Anaemia of Chronic Renal Disease
   Urinary Tract Infection
   Parkinson's Disease
   Management of Difficult Asthma
   Advances in the Treatment of Rheumatoid Arthritis and Spondyloarthropathes

Textbook

1. Clinical Medicine by AK Agarwal and DG Jain

M.Tech (Bio-Medical Engineering)

II – Semester

Syllabus for

Elective III(b): BIOLOGICAL EFFECTS OF RADIATION

Credits : 4

Subject Code : MTBM – 2.4 **Max. Marks :** 70

Sessionals : 30

1. **Action of Radiation in Living cells**

Various theories related to radiation at cellular level. DNA and chromosomal damages.

2. **Somatic Application of Radiation**

Radio sensitivity protocols of different tissues of human. LD50/30 effective radiation on skin, Bone marrow, eye, endocrine glands, and basis of radio therapy.

3. **Genetic Effects of Radiation**

Threshold and linear dose, gene control hereditary diseases effect of dose.

4. **Effect of Microwave and RF with matters**

Effects of various human organs and systems. Wavelength in tissue, non thermal interaction. Standards of protection, national and international standards and precautions.

5. **UV Radiation**

Classification of sources, measurement, photo medicine, UV radiation safety visible and infrared radiation.

TEXT BOOKS:

1. Glasser O., *Medical Physics,* Volume I, II, III, The year book publishers Inc, Chicago 1980.

REFERENCE BOOKS:

1. Moselly H., *Non ionizing Radiation, Adam-Hilgar*, Bristol 1988.

M.Tech (Bio-Medical Engineering)

II – Semester

Syllabus for

Elective III(c): BIOMEMS AND BIOSENSORS

Credits : 4

Subject Code : MTBM –2.4 **Max. Marks :** 70

Sessionals : 30

1. Introduction to BioMEMS, Silicon Microfabrication, "Soft" Fabrication Techniques, Polymer Materials,Microfluidic Principles.

2. Sensor Principles and Microsensors, Microactuators and Drug Delivery, ClinicalLaboratory Medicine, Micro-Total-Analysis Systems, Detection and Measurement Methods,.

3. Genomicsand DMA Microarrays, Proteomics and Protein Microarrays, Emerging BioMEMS Technology, Packing,Power, Data, and RF Safety, Biocompatibility.

4. Biosensors based on antigen-antibody interactions,avidin-biotin mediated biosensors, functionalized electrodes as electrochemical biosensors, wiredperoxidase based biosensors.

5. Electrochemical enzyme immunoassay, liposomes inimmunodiagnostics, polyion sensors, piezoelectric immunosensors, SPV biosensors, SPR biosensors,dual electrode enzyme sensors.

Text books:

1. Handbook of Biosensors and Electronic Noses: Medicine, Food and the Environment: CRC-Press; 1
edition;1996
2. Steven S. Saliterman, Fundamentals of BioMEMS and Medical Microdevices ,SPIE Press Monograph
Vol. PM153, 2006

Reference :

1. Biosensors: Oxford University Press, USA; 2 edition, 2004 D. L. Wise, Biosensors: Theory and Applications, CRC Press,1993
2. Rao & Guha, Principles of Medical Electronics & Biomedical Instrumentation, Orient Longman.2001

M.Tech (Bio-Medical Engineering)

II – Semester
Syllabus for
PRINCIPLES OF ELECTROTHERAPY

Credits : 4

Subject Code: MTBM-2.5 **Max. Marks:** 70

Sessionals: 30

1. Introduction

   Low Frequency Currents

2. Medium Frequency Currents

   High Frequency Currents

3. Radiation Therapy

   Laser Therapy

4. Superficial Heating Modalities

   Ultrasonic Therapy

5. Cryotherapy

Textbook

1. Step by Step Practical Electrotherapy by Jagmohan Singh, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, 2006.

M.Tech (Bio-Medical Engineering)

II – Semester
Syllabus for
Elective IV (a): BIO-MATERIALS AND ARTIFICIAL ORGANS

Credits: 4

Subject Code: MTBM-2.6 **Max. Marks:** 70

Sessionals : 30

1. Structure of biomaterials:
   Definition and classification of biomaterial – mechanical properties – visco – elasticity, elasticity of Non – Hoopkean material
2. Biocompatibility:
   Wound healing process – body response to implants – blood compatibility
3. Metallic implants:
   Stainless steel – cobalt based alloys – titanium based alleys – applications – deterioration of metallic implants
4. Ceramic and polymeric implants:
   Aluminum oxides, Hydrokyapatite, Glass ceramics carbons, polymerization, acrylic polymers, rubbers, high strength thermoplastics, medical applications, deterioration of polymers.
5. Soft – tissue replacement implants:
   Sutures, Surgical tapes, adhesives, percutaneous and skin implants
6. Hard – tissue replacement implants:
   Internal fracture fixation devices, joint replacements dental implants
7. Artificial kidney devices:
   Methods of artificial waste removal – hemodialysis, artificial kidney system.
8. Artificial heart – lung devise:
   Use of patients Lungs for gas exchange – the ideal heart – lung devices – comparison of natural and artificial lungs.

Reference Books:

1. "Biomaterials science and engineering" 1984, Plenum press, New York, John Bu Park
2. "Biomaterial – an Interfacial approach" 1982, Academic press, New York, L.L. Hence & E.C. Ethridge.
3. "Biomedical engineering principles – an introduction to fluid, heat and mass transport processors" 1976, Marcel Decker, New York, David D. Cooney
4. Introduction to Bio – Materials by J. Park.

M.Tech (Bio-Medical Engineering)

II – Semester
Syllabus for
Elective IV (b): ROBOTICS AND ARTIFICIAL INTELLIGENCE

Credits: 4

Subject Code: MTBM-2.6 **Max. Marks:** 70

Sessionals: 30

1. Robots: Basic components – Classification – performance characteristics.

2. Sensors and vision systems: Transducers and sensors – Tactile sensors – Proximity and range sensors – Acoustic sensors – Vision systems – Image processing and analysis – Image data reduction – Segmentation feature extraction – Object recognition.

3. Robot motion analysis and control: Manipulator kinematics – Homogeneous transformation and robot kinematics – Robot dynamics – Configuration of a robot controller.

4. Definition and scope of Artificial Intelligence (AI) – Fundamentals of expert systems – date base programs versus expert systems – components, features and categories of expert systems.

5. Heuristic search – 8 puzzle problem – control strategies – production system characteristics – knowledge representation – matching heuristic function – search methods – problem reductions – Hierarchical planning.

6. Introduction to knowledge representation – representing simple facts in logic – resolution – prepositional logic – predicate logic – predicate logic – Non monotonic reasoning – statistical and probabilistic reasoning – rule based systems.

7. Characteristics of AI language – PROLOG and LISP – symbol manipulation – LISP functions definitions, prediticates, conditional, recursion – iteration – properties – lists, arrays, I/O statements – search, sort, hill climbing methods – perception and learning.

Match (Bio-Medical Engineering)

II – Semester

Syllabus for

Elective IV(c): NANOTECHNOLOGY AND APPLICATIONS

Credits: 4

Subject Code: MTBM-2.6 **Max. Marks:** 70

Sessionals : 30

Unit 1: Introduction to Nanotechnology

Essence of Nanotechnology, Nano in daily life, Brief account of nano applications, Properties of nano materials, Metal nano clusters, Semiconductor nano particles.

Unit 2: Nano Materials

Nano composites, Nanofying electronics, Sensing the environment, Mechanising the micro world, Energy and cleaner environment with nano technology.

Unit 3 : Carbon Nano Structures

Introduction, Carbon molecules, Carbon clusters, Carbon nanotubes, Applications of carbon nanotubes.

Unit 4: Diagnosing Personal Health and Medical Applications

Lab on a chip, Super X-ray vision, Mapping the genes, Understanding how pharmaceutical company develops drugs, Delivering a new drug the Nanotech way, Cooking cancer with nano cells, Biomimetics.

Unit 5: Biological Materials

Introduction, Biological building blocks, Nucleic acids, Biological nanostructures.

Textbooks

1. Nanotechnology by Richard Booker, Earl Boysen, Wiley Publishing Inc., 2006.
2. Introduction to Nanotechnology by Charles P. Poole Jr., Frank J. Owens, John Wiley & Sons Publications, 2003.

M.Tech (Bio-Medical Engineering)

II – Semester

Syllabus for

BIO-INSTRUMENTATION LAB

Credits: 4

Subject Code: MTBM-2.7 **Max. Marks:** 70

Sessionals : 30

1. Transducers for physiological parameters.

2. Polygraph studies – ECG, EMG, EEG, EPG, EOG experiments.

3. Bio – Medical instrumentation amplifiers

4. Computerized signal acquisitions A/D, D/A interfacing.

5. Nerve – muscle stimulation.

6. Spirometer and respiratory measurements

7. Photometric and optical instrumentation, photoplethysmography.

Reference Books:

1. R.S. Khandpur: Biomedical instrumentation.

2. L.Cromwell: Principles of biomedical instrumentation.

1st SEMESTER MODEL QUESTION PAPERS

M.Tech (BIO-MEDICAL ENGINEERING)

First Semester

ANATOMY & PHYSIOLOGY (MTBM-1.1)

(Effective from the admitted batch of 2015-2016)

Time:3 Hours Max. Marks: 70

Answer any FIVE Questions

All questions carry equal marks

1. (a) Describe different types of cells and compare their properties.(7)
   (b) Briefly describe atleast two methods of cell division. (7)
2. (a) What is the structure of the brain and explain the properties of spinal cord. (7)
   (b) Describe atleast two special sensors in the human body. (7)
3. (a) How does metabolism take place. Describe the relation between nutrition and energy balancing. (7)
   (b) Explain Neuromuscular junction in detail. (7)
4. Write an essay on various aspects of Nutrition. (14)
5. Describe the following:
   (a) Anatomy of lungs. (7)
   (b) Hypoxia. (7)
6. (a) How does the gas exchange in lungs. Explain. (7)
   (b) Give an account of exercise physiology and add a note on isometric and isotonic exercises(7)
7. (a) Describe how kidney functions. What is ment by dialysis. (7)
   (b) What are the effects of kidney disorders in renel function. (7)
8. (a) Describe the structure of skeletal and smooth muscle. (7)
   (b) Explain the auditory pathway and visual pathway. (7)

MODEL QUESTION PAPER

M.Tech (BIO-MEDICAL ENGINEERING)

First Semester

ELECTRONIC DEVICES & CIRCUITS (MTBM-1.2)

(Effective from the admitted batch of 2015-2016)

Time:3 Hours Max. Marks: 70

Answer any FIVE Questions. All questions carry equal marks.

1. (a) explain the volt ampere characteristics on PN diode (7)

(b) explain the temperature dependence of VI characteristics (7)

2. (a) explain why abridge rectifier is over a center –tap rectifier (7)

(b) a diode has an internal resistance of 20Ω and 1000Ω load from a 110V rms source of supply. Calculate (7)

I. The efficiency of rectification

II. The percentage of regulation from no load to full load

3.(a) Explain the input and output characteristics of common base transistor configuration (7)

(b) if the various parameters of a CE amplifier which uses the self bias method are $V_{cc}=12V, R_1=10K\Omega, R_c=1K\Omega R_e=2K\Omega$ and $\beta=100$. Find (7)

(a) The coordinates of the operating point

(b) The stability factor , assuming the transistor be on silicon.

4. (a) Draw the self bias circuit and derive the expression for the stability of factor "S" . (7)

(b) Explain the bias compensation using sensistors. (7)

5. (a) Explain the construction and operation of n-channel JFET. (7)

(b) Sketch the typical family of drain characteristics for an n-channel JFET with various levels of V_{gs} (7)

6. (a) What do you understand by feedback in amplifiers ? explain the terms feedback factors and open loop gain. (7)

(b) Calculate the gain ,input impedance ,output impedance of voltage series feedback amplifier having $A=300, R_i=1.5K, R_0=50K$ and $\beta=1/12$. (7)

7. (a) Draw the circuit diagram of a RC phase shift oscillator using BJT.

Derive the expression for frequency of oscillations. (7)

(b) Why Rc oscillators are not suitable for high frequency applications? (7)

8. (a) What is an op-amp? Explain the working of its basic circuit. (7)

(b) Define CMRR of an op-amp. If a non inverting amplifier is designed for a gain of 100,using on op-amp with 95db CMRR, calculate the common mode output for a common mode input of 2V (7)

MODEL QUESTION PAPER

M.Tech (BIO-MEDICAL ENGINEERING)

First Semester

Elective –I

EMI/EMC (MTBM-1.3 (a))

(Effective from the admitted batch of 2015-2016)

Time:3 Hours Max. Marks: 70

Answer any FIVE Questions

All questions carry equal marks

1. (a) List out sources of EMI in detail (7)

   (b)Explain about EM fields produced by lightening. (7)

2. (a) Explain about noise from relays and switches. (7)

   (b)Explain about Cross talk in transmission lines. (7)

3. (a)Explain propagation of surges in low- voltage AC lines. (7)

   (b) Define shielding effectiveness and explain different methods of shielding and design methodologies.(7)

4. (a)Explain power line filter design. (7)

   (b)Explain semiconductor transient suppressors. (7)

5. (a)What are the standards for RF interference? (7)

   (b)Explain how sun spot activity may affect communication? (7)

6. Describe Electromagnetic environment. List out the Frequency spectrum conservations. (14)

7. (a) Explain surges on main power supply. (7)

   (b) Explain in detail about open area test site measurements. (7)

8. (a) Explain about normalized site attenuation. (7)

(b)Explain characterization of conduction currents and voltages. (7)

MODEL QUESTION PAPER

M.Tech(BIO-MEDICAL ENGINEERING)

First Semester

MEDICAL IMAGE PROCESSING (MTBM-1.4)

(Effective from the admitted batch of 2015-2016)

Time:3 Hours Max. Marks: 70

Answer any FIVE Questions

All questions carry equal marks

1. What is meant by CT. Explain it along with its applications.(14)
2. List out different types of Ultrasonic diagnostic methods and describe atleast two of them in detail. (14)
3. What do you mean by image resonance. Explain atleast two methods of imaging techniques. (14)
4. How do you make image smoothing. Explain imaging smoothing algorithm in frequency domain. (14)
5. Define image compression. Describe it using DCT. (14)
6. Define Voxel. Discuss Histogram equalization technique in detail. (14)
7. How do you generate X-Ray imaging. Explain X-ray detection techniques.(14)
8. Write short notes: (a) Power law (b) MRI techniques.(14)

MODEL QUESTION PAPER

M.Tech (BIO-MEDICAL ENGINEERING)

First Semester

Elective – II

ORTHOPEDICS & REHABILITATION(MTBM-1.5 (a))

(Effective from the admitted batch of 2015-2016)

Time:3 Hours Max. Marks: 70

Answer any FIVE Questions

All questions carry equal marks

1. Explain the metabolism of vitamins C and D. Describe the structure of bone. (14)
2. What is an amputation and explain the reasons for it. What is the anatomy of upper and lower limbs. (14)
3. Describe EMG, EOG, ERG in detail. (14)
4. Explain the following in detail. (a)Bone Nutrition (b) Osteoblast (14)
5. Describe Tarsal bones and vertebrae in detail. (14)
6. Explain how blood formation takes place in detail (14)
7. What are the diagnostic aids in orthopedics and describe two of them. (14)
8. Write short notes on : (a) Fracture healing (b) Arthroscopy (14)

MODEL QUESTION PAPER

M.Tech (BIO-MEDICAL ENGINEERING)

First Semester

BIO-MEDICAL INSTRUMENTATION – I (MTBM-1.6)

(Effective from the admitted batch of 2015-2016)

Time:3 Hours Max. Marks: 70

Answer any FIVE Questions

All questions carry equal marks

1. What is electrocardiography? Discuss various characteristic features of ECG amplifiers. [14]
2. Explain a method of heart sound measurement [14]
3. Explain the ECG recorders, (i) three channel, (ii) vector cardiograph [14]
4. What is the importance of blood flow? Discuss the biomedical instruments that are used to measure the blood flow [14]
5. Discuss about the electrodes and leads that are fixed to the body of the patient in order to record an electrocardiogram. [14]
6. Write short notes on
   a)pacemakers [7]
   b)defibrillators [7]
7. What are the elements of intensive care monitoring? Also explain patient monitoring displays. [14]
8. Discuss various respiratory therapy equipments. What are nebulizers. Explain the working principle of ultrasonic nebulizer [14]

2nd SEMESTER MODEL QUESTION PAPERS

M.Tech (**BIO-MEDICAL ENGINEERING)**

Second Semester

BIO – MEDICAL INSTRUMENTATION – II (MTBM-2.1)

(Effective from the admitted batch of 2015-2016)

Time:3 Hours Max. Marks: 70

Answer any FIVE Questions

All questions carry equal marks

1. What are resting and action potentials? Explain with suitable diagrams? (14)

2. (a) Explain the characteristics of blood flow? (7)

   (b) Explain different heart sounds? (7)

3. (a) Explain the physiology of the respiratory system? (7)

   (b) Explain in detail about lung-volume and capacities? (7)

4. Discuss various types of respiratory therapy equipment? (14)

5. (a) What is bio-telemetry? List out various applications of bio-telemetry? (7)

   (b) what are the physiological parameters adaptable to bio-telemetry? (7)

6. Discuss the components of bio-telemetry system? (14)

7. What are the methods of accident presentation? (14)

8. Discuss about the shock hazards from electrical equipment? (14)

MODEL QUESTION PAPER

M.Tech (BIO-MEDICAL ENGINEERING)

Second Semester

PRINCIPLES OF RADIOLOGY (MTBM-2.2)

(Effective from the admitted batch of 2015-2016)

Time:3 Hours Max. Marks: 70

Answer any FIVE Questions

All questions carry equal marks

1. Briefly explain different kinds of diseases that are associated with liver? (14)
2. (a). What are the problems associated with Female Genital tract? (7)
   (b). how they are diagnosed by radiology? (7)
3. (a). Differentiate helical CT and general CT? (7)
   (b). Explain protocols involved in helical CT? (7)
4. Discuss briefly about evaluation of Intestinal Volvulus? (14)
5. (a). Difference between Crohns Disease and Ulcerative Colitis? (7)
   (b). Short notes on Ischemic Colitis? (7)
6. Write short notes on
   (a). Acute intra abdominal vascular emergencies (7)
   (b). Haemorrhage (7)
7. Explain the principle involved in Neuroimaging? (14)
8. Explain the principle involved in Body imaging (14)

MODEL QUESTION PAPER

M.Tech(BIO-MEDICAL ENGINEERING)

Second Semester

HOSPITAL MANAGEMENT & SUPPORT SERVICES (MTBM-2.3)

(Effective from the admitted batch of 2015-2016)

Time:3 Hours Max. Marks: 70

Answer any FIVE Questions

All questions carry equal marks

1. Explain the services involved in Outpatient department? (14)
2. Explain the management of laboratory services? (14)
3. What are the requirements of Central Sterile Supply Department? (14)
4. What are the ethics to be followed by Hospital Management? (14)
5. What are the requirements of Hospital Building? (14)
6. Write a short note on
   (a). Autopsy and Mortuary management (7)
   (b). Ambulance services (7)
7. Explain about Hospital Waste Management? (14)
8. What are the precautions to be followed by Hospital Administration to avoid Fire Accident? (14)

MODEL QUESTION PAPER

M.Tech(BIO-MEDICAL ENGINEERING)

Second Semester

ELECTIVE-III

CLINICAL MEDICINE (MTBM-2.4 (a))

(Effective from the admitted batch of 2015-2016)

Time:3 Hours Max. Marks: 70

Answer any FIVE Questions

All questions carry equal marks

1. (a) What is meant by Headache? Explain the classification of Headache, characteristics of different kinds of headache? (7)

   (b) Explain the principals of Headache evolution? (7)

2. (a) Explain about Bruce protocol and explain modified Bruce protocol? (7)

   (b) Explain about exercise Echocardiograph? (7)

3. (a) Explain the mechanism of Hyperglycemic Damage? (7)

   (b) Management of post Prandial Hyper Glycaemia in Diabetes Mellitus? (7)

4. (a) Write a short note on criteria for diagnosis of Diabetes Mellitus? (7)

   (b) Explain the management of Type2 Diabetes Mellitus? (7)

5. Explain briefly about Typhoid Fever? (14)

6. Explain about

   (a). Causes of Drug Resistance (7)

   (b). Explain Laboratory Diagnosis technique for Diagnosing Malaria? (7)

7. Define Anemia and causes of Anemia and Management strategy for Anemia? (14)

8. Define Parkinson's disease? Explain clinical features of Parkinson's disease? (14)

MODEL QUESTION PAPER

M.Tech(BIO-MEDICAL ENGINEERING)

Second Semester

PRINCIPLES OF ELECTROTHERAPY (MTBM-2.5)

(Effective from the admitted batch of 2015-2016)

Time:3 Hours Max. Marks: 70

Answer any FIVE Questions

All questions carry equal marks

1. What are the physiological effects of Low-frequency currents? (14)

2. What is Diathermy? Explain the principle of Shortwave Diathermy with its circuit diagram? (14)

3. What are Infrared radiations and explain the techniques involved in the treatment? (14)

4. What are the physiological effects of ultraviolet radiations? Explain their production? (14)

5. What are the techniques involved in application of Ultrasound therapy? (14)

6.(a) What are the therapeutic uses of Ultrasound? (7)

(b). Write a short notes on Phonophoresis? (7)

7. What are the various techniques used in Administering cold? (14)

8. Explain the physiological effects in therapeutic uses of Cold therapy? (14)

MODEL QUESTION PAPER

M.Tech(BIO-MEDICAL ENGINEERING)

Second Semester

ELECTIVE – IV

NANO-TECHNOLOGY AND APPLICATIONS(MTBM-2.6 (a))

(Effective from the admitted batch of 2015-2016)

Time: 3 Hours Max. Marks: 70

Answer any FIVE Questions

All questions carry equal marks

1. What is meant by Nanotechnology? Explain its importance in daily life? (14)
2. Explain the application of Nanotechnology in the field of Electronics? (14)
3. (a). Discuss about Nanoclusters (7)

   (b). Explain the role of carbon in the field of Nanotechnology? (7)
4. . (a). Explain the uses of carbon Nanotubes in the field of Healthcare? (7)

   (b). Explain the effects of carbon Nanotubes on the materials? (7)
5. What are Chip materials and Fabrication technologies involved in Lab-on-chip? (14)
6. (a). Explain the technology of Super X ray vision? (7)

   (b). How Genes are mapped using Nanotechnology? (7)
7. Discuss about Nucleic Acids with their structures? (14)
8. Discuss about biological Nanostructures with their Applications? (14)