

**M.D. UNIVERSITY, ROHTAK**  
**SCHEME OF STUDIES & EXAMINATION**  
**B.TECH IN BIOMEDICAL ENGINEERING**  
**SEMESTER VII**  
**‘F’ Scheme effective from 2011-12**

Course No	Subject	Teaching Schedule				Marks of Class Work	Examination		Total Marks	Duration of Exam (in Hrs)
		L	T	P	Total		Theory	Practical		
BME-413-F	Principles of Medical Imaging II	3	1	-	4	50	100	-	150	3
BME-415-F	Principles of Medical Imaging II Lab	-	-	2	2	50	-	50	100	3
BME-417-F	Nuclear Medicine Radiation & Safety	3	1	-	4	50	100	-	150	3
BME-419-F	Bio-Medical Ethics & device regulation	3	1	-	4	50	100	-	150	3
BME-421-F	Computational Techniques	3	1	-	4	50	100	-	150	3
BME-423-F	Computational Techniques Lab	-	-	2	2	25	-	25	50	3
	Open Elective	3	1	-	4	50	100	-	150	3
	Dept. Elective	3	1	-	4	50	100	-	150	3
BME-409-F	Practical Training-II (6 weeks)	-	-	--	--	-	-	-	-	3
BME-421-F	Independent Study Seminar	-	-	4	4	100	-	-	100	3
GPBME-402-F	General Fitness for the Profession	-	-	-	-	--	-	50	50	3
	<b>Total</b>	<b>18</b>	<b>6</b>	<b>8</b>	<b>32</b>	<b>475</b>	<b>600</b>	<b>125</b>	<b>1200</b>	

List of Open Electives

1	HUM-451-F	Language Skills for Engineers	9	CSE-303-F	Computer Graphics
2	HUM-453-F	Human Resource Management	10	CSE-451-F	Artificial Intelligence & Expert Systems
3	HUM-455-F	Entrepreneurship	11	IC-403-F	Embedded Systems
4	HUM-457-F	Business Communication	12	IC-455-F	Intelligent Instrumentation for Engineers
5	HUM-459-F	Renewable Energy Resources and Technology	13	CH-451-F	Pollution & Control
6	PHY-451-F	Nano technology	14	IT-204-F	Multimedia Technologies
7	PHY-453-F	Laser Technology	15	IT-471-F	Management Information System
8	ME-451-F	Mechatronics Systems	16	OR-401-F	Operations Research

List of Departmental Electives

1	BME-451-F	Medical Physics	6	BME-452-F	Rehabilitation Engineering
2	BME-453-F	Fiber Optics and Lasers in Medicine	7	BME-454-F	Bio-Electromagnetism
3	BME-455-F	Principles of Bioengineering	8	BME – 456 – F	Biological Control System
4	BME-457-F	Tissue Engineering	9	BME – 458-F	Advanced Biomedical Engineering
5	BME -459-F	Bionanotechnology			

**Note**

- 1. Students are allowed to use single memory, non-programmable scientific calculator during exam.**
- \*Student will be permitted to opt for any one elective run by the other department. However the departments will offer only those electives for which they have expertise. The choice of the students for any elective shall not be a binding for the department to offer, if the department does not have expertise.**
- A team consisting of Principal / Director HOD of concerned department and external examiner appointed by the University shall carry out the evaluation of the student for his / her General Fitness for the Profession.**
- Assessment of Practical Training-II, undergone at the end of IV semester, will be based on seminar, viva-voce, report and certificate of practical training obtained by the student from the industry. According to performance letter grades A, B, C, F are to be awarded. A student who is awarded 'F' grade is required to repeat Practical Training.**

**M.D. UNIVERSITY, ROHTAK**  
**SCHEME OF STUDIES & EXAMINATION**  
**B.TECH IN BIOMEDICAL ENGINEERING**  
**SEMESTER VIII**  
**‘F’ Scheme effective from 2011-12**

<b>Sr. No.</b>	<b>Course No.</b>	<b>Subject</b>	<b>Internal Marks</b>	<b>External Marks</b>	<b>Total Marks</b>
1	BME - 402 - F	Industrial Training / Institutional Project Work	150	150	300

**Note :**

The students are required to undergo Industrial Training or Institutional Project Work of Duration not less than 5 months in a reputed organization or concerned institute. The students who wish to undergo industrial training, the industry chosen for undergoing the training should at least be a private limited company. The students shall submit and present the mid-term progress report at the institute. The presentation will be attended by a committee. Alternatively, the teacher may visit the industry to get the feedback of the students.

The final viva-voce of the industrial training or institutional project work will be conducted by an external examiner and one internal examiner appointed by the institute. External examiner will be from the panel of examiners submitted by the concerned institute approved by the Board of Studies in Engg. And Technology. Assessment of Industrial Training or Institutional Project Work will be based on seminar, viva-voce, report and certificate of Industrial Training or Institutional Project Work obtained by the student from the industry or Institute.

**The internal marks distributions for the students who have undergone Industrial Training consist of 50 from the industry concerned and 100 marks by the committee members consisting of faculty members of concerned department of the institute**

The teachers engaged for Institutional Project Work shall have a workload of 2 hours per group ( at least 4 student ) per week.

**SEMESTER - VII**  
**PRINCIPLES OF MEDICAL IMAGING II**

**BME – 413 F**

	Class Work	:	50 Marks
L T P	Theory	:	100 Marks
3 1 - -	Total	:	150
	Duration of Exam	:	3 Hrs

**Note:** For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

**CONTENTS**

**SECTION A**

Fundamentals of Acoustic Propagation, characteristic impedance, intensity, radiation force, reflection and refraction, attenuation, absorption, scattering.

Generation and detection of ultrasound: piezoelectric effect, ultrasonic transducers (mechanical and electrical matching), transducer beam characteristics, axial and lateral resolution, focusing arrays.

**SECTION B**

Ultrasonic diagnostic methods: pulse-echo systems (A or amplitude mode, B or brightness mode, M or motion mode and C- mode), Doppler Effect and Doppler methods, color Doppler. Biological effects of ultrasound: Acoustic phenomena at high intensity levels, ultrasound bioeffects.

**SECTION C**

Fundamentals of Nuclear magnetic Resonance: angular momentum, magnetic dipole moment, magnetization, Larmor frequency, rotating frame of reference and the RF magnetic field.

Generation and Detection of NMR Signal: The magnet (superconducting magnets, permanent magnets), magnetic field gradients, the NMR coil/probe, data acquisition.

**SECTION D**

Imaging Methods: Slice selection, frequency encoding, phase encoding, spin-echo imaging, gradient-echo imaging, blood flow imaging.

Biological effects of magnetic fields: Static magnetic fields, radio frequency fields, gradient magnetic fields.

Radiotherapy equipment: Introduction to dental X-ray machines, Cobalt-60 machines, Medical linear X-ray machines.

**TEXT**

1. K. Kirk Shung, Michael B Smith, Benjamin Tsui, Principles of Medical Imaging, academic Press, inc., London, 1992
2. Textbook of Radiology: Christensen
3. Handbook of Biomedical Instrumentation: R S Khandpur

References:

1. Avinash C. Kak, Malcolm Slaney available in pdf format at [www.slaney.org/pct/index.html](http://www.slaney.org/pct/index.html), Principles of Computerized Tomographic Imaging, IEEE Press, New York, 1988
2. B. H. Brown, R H smallwood, D C Barbere et al, medical Physics and Biomedical engineering, Institute of physics, 1999

**SEMESTER - VII**  
**PRINCIPLES OF MEDICAL IMAGING II LAB**

**BME – 415 F**

	Class Work	:	50 Marks
L T P	P/ VV	:	50Marks
-- 2	Total	:	100 Marks
	Duration of Exam	:	3 Hrs

**CONTENTS**

1. Generation and detection of ultrasound using ultrasound equipment.
2. Understanding of various Ultrasound modes- A mode, B mode, AB mode, C mode and M mode using ultrasound equipment
3. Study of Generation and Detection of NMR Signal using MRI machine.
4. Image formation and X-ray film processing.
5. Study different types of magnets used in Imaging with their properties.
6. With help of magnets study the fundamentals of Nuclear magnetic Resonance
7. Using different ultrasound probes study US image formation.
8. Study of Radiotherapy instrument
9. Study of Biological effects of electromagnetic radiation
10. Study of different images taken by MRI

Note: Visit to a Diagnostic center /Hospital / Industry dealing with Medical Imaging Equipment is compulsory. Ten experiments are to be performed selecting any seven experiments from the above list. Remaining three experiments may either be performed from the above list, or designed and set by the concerned institution as per the scope of the syllabus.

**SEMESTER – VII**  
**NUCLEAR MEDICINE: RADIATION AND SAFETY**

**BME – 417- F**

	Class Work	:	50 Marks
L T P	Theory	:	100 Marks
3 1 -	Total	:	150
	Duration of Exam	:	3 Hrs

**Note: For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.**

**CONTENTS**

**SECTION A**

Introduction: Properties and effects of radio active emissions and their applications in nuclear medicine. Kinetics of Radioactive Decay. Units of Radioactivity, Interaction of Radiation with Matter : Interaction of Charged Particles,  $\alpha$ -Radiations, Neutrons

**SECTION B**

Radiation detectors: Gas Filled Detectors, Scintillation and Semiconductor Detectors types and their applications in nuclear medicine.

**SECTION C**

Radio Isotope Imaging Equipments : The gamma camera, Construction and working, Performance Characteristics  
SPECT Construction, Working, Image Reconstruction techniques  
Positron Emission Tomography – Introduction to PET Imaging, Properties of PET, Study of PET machine.

**SECTION D**

The computer in NM: Basics of Computer, Applications  
Radiation protection and safety. Safety of non - ionizing and Ionizing radiation. Stochastic and non-Stochastic effects, ALARA, Risk Factors, Safety limits.  
Principles of radiation dosimetry; Internal and External dosimetry, Units of exposure and dose.

**TEXT**

1. The physics of radiology By H. E. Johns and J. R. Gunningham.
2. Physics and Radiobiology in Nuclear Medicine By Saha G (Springer Verlag N. Y. )
3. Quality control of Nuclear Medicine instrumentation By R. F. Mould (IPSM. York)

VII SEMESTER  
BIOMEDICAL ETHICS AND DEVICE REGULATIONS

**BME-419 F**

L    T    P  
3    1    -

Class Work           : 50 Marks  
Theory                : 100 Marks  
Total                   : 150 Marks  
Duration of Exam    : 3Hrs.

**Note: For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.**

SECTION A

Medical Ethics : History of medical ethical systems, The role and sources of codes  
Principles of Medical Ethics : Moral justification, theories, principles and rules  
The Health care professional : Depersonalizing trends, traditional ideas and its biases

SECTION B

Consent : concept and quality of consent, law and its limits, competence to consent and justification for not obtaining consent,  
Death - definition and determination, mystery and fear, framework for life support decisions, euthanasia

SECTION C

Human Experimentation and Ethics : Justification and principles, Nuremberg code,  
Reproductive technologies – Amniocentesis,, Fetal testing, Abortion – Laws, Contraception and sterilization methods, reconstructive and cosmetic surgery  
Organ Transplantation – Intrinsic Morality, Supply of organs,

SECTION D

Principles for Clinical Evaluation of Drugs, Vaccines, Diagnostic Agents, Medical Devices and Surgical Procedures  
Regulation of medical devices – safety of medical devices, product control, quality system requirements, standards for medical devices

TEXTS :

Medical Ethics - Robert M. Veatch, Jones & Bartlett Publishers, Inc

Health Care Ethics : A Theological Analysis - Ashley, Benedict M.; O'Rourke, Kevin D. ; Georgetown University Press



**SEMESTER – VII**  
**COMPUTATIONAL TECHNIQUES**

**BME – 421 – F**

	Class Work	:	50 Marks
L T P	Theory	:	100 Marks
3 1 -	Total	:	150
	Duration of Exam	:	3 Hrs

**Note:** For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

**Section A**

**Errors In Numerical Calculations:** Introduction, Numbers and their accuracy, Absolute, relative and percentage errors and their analysis, General error formula.

**Interpolation and Curve Fitting:** Interpolation: Newton's forward and backward interpolation formulae, Gauss forward and backward interpolation formulae, Central difference formula, Lagrange's interpolation formula, Divided difference, Newton's divided difference formula, Least squares approximations, curve fitting.

**Section B**

**Non linear Equations:** Bisection method, Regula Falsi method, Secant method, Iteration Method, Newton's Raphson method, Muller's method.

**Simultaneous Linear Equations:** Gauss Elimination method, Gauss-Jordan method, UV-Factorization Method, Jacobi's method, Gauss- Seidal method, Relaxation method.

**Section C**

**Numerical Differentiation and Integration:** Derivatives from differences tables, higher order derivatives, Newton-cotes integration formula, Trapezoidal rule, Simpson's rules, Boole's rule and Weddle's rule, Romberg's Integration.

**Numerical Solution of Ordinary Differential Equations:** Taylor series methods, Euler and modified Euler method, Runge-Kutta methods, Milne's method, Adams-Moulton method.

**Section D**

**Numerical Solution of Partial differential Equations:** finite difference approximation of partial derivatives, solution of Laplace equation (standard 5-point formula only), one dimensional heat equation (Schmidt method, Crank-Nicolson method, Dufort and Frankel method)

**TEXT BOOKS:-**

1. Applied Numerical Analysis : Curtis F Gerald and Patrick, G Wheatley-Pearson Education.
2. Numerical Methods : E Balagusamy
3. Numerical Methods for Mathematics, Science and Engineering by John H Mathews PHI

4. Applied Numerical Methods : Carnahan B H; Luthar H A; Wikes J O
5. Numerical Methods in Engineering and Science by B S Grewal, Khanna Publishers

**SEMESTER - VII**  
**COMPUTATIONAL TECHNIQUES LAB**

**BME – 423 F**

	Class Work	:	25 Marks
L T P	P/ VV	:	25Marks
-- 2	Total	:	50 Marks
	Duration of Exam	:	3 Hrs

**CONTENTS**

WRITE DOWN AND EXECUTE THE FOLLOWING PROGRAMS USING C/C++/MATLAB

1. To find the roots of non-linear equation using Bisection method.
2. To find the roots of non-linear equation using Newton's method.
3. Curve fitting by least - square approximations.
4. To solve the system of linear equations using Gauss- Elimination method.
5. To solve the system of linear equations using Gauss-Seidal iteration method.
6. To solve the system of linear equations using Gauss-Jorden method.
7. To Integrate numerically using Trapezoidal rule.
8. To Integrate numerically using Simpson's rules.
9. To find the largest eigen value of a matrix by power-method.
10. To find numerical solution of ordinary differential equations by Euler's method.
11. To find numerical solution of ordinary differential equations by Runge-Kutta method.

**SEMESTER VII**  
**Practical Training – II (6 Weeks)**

<b>BME – 409 F</b>	Class Work	: A,B,C,F
L T P	P/VV	: -
- - -	Total marks	: A,B,C,F

At the end of sixth semester each student would undergo six weeks practical training in an industry/ Professional organization/ research laboratory/ Hospital with the prior approval of the Director Principal/ Principal of the concerned college and submit a written typed report along with a certificate from the organization. The record will be evaluated by examiner(s) to be appointed by the Director Principal/ Principal of the concerned college.

**SEMESTER VII  
INDEPENDENT STUDY SEMINAR**

**BME- 421 F**

**L T P**

**- - 4**

**Class Work : 100 Marks**

**Total : 100 Marks**

The student will select a topic in emerging areas of Biomedical Engineering and study independently. He/She must submit two hard copies and soft copy of their report and presentation to the department after getting the same approved by the concerned faculty. He/She will give a seminar talk on the same before the committee constituted by the **Head** of the dept. The committee should comprise of at least three faculty members.

**SEMESTER VII  
GENERAL FITNESS FOR THE PROFESSION**

**GPBME- 402 F**

L T P  
- - -

Class Work : -- Marks  
P V/V : 50 Marks  
Total Marks : 50 Marks  
Duration of Exam : 3Hrs.

At the end of the year students will be evaluated on the basis of their performance in various fields in Biomedical Engineering. The evaluation will be made by the panel of three experts/examiners/teachers to be appointed by the Principal/Director of the College. A specimen perform indicating the weightage to each component/ activity is given below :

Name : \_\_\_\_\_ College Roll No. \_\_\_\_\_  
Univ. Roll No. \_\_\_\_\_  
Branch \_\_\_\_\_ Year of Admission \_\_\_\_\_.

**I. Academic Performance (15 Marks) :**

Performance in University Examinations:

Sem.	Result	%age of Marks obtained	Number of Attempt in which the Sem. exam. has been cleared
I			
II			
III			
IV			
V			
VI			
VII			

**II. Extra Curricular Activities (10 Marks) :**

Item	Level of Participation	Remarks (Position Obtained)
Indoor Games (Specify the Games)	_____ _____ _____	_____
Outdoor Games (Specify the Games)	_____ _____ _____	
Essay Competition	_____ _____	
Scientific Technical	_____ _____	

Exhibitions	_____
Debate	_____ _____ _____
Drama	_____ _____ _____
Dance	_____ _____ _____
Music	_____ _____ _____
Fine Arts	_____ _____ _____
Painting	_____ _____ _____
Hobby Club	_____ _____ _____
N.S.S.	_____ _____ _____
Hostel Management Activities	_____ _____ _____
Any other activity (Please Specify)	_____ _____ _____

**III. Educational tours/visits/Membership of Professional Societies (5 Marks)**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_

**IV. Contribution in NSS Social Welfare Floor Relief/draught relief/Adult Literacy mission/Literacy Mission/Blood Donation/Any other Social Service**

**(5 Marks)**

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_

**V. Briefly evaluate your academic & other performance & achievements in the Institution (5 Marks)**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**VI. Performance in Viva voce before the committee (10 Marks)**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

\*Marks obtained I.( )+II( )+III( )+IV( )+V( )+VI( ) =

\*\*Total Marks :

Member

Member

Member



## DEPARTMENTAL ELECTIVE

### SEMESTER VII MEDICAL PHYSICS

**BME – 451 – F**

L T P  
3 1 -

Class Work	:	50 Marks
Theory	:	100 Marks
Total	:	150
Duration of Exam	:	3 Hrs

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## CONTENTS

### SECTION A

Body Fluid : Properties of body fluid, Pressures in the body, Properties of fluid in motion – newtonian fluid and other viscosity models, Flow of viscous fluids in tubes and orifice, Influence of elastic walls.

### SECTION B

Cardiovascular System : Physics of the Circulation System, Properties of Blood, Blood Pressure and Flow in Vessels, Capillaries and Osmotic Pressure, Blood Flow Rates and Speeds, Consequences of Clogged Arteries, Work Done by the Heart and the Metabolic Needs of the Heart. Strokes and Aneurysms, Arterial Bifurcations and Saccular Aneurysms, Stenosis and Ischemic Strokes, Equation of Motion of Arteries and Aneurysms during Pulsatile Flow, Modeling the Circulatory System and the Heart, Model of the Heart, Model of the overall Flow in the Circulatory System, The Arterial Pulse, Windkessel Mode, Modeling the Malfunctioning Heart.

### SECTION C

Electrical and Magnetic Properties: Review of Electrical Properties, Electrical Properties of Body Tissues, Electrical Conduction through Blood and Tissues, Nerve Conduction, Cell Membranes and Ion Distributions, Types of Cell Membrane Excitations, Model of Electrical Conduction along an Axon, Ion Channels, Hair Cells, Balance, Taste, and Smell, Electrical Properties of the Heart, Electrical Signals in the Brain, Effects of Electric Shock, Magnetic Properties, Magnetic Field from an Axon, Magnetic Sense, Electromagnetic Waves. Regulation of the Body Temperature, Control of Blood Pressure, Regulation During Exercise  
Sound in Medicine : The physics of sound waves, Speech Production, Hearing

### SECTION D

Lungs and Breathing: Structure of the Lungs. The Physics of the Alveoli, Physics of Breathing, Volume of the Lungs, Breathing Under Usual and Unusual Conditions, Flow of Air During Breathing, Mechanical Model of Breathing and Model Parameters, Inspiration/Expiration Cycle, Breathing with a Diseased Lung, Breathing at Higher Elevations, Work Needed to Breathe.  
Light in Medicine : Structure of Eye, Focusing and Imaging with lenses, Imaging and Detection by the eye

## TEXT

Physics of the Human Body- Herman I.P., Springer

Medical Physics and Biomedical Engineering ; B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose ; Institute of Physics Publishing,

Physics of the Body ; John Roderick Cameron, James G. Skofronick, Roderick M. Grant; Medical  
Physics Publishers

## DEPARTMENTAL ELECTIVE

### SEMESTER VII FIBER OPTICS AND LASERS IN MEDICINE

#### BME-453 F

L	T	P
3	1	-

Class Work	: 50 Marks
Theory	: 100 Marks
Total	: 150 Marks
Duration of Exam	: 3Hrs.

**Note:** For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

#### CONTENTS

##### SECTION A

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.

Optic fiber & its properties: Introduction, Basic fiber construction, propagation of light, modes of operation, refractive index profile, types of fibres, dispersion, data rate and bandwidth, attenuation, losses.

##### SECTION B

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, photo detectors: introduction, PIN photodiode, avalanche photodiode, photodiode parameters, detector noise, speed of response, SNR.

##### SECTION C

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, CO<sub>2</sub> laser, Nd-Y AG laser and related solid state laser.

##### SECTION D

Laser -Tissue Interaction:Terminology : spectral band designations, energy & power, irradiant & radiant exposure, fluence, thermal diffil sion fibers & contact tips, Types of laser-tissue interactions  
Laser Application in Medical Therapy: Introduction, application in general surgery, dermatology, ophthalmology, cardiovascular & chest surgery, dentistry, neuro surgery, otolaryngology & head and neck surgery, tumor surgery, gynecologic laser.

#### TEXT

1. Therapeutic Lasers -Theory and practice by G. David Baxter, Churchill livingstone publications.
2. Medical Lasers and their safe use by David H Shiney, Stephen and L. Trokel, Springer-Verlag publications.
3. Elements of fiber optics by S. L. Wymer, Regents-Prentice Hall publications.
4. Biomedical Electronics & Instrumentation by S. K. Venkata Ram, Galgotia publications.

#### REFERENCE

1. Laser and optical fibers in medicine by Katzer and Abraham, Academic press publications
2. An Introduction to optical fibers by A. M. Cherin, McGraw Hill publications.

## DEPARTMENTAL ELECTIVE

### SEMESTER VII PRINCIPLES OF BIOENGINEERING

#### BME-455 F

L	T	P
3	1	-

Class Work	: 50 Marks
Theory	: 100 Marks
Total	: 150 Marks
Duration of Exam	: 3Hrs.

**Note:** For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

#### CONTENTS

##### SECTION A

- Human Physiological Fluid Mechanics
- Physiology of the Human Circulatory System, Hemodynamics in the Arterial System.
- Blood Flow in the Microcirculation, and other Body Fluid Systems
- Pulse and Wave Propagation in Blood Vessels
- Mechanical Forces on Blood Vessels: Pressure, Stretch, and Shear Force
- Viscoelasticity and Mechanical Properties of the Vessel

##### SECTION B

- Membrane Potentials & Cable Model
- Dielectric Properties of Cells & Biopolymers
- Quantitative Physiology of Brain Blood Flow
- Visual System Psychophysical Bioengineering: Matching warning signals to the properties of the eye and the visual nervous system
- Optical Imaging

##### SECTION C

- Multi-Dimensional Signal Processing
- Basic Electronics for Bioengineers
- Capacitors, Inductors and Semiconductors
- Wireless Bioengineering
- Imaging as an Inverse Problem
- Human Molecular Imaging

##### SECTION D

- DNA Arrays
- Biostatistics: Applications of DNA arrays to schizophrenia disease genetics
- Bioreactor Arrays
- Bioheat Transfer Applications to Cryosurgery
- Stem Cell Research
- Biological Molecular Structure and Function
- Computational Modeling of Protein Structure and Function
- Molecular Structure/ Function of Neurodegeneration

#### TEXT

1. S. Berger, Introduction to Bioengineering

## DEPARTMENTAL ELECTIVE

### SEMESTER VII TISSUE ENGINEERING

#### BME-457 F

L	T	P
3	1	-

Class Work	: 50 Marks
Theory	: 100 Marks
Total	: 150 Marks
Duration of Exam	: 3Hrs.

**Note:** For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

#### CONTENTS

##### SECTION A

**Introduction:** Basic definition of tissue engineering, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing.

**Cell culture:** Different types of cell, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction. Aspect of cell culture: cell expansion, cell transfer, cell storage and cell characterization, Immunomodulation and Immunoisolation, Bioreactors.

##### SECTION B

**Molecular biology aspects:** Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, cell migration, cell-cell communication, receptor-ligand binding, and Cell surface markers.

##### SECTION C

**Scaffold and transplant:** Engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells: introduction, hepatopoiesis.

##### SECTION D

**Case study and regulatory issues:** Mechanical properties of Biological tissues, Transport properties of biological tissues, Cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues of tissue engineering.

#### Text / Reference books:

1. Principles of tissue engineering, Robert. P.Lanza, Robert Langer & William L. Chick, Academic press.
2. The Biomedical Engineering –Handbook, Joseph D. Bronzino, CRC press.
3. Introduction to Biomedical Engg. , Endarle, Blanchard & Bronzino, Academic press.
4. Frontiers of Tissue Engineering – Patrick. Mikos, MacIntire, Pergamon Press
5. Tissue Engineering, B. Palsson, J.A. Hubbell, R.Plonsey & J.D. Bronzino, CRC- Taylor & Francis

## DEPARTMENTAL ELECTIVE

### SEMESTER VII BIONANOTECHNOLOGY

BME-459 E  
L T P  
3 1 -

Class Work : 50 Marks  
Theory : 100 Marks  
Total : 150 Marks  
Duration of Exam : 3Hrs.

**Note:** For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

#### SECTION A

**Introduction to MEMS :** Introduction to BioMEMS; Historical background – Smart Materials and structures, Microsystems and their advantages. Materials used – Technology involved in MEMS. General Application in Healthcare

#### SECTION B

**Micromachining Technology :** Soft Lithography, Etching, Ion implantation, wafer bonding, Integrated processing, Wet & Dry Bulk micro machining, surface micromachining, coating technology and CVD –LIGA process

**Principles of Microsystems :** General principles – Microsystems – Pressure system ; Actuators, Electrostatic forces ; Piezoelectric Crystals.

#### SECTION C

**BIOMEMS :** Special features, Requirements for medical applications, MEMS for Health care, Drug delivery systems, Application in Blood pressure sensors, Biochip, Micro needles, Microelectrodes, Prosthesis and catheter end sensors

#### SECTION D

**Biomedical Nanotechnology :** Trends in Biomedical Nanotechnology; Drug Delivery Systems and Drug Synthesis; Nanotechnology in diagnostics; nano-enabled components for biodefense; implants and prosthetics , Toxicity in nanomaterials

#### TEXT BOOKS :

4. The MEMS Handbook, Second Edition - 3 Volume Set (Mechanical Engineering) ; Mohamed Gad-el-Hak ; CRC; 2 edition (2005)
5. Fundamentals of Micro fabrication: The Science of Miniaturization, Second Edition ; Marc J. Madou ; CRC; 2 edition (2002)

#### REFERENCE BOOKS :

1. Fundamentals of BioMEMS and Medical Microdevices (SPIE Press Monograph Vol. PM153) ; Steven S. Saliterman ; SPIE--the International Society for Optical Engineering (2006)
2. MEMS and Microsystems: Design and Manufacture ; Tai-Ran Hsu ; McGraw-Hill ; 1 edition ( 2001)
3. Biomedical Nanotechnology ; Neelina H Malsch ; CRC (2005)

**DEPARTMENTAL ELECTIVE**

**SEMESTER VII**

**REHABILITATION ENGINEERING**

**BME-452-F**

L T P  
3 1 -

Class Work : 50 Marks  
Theory : 100 Marks  
Total : 150 Marks  
Duration of Exam : 3Hrs.

**Note:** For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

**SECTION A**

**Introduction to Rehabilitation Engineering**

Principles and Application involved in the study of Rehabilitation Engineering

**Rehabilitation Engineering – Science and Technology**

**SECTION B**

Concepts in Motor rehabilitation and Communication disorders

**SECTION C**

**Prosthetics and Orthotics in Rehabilitation Engineering**

Introduction, Fundamentals and applications of externally powered and controlled orthotics and prosthetics.

**Sensory Augmentation and Substitution**

**SECTION D**

**Visual Systems – Retinal Implants, Auditory system- Cochlear Implants, Tactual System**

**Future development of Rehabilitation Science – Neural Prosthesis**

**Text book / Reference Books**

1. The Biomedical Engineering Handbook ; Joseph D Bronzino ; 3<sup>rd</sup> Ed.; CRC Press (2006)
2. Handbook of Biomedical Engineering (Handbooks in Science and Technology) ; Jacob Kline ; Academic Press (1988)

## DEPARTMENTAL ELECTIVE

### SEMESTER VII

### BIOELECTROMAGNETISM

#### BME-454-F

L T P  
3 1 -

Class Work : 50 Marks  
Theory : 100 Marks  
Total : 150 Marks  
Duration of Exam : 3Hrs.

**Note:** For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

#### CONTENTS

##### SECTION A

The Concept of Bioelectromagnetism; Subdivisions of Bioelectromagnetism - Theoretical and Anatomical basis; Importance and History of Bioelectromagnetism.  
Anatomical and Physiological basis of Bioelectromagnetism

##### SECTION B

Bioelectric Sources and Conductors and their Modeling  
Theoretical Methods in Bioelectromagnetism

##### SECTION C

Electric and Magnetic Measurement of the Electric Activity of Neural Tissue  
Electric and Magnetic Measurement of the Electric Activity of the Heart  
Electric and Magnetic Stimulation of Neural Tissue

##### SECTION D

Electric and Magnetic Stimulation of the Heart  
Measurement of the Intrinsic Electric Properties of Biological Tissues  
Other Bioelectromagnetic Phenomena

#### TEXT

Bioelectromagnetism: Principles and Applications of Bioelectric and Biomagnetic Fields, by Malmivuo, J. Oxford University Press, New York, 1995.



## DEPARTMENTAL ELECTIVE

### SEMESTER VII

## Biological Control Systems

### BME-456 F

L	T	P
3	1	-

Class Work	: 50 Marks
Theory	: 100 Marks
Total	: 150 Marks
Duration of Exam	: 3Hrs.

**Note:** For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

## CONTENTS

### SECTION A

Introduction to state variable analysis of control systems: -Introduction to state variable concept, definition of state variables, matrix representation of state equation, state transition equation, properties of transition matrix, relationship between state equations and higher order differential equations, state equation and transfer function, characteristics equation, Eigen values & Eigen vectors.

Transformation to phase variables canonical forms of state variables, controllability canonical form, observability canonical form Jordan canonical form, controllability of linear system, observability of linear system relationship among controllability, observability and transfer function.

### SECTION B

Introduction to biological control system: Introduction, Dynamic systems and their control, modeling and block diagrams, the pupil control systems, general structure of control systems, the dynamic response characteristics of the pupil control system, open & close loop systems instability, automatic aperture control.

### SECTION C

Mathematical modeling of the system: Thermo regulation, Thermoregulation of cold bloodedness & warm bloodedness, the anatomy of thermo regulation, lumping & partial differential equations, heat transfer examples, mathematical model of the controlled process of the body.

Biological receptors: -Introduction, receptor characteristics, transfer function models of receptors, receptor and perceived intensity.

### SECTION D

Modeling the body as compartments, behaviour in simple compartmental system, pharmacy kinetic model, urea distribution model, multi compartmental system. Dissolution of drugs in solid form, distribution and accessibility of body water & tissue compartments, basis for zero order & first order chemical kinetic behavior in the biological system.

## TEXT

1. Automatic control systems: By Benjamin C Kuo.
2. Control system Engineering: By I. J . Nagarath. & M. Gopal.
3. Bio- Medical Engineering Principles By: David. O. Cooney , Michel Deckker INC
4. Biological control systems: John H Milsum Mc Graw Hill 1966.

5. The Application Of Control Theory Of A Physiological System by Howard T Milhorn  
Sounders Publication

**REFERENCE**

1. Modern Control Engineering: By K. Ogata

## DEPARTMENTAL ELECTIVE

### SEMESTER VII

#### ADVANCED BIOMEDICAL ENGINEERING

##### BME – 458- F

	Class Work	:	50 Marks
L T P	Theory	:	100 Marks
3 1 -	Total	:	150
	Duration of Exam	:	3 Hrs

**Note:** For setting up the question paper, Question No 1 will be set up from all the four sections which will be compulsory and of short answer type. Two questions will be set from each of the four sections. The students have to attempt first common question, which is compulsory, and one question from each of the four sections. Thus students will have to attempt 5 questions out of 9 questions.

#### CONTENTS

##### SECTION A

Introduction: Substitutive medicine, outlook for organ replacement, design consideration, evaluation process.

Artificial Heart and Circulatory Assist Devices: Engineering design, Engg design of artificial heart and circulatory assist devices, blood interfacing implants – introduction, total artificial hearts & ventricular assist devices, vascular prostheses, Non-blood interfacing implants for soft tissues- sutures and allied augmentation devices, percutaneous and skin implants, maxillofacial implants, eye and ear implants.

Artificial blood: Artificial oxygen carriers, fluorocarbons, hemoglobin for oxygen carrying plasma expanders, hemoglobin based artificial blood.

##### SECTION B

**Cardiac Valve Prostheses:** Mechanical valves, tissue valves, current types of prostheses, tissue versus mechanical, engineering concerns and hemodynamic assessment of prosthetic heart valves, implications for thrombus deposition, durability, current trends in valve design, vascular grafts- history, synthetic grafts, regional patency, thrombosis, neointimal hyperplasia, graft infections.

Artificial Kidney: Functions of the kidneys, kidney disease, renal failure, renal transplantation, artificial kidney, dialyzers, membranes for haemodialysis, haemodialysis machine, peritoneal dialysis equipment-therapy format, fluid and solute removal.

##### SECTION C

Artificial Lungs: Gas exchange systems, Cardiopulmonary bypass (heart-lung machine)-principle, block diagram and working, artificial lung versus natural lung. Liver functions, hepatic failure, liver support systems, general replacement of liver functions.

Artificial Pancreas: Structure and functions of pancreas, endocrine pancreas and insulin secretion, diabetes, insulin, insulin therapy, insulin administration systems.

Tracheal replacement devices, laryngeal replacement devices, Artificial esophagus

Artificial Skin: Vital functions of skin, current treatment of massive skin loss, design principles for permanent skin replacement.

##### SECTION D

Biodegradable Polymeric Biomaterials: Introduction, Glycolide based biodegradable homopolymers polyesters, non-glycolide linear aliphatic polyesters, aliphatic and aromatic polycarbonates, biodegradation properties of synthetic biodegradable polymers.

Tissue Engineering- Basic principles of Tissue Engineering, Gene Therapy and Tissue Engineering, Biomaterials: Protein – Surface Interactions

TEXT

1. Biomedical Engineering Handbook edited by Bronzino D Joseph, CRC Press (New York) 1995

References:

1. Biomedical Engineering Principles Volume 1 by Cooney David Marcel Decker 1976
2. Handbook of Biomedical Engineering. Kline Jacob, Academic press (New York) 1988