DEPARTMENT OF MEDICAL PHYSICS

ANNA UNIVERSITY, CHENNAI

VISION

The Medical Physics course is planned in such a way that it is committed to being at the forefront of finding better diagnosis and treatments for cancer patients by way of superior clinical care and clinical trials coupled with cutting edge research in medical physics field, cancer biology and health services.

MISSION

The Mission of the medical physics program is to introduce advancement in the practice of principles of Physics for diagnosis and treatment of disease by educating students, on the concepts of radiological physics, medical imaging, radiation therapy and radiation safety aspects. The program aims to provide students with necessary foundation and confidence through rigorous teaching, hands on practice and mentored research.

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.Sc. MEDICAL PHYSICS (2 YEARS)

REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM

1. PROGRAM EDUCATIONAL OBJECTIVES (PEO)

I. Students during the course of their educational program, provided the opportunity to learn mathematical, analytical and programming skills and to gain knowledge of the structure and the function of the body at normal and abnormal conditions for clinical diagnostic imaging and radiation oncology.

II. To impart knowledge of radiation and radioactivity, units of measurement, dosimetry measurements concepts and methods, nuclear medicine and brachytherapy methods and to impart knowledge about Artificial Intelligence(AI) for the management of malignant disease also students will have the ability to design and complete independent research projects.

III. To provide students with knowledge on radiation safety practices and procedures including the design and determination of radiation shielding requirements, biological effects of ionizing radiation and various quality assurance programs to comply with the specifications of the treatments and diagnostics machines.

IV. To develop students with radiation treatment planning, decision making skills in radiation oncology and will able to develop uniform dose distribution and accurate treatment time calculations within acceptable degree of accuracy. Also, students will have ability to perform the clinical support procedures required for a medical physicist.

2. PROGRAM OUTCOMES (POs)

1. An ability to independently carry out research/investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the programme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.
4. Students will be skilled to perform the clinical support procedures required of a medical physicist and also can able to revolutionize the radiation therapy for cancer patients by practicing advanced techniques like IGRT and IMRT and will provided with the knowledge of the operation and principles used in the treatment systems and procedures associated with the clinical work.
5. Students will have the ability to support with the goal of improving the effectiveness and safety in the use of physics and technologies in medicine and to develop and train manpower in radiation physicists profession in management of dreaded disease “CANCER”.
6. Students can acquire knowledge, skills, and competencies required for safe application of technology in the practice of radiation oncology and the ability to carry out QA procedures related to various radiation therapy delivery and planning and also practice ethical, responsible, reliable and dependable behaviour in all aspects of their professional lives and a commitment to a medical profession and society.

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3. PEO / PO Mapping

PEO	PO					
	PO1	PO2	PO3	PO4	PO5	PO6
I.	2	2	3	3	3	3
II.	3	3	3	3	3	3
III.	3	3	3	3	3	3
IV.	3	3	3	3	3	3

4. Mapping of Course Outcome and Programme Outcome

ANNA UNIVERSITY, CHENNAI

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6
Year 1	Semester 1	Radiation Physics	2.8	2.6	2.6	2.8	2.8	2.8
		Radiation Generating Equipments in Medicine	2.6	2.6	2.8	2.6	2.4	2.6
		Electronics and Biomedical Instrumentation	1.8	2.8	3	2	2.8	3
		Professional Elective - I	2	3	3	2	3	3
		Mathematical Physics and Bio-Statistics	3	1	3	2	3	3
		Anatomy Physiology and Tumor Pathology	2.8	2.8	2.4	2.4	2.8	2.6
		Electronics and Bio Medical Instrumentation Laboratory	3	2	3	1	3	3
		Engineering Graphics	1.2	1.2	1.8	1.8	1.8	1.8
	Semester 2	Biological effects of ionizing radiation	2.6	2.8	2.4	2.4	2.8	2.8
		Numerical Methods	3	1	3	2	3	3
		Radiation Dosimetry and Standardization	2.6	2.6	2.6	2.8	2.6	2.6
		Physics of Medical Imaging	2.4	3	3	2.2	2.6	3
		Python & MATLAB	2	3	3	3	3	3
		Solid State Physics	2.2	3	3	3	3	3
		Programming Lab- Python & MATLAB	2	3	3	3	3	3
		Radiation Diagnostics and Therapeutic Lab	3	2.7	3	3	2.7	3
Year 2	Semester 3	Brachytherapy Physics	2.6	2.8	2.4	2.4	2.8	2.8
		Nuclear Medicine	2.6	2.4	2.8	2.4	2.8	2.8
		Radiotherapy Treatment Planning algorithm	2.6	2.8	2.4	2.4	2.8	2.8
		Professional Elective - II	2	3	2	2	3	3
		Professional Elective - III	2.4	2.4	2.4	2.4	2.4	2.4
		Professional Elective - IV	2.6	2.6	2.8	2.8	2.8	2.6
		Radiation Therapy, Dosimetry & Treatment Planning Laboratory	3	3	3	3	3	3
	Semester 4	Radiation Hazards & Evaluation control	3	2.6	2.6	2.8	2.6	2.8
		Advanced Radiation Therapy Techniques	2.6	2.4	2.4	2.8	2.6	2.8
		Professional Ethics for Medical Physicist	2	3	3	3	3	3
		Project Work	3	3	3	3	3	3
		Seminar	3	3	3	3	3	3

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UNIVERSITY DEPARTMENTS

M.Sc. MEDICAL PHYSICS (2 YEARS)

REGULATIONS 2023

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MP3101	Radiation Physics	PCC	3	0	0	3	3
2.	MP3102	Radiation Generating Equipments in Medicine	PCC	3	0	0	3	3
3.	MP3103	Electronics and Biomedical Instrumentation	PCC	3	0	0	3	3
4.		Professional Elective - I	PEC	3	0	0	3	3
5.	MP3104	Mathematical Physics and Bio-Statistics	FC	3	0	0	3	3
6.	MP3105	Anatomy Physiology and Tumor Pathology	PCC	3	0	0	3	3
PRACTICAL								
7.	MP3111	Electronics and Bio Medical Instrumentation Laboratory	PCC	0	0	4	4	2
8.	MP3112	Engineering Graphics Laboratory	EEC	0	0	4	4	2
			TOTAL	**18**	**0**	**8**	**26**	**22**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MP3201	Radiobiology	PCC	3	0	0	3	3
2.	MP3202	Numerical Methods	FC	3	0	0	3	3
3.	MP3203	Radiation Dosimetry and Standardization	PCC	3	0	0	3	3
4.	MP3204	Physics of Medical Imaging	PCC	3	0	0	3	3
5.	MP3205	Python & MATLAB	PCC	3	0	0	3	3
6.	MP3206	Solid State Physics	PCC	3	0	0	3	3
PRACTICAL								
7.	MP3211	Programming Lab- Python and MATLAB	EEC	0	0	4	4	2
8.	MP3212	Radiation Diagnostics and Therapeutic Lab	PCC	0	0	4	4	2
			TOTAL	**18**	**0**	**8**	**26**	**22**

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SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MP3301	Brachytherapy Physics	PCC	3	0	0	3	3
2.	MP3302	Nuclear Medicine	PCC	3	0	0	3	3
3.	MP3303	Radiotherapy Treatment Planning Algorithm	PCC	3	0	0	3	3
4.		Professional Elective - II	PEC	3	0	0	3	3
5.		Professional Elective - III	PEC	3	0	0	3	3
6.		Professional Elective - IV	PEC	3	0	0	3	3
PRACTICAL								
7.	MP3311	Radiation Dosimetry and Treatment Planning Laboratory	PCC	0	0	4	4	2
8	MP3312	Industrial visit (**2 weeks)**	EEC	-	-	-	-	**1**
			TOTAL	**18**	**0**	**4**	**22**	**21**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MP3401	Radiation Hazards, Evaluation and Control	PCC	3	0	0	3	3
2.	MP3402	Advanced Radiation Therapy Techniques	PCC	3	0	0	3	3
3.	MP3403	Professional Ethics for Medical Physicist	PCC	1	0	0	1	1
PRACTICAL								
4.	MP3411	Project Work	EEC	0	0	24	24	12
5.	MP3412	Seminar	EEC	0	0	2	2	1
			TOTAL	**7**	**0**	**26**	**33**	**20**

TOTAL NO. OF CREDITS: 85

FOUNDATION COURSE (FC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MP3104	Mathematical Physics and Bio-Statistics	FC	3	0	0	3	3
2.	MP3202	Numerical Methods	FC	3	0	0	3	3

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PROFESSIONAL CORE COURSES (PCC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MP3101	Radiation Physics	PCC	3	0	0	3	3
2.	MP3102	Radiation Generating Equipments in Medicine	PCC	3	0	0	3	4
3.	MP3103	Electronics and Biomedical Instrumentation	PCC	3	0	0	3	3
4.	MP3105	Anatomy Physiology and Tumor Pathology	PCC	3	0	0	3	3
5.	MP3111	Electronics and Bio Medical Instrumentation Laboratory	PCC	0	0	4	4	2
6.	MP3201	Radiobiology	PCC	3	0	0	3	3
7.	MP3203	Radiation Dosimetry and Standardization	PCC	3	0	0	3	3
8.	MP3204	Physics of Medical Imaging	PCC	3	0	0	3	3
9.	MP3205	Python and MATLAB	PCC	3	0	0	3	3
10.	MP3206	Solid State Physics	PCC	3	0	0	3	4
11.	MP3212	Radiation Diagnostics and Therapeutic Lab	PCC	0	0	4	4	2
12.	MP3301	Brachytherapy Physics	PCC	3	0	0	3	3
13.	MP3302	Nuclear Medicine	PCC	3	0	0	3	3
14.	MP3303	Radiotherapy Treatment Planning algorithm	PCC	3	0	0	3	3
15.	MP3311	Radiation Dosimetry and Treatment Planning Laboratory	PCC	0	0	4	4	2
16.	MP3401	Radiation Hazards and Evaluation control	PCC	3	0	0	3	3
17.	MP3402	Advanced Radiation Therapy Techniques	PCC	3	0	0	3	3
18.	MP3403	Professional Ethics for Medical Physicist	PCC	1	0	0	3	1

PROFESSIONAL ELECTIVE COURSES (PEC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MP3001	Non-Ionizing Radiation Physics in Medicine	PEC	3	0	0	3	3
2.	MP3002	Materials for Radiation Dosimeters	PEC	3	0	0	3	3
3.	MP3003	Artificial Intelligence in medical physics	PEC	3	0	0	3	3

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4.	MP3004	Precision Conformal Radiotherapy	PEC	3	0	0	3	3
5.	MP3005	Materials for Radiological Applications	PEC	3	0	0	3	3
6.	MP3006	Physics of Diagnostic Radiology	PEC	3	0	0	3	3
7.	MP3007	Biophotonics	PEC	3	0	0	3	3
8.	MP3008	Biosensors	PEC	3	0	0	3	3
9.	MP3009	Industrial Radiography	PEC	3	0	0	3	3
10.	MP3010	Monte Carlo Techniques in Dosimetry	PEC	3	0	0	3	3
11.	MP3011	Nanoscience for Medical Applications	PEC	3	0	0	3	3
12.	MP3012	Fabrication Techniques of Nanobiosensor	PEC	3	0	0	3	3
13.	MP3013	Ultrasonics in Medicine	PEC	3	0	0	3	3
14	MP3014	Lasers For Medical Applications	PEC	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSE (EEC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1 .	MP3112	Engineering Graphics Laboratory	EEC	0	0	4	4	2
2.	MP3211	Programming Lab- Python and MATLAB	EEC	0	0	4	4	2
3.	MP3312	Industrial visit	EEC				**2 weeks**	**1**
4.	MP3411	Project Work	EEC	0	0	24	24	12
5.	MP3412	Seminar	EEC	0	0	2	2	1
			TOTAL	**0**	**0**	**34**	**34**	**17**

SUMMARY

	M.Sc. MEDICAL PHYSICS (2 YEARS)					
	Subject Area	**Credits per Semester**				**Credits Total**
		I	**II**	**III**	**IV**	
1.	Foundation Course (FC)	03	03			**06**
2.	Professional Core Courses (PCC)	14	17	11	07	**49**
3.	Professional Elective Courses (PEC)	03		09		**12**
5.	Employability Enhancement Courses (EEC)	02	02	01	13	**18**
	Total Credit	**22**	**22**	**21**	**20**	**85**

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MP3101 **RADIATION PHYSICS** **L T P C**
3 0 0 3

OBJECTIVES

Topics in this paper is designed to

- Make the students to learn about nuclear transformation and atomic physics aspects.
- Familiarize the Students with different interaction mechanism of radiation with matter.
- Ensure the students understand the various dosimetric quantities and concepts.
- Make the medical physics students to learn principles of radiation detection.
- Gain knowledge about various radiation measuring and monitoring instruments.

UNIT I ATOMIC PHYSICS AND NUCLEAR TRANSFORMATION 9

Structure of matter - atom - nucleus -atomic mass and energy units - natural and artificial radioactivity - Unit - relationship between half life and decay constant - production of radio isotopes - Fission Products - Telecobalt and Brachytherapy sources- Caesium sources - Ir-192 sources - distribution of orbital electrons - atomic energy levels -nuclear forces -nuclear energy levels- particle radiation -Electro magnetic radiation- Binding energy - General properties of alpha, beta and gamma rays. Laws of equilibrium – modes of radioactive decay - nuclear isomerism -nuclear reactions - Elementary ideas of fission and reactors – fusion.

UNIT II INTERACTION OF RADIATION WITH MATTER 9

Interaction of electromagnetic radiation with matter, Thomson scattering, Rayleigh scattering, Compton scattering, Photoelectric absorption, Pair production – Relative importance of various processes - Cerenkov radiation- mass-energy- attenuation and absorption coefficient - Interaction of light and heavy charged particles with matter – Specific ionization - Bethe-Block formalism for energy loss by heavy charged particles, mass-collision – Bragg peak, mass-radioactive stopping power, range and path length of charged particles - Interaction of neutron with matter.

UNIT III DOSIMETRIC QUANTITIES AND UNITS 9

Introduction - Radiometric quantities:- Radiation field - Flounce (rate) - Energy flounce (rate) - Interaction coefficient related quantities: Linear attenuation coefficient - mass attenuation coefficient - LET - stopping power - Patient dosimetric quantities: exposure- Exposure rate - absorbed dose - KERMA - CEMA - charged particle equilibrium - Radiation protection level quantities:- Radiation Dose Equivalent - radiation weighting factors - Effective dose - tissue weighting factors (as per ICRP recommendation 107) - relationship between the dosimetric quantities - stopping power ratio.

UNIT IV PRINCIPLES OF RADIATION DETECTION AND DOSIMETERS 9

Principles of Radiation detection – properties of dosimeters - calorimeters - Theory of gas filled detectors – Ion chamber dosimetry systems - free air ion chamber – parallel plate chamber - ionization chamber – proportional chamber - GM counter– thimble chambers working and different applications – film dosimetery- Luminescence dosimetry - TLD - OSLD - semiconductor dosimetry - Gel dosimetry – radiographic and radiochromic films – scintillation detections - Neutron Dosimeters.

UNIT V RADIATION MONITORING INSTRUMENTS 9

Introduction –- operational quantities for Radiation monitoring – Area survey meters – Ionization chambers – proportional counters – neutron area survey meters – GM survey meters – scintillation detectors – Personal monitoring -Pocket Dosimeters– film badge – TLD – Properties of personal monitors - Liquid scintillation counting systems.

TOTAL: 45 PERIODS

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OUTCOMES

Upon completion of the course

CO1: Medical physics students will demonstrate understanding of radiological physics applied to medicine.

CO2: students will able to apply the interaction of radiation knowledge effectively in shielding calculation.

CO3: Will able to apply confidently the concepts of radiation dosimetry in radiation therapy .

CO4: Will be able to measure accurately the radiation dose radiation treatment.

CO5: Will be able to select appropriate monitoring radiation instruments for survey and protection purpose.

REFERENCES:

1. E.B.Podgorsak, Radiation Physics for Medical Physicists, 2016, 3rd Edition, Springer,.
2. F.M.Khan, The Physics of Radiation Therapy, 2015, Fifth Edition, Lippincott Williams and Wilkins, U.S.A..
3. W. J. Meredith and J. B. Massey, Fundamental Physics of Radiology, John Wright and Sons, U. K., 2000.
4. H. E. Johns, J. R. Cunningham, The Physics of Radiology, 2002, Charles C. Thomas, New York.
5. Frank Herbert Attix, Introduction to Radiological Physics and Radiation Dosimetry, 2007, Wiley- VCH Verlag.
6. Donald T. Graham, Paul J. Cloke, Principles of Radiological Physics, 2003, Churchill Livingstone.

Mapping of CO with PO

CO	PO					
	1	2	3	4	5	6
1	3	3	3	3	3	3
2	2	3	3	3	2	3
3	3	2	2	3	3	3
4	3	2	3	3	3	2
5	3	3	2	2	3	3
Avg	**2.8**	**2.6**	**2.6**	**2.8**	**2.8**	**2.8**

MP3102 RADIATION GENERATING EQUIPMENTS IN MEDICINE L T P C
3 0 0 3

OBJECTIVES

The course is designed

- To enablestudentstobecomeknowledgeableandtechnicallyproficientmedicalphysicists.
- To familiarize the students with design of telecoblat unit and its safety features.
- To gain knowledge about the high energy linear accelerators design and functional aspects.
- To ensure enough information about radiotherapy simulators role in treatment of cancer.
- To make the students develop the knowledge for clinical competence in radiation therapy.

UNIT I TELEGAMMA MACHINES 9

Teletherapy sources -source containers -international source capsusle-Different Shutter systems-effect of penumbra-Umbra- Types of collimators – Single plane , multi vane and John Mccay - -Jaws-MLC - beam directing devices – beam modifiying devices —R & V systems

UNIT II PARTICLE ACCELERATORS 9

Particle accelerators for medical applications – Resonant transformer – cascade generator-Van De Graff Generator – Pelletron – Cyclotron – Betatron – Synchro- cyclotron - electron synchrotron-Protron Synchrotron-**Applications of cyclotrons in medicine**

UNIT III LINEAR ACCELERATORS 9

Production of X-Ray - Components of modern linear Accelerator-Standing and travelling wave guides, Magnetrons and Klystrons. Bending Magnet, Target, flattening filter, Beam transport systems - **Beam Delivery Systems-Auxiliary equipment and their safety significance vacuum pumps, RF-power**, -Collimators- KV and MV Imaging systems, Portal Dosimetry.Telecobalt Vs Linacs-C arm, ring and Robotic gantry.

UNIT IV RADIOTHERAPY SIMULATORS 9

Conventional simulators-CT simulators - cone beam CT (CBCT)- comparison and quality assurance of simulators-different simulation Techniques-Virtual Simulation Systems

UNIT V ADVANCED RADIOTHERAPY EQUIPMENTS 9

Radio Surgery equipment - Gamma knife - cyber knife - Intra operative radiation therapy units-Tomotherapy -Neutron Therapy **Units**-Boron Neutron Capture Therapy **methodology** –proton therapy **proton accelerators Units- Beam Delivery using passive Scanning-Particle Beam scanning-MR LINAC**

TOTAL:45 PERIODS

OUTCOMES

Upon completion of the course

CO1: Students will be able perform the operation and quality assurance tests of Telecobalt unit effectively.

CO2: Will be able to demonstrate effective utilization of accelerators.

CO3: Studentswillproperlyemploytheaccessoriesandimmobilizationdevicesforradiation therapy.

CO4: Will be able to demonstrate competence in simulation procedures for delineating tumor and normal tissues and organs.

CO5: Students will demonstrate competence in radiation treatment delivery.

REFERENCES

1. F.M.Khan,The Physics of Radiation Therapy, FifthEdition,2015.
2. Radiation Oncology physics: A Handbook for teachers and students. 2005.
3. David Greene,P.C Williams Linear Accelerators for Radiation Therapy, 1997
4. David Greene, P.C.Williams, Linear Accelerators for Radiation Therapy, 2nd Edition, 1997.
5. Samantha Morris, Radiotherapy physics and equipment, 2001
6. David M.Hailey, Australian Institute of Health, High Energy Radiotherapy Equipment: A Discussion Paper, 1989.

Mapping of CO with PO

CO	PO				
	1	**2**	**3**	**4**	**5**
1	3	2	2	2	2
2	2	3	3	3	3
3	2	3	3	3	2
4	3	3	3	3	3
5	3	2	3	2	2
Avg	**2.6**	**2.6**	**2.8**	**2.6**	**2.4**

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MP3103 ELECTRONICS AND BIOMEDICAL INSTRUMENTATION **L T P C**
3 0 0 3

OBJECTIVES:

- To make students understand the concepts of electronics used in medical devices
- To provide a detailed overview on the construction and working of microprocessors
- To understand the fundamentals of analog and digital electronics and its advancement in modern world.
- To gain knowledge about various electronic circuits involved in nuclear instrumentation.
- To emphasis the electronic circuits in processing and analysing the signals from radiation detectors.

UNIT I ANALOG AND DIGITAL ELECTRONICS 9

Semiconductor diodes-JFET- MOSFET- Operational Amplifiers- Addition- subtraction- Integration and Differentiation-Active and passive filters-Oscillators-Relaxation oscillator and timer as oscillator-Introduction to Digital electronics- Basic logic gates, Sequential and combinational circuits- Universal logic gates-Encoder and decoder-Flip-flops-Counters and shift registers-Multiplexers and demultiplexers.

UNIT II MICROPROCESSOR AND MICROCONTROLLER 9

Architecture of Microprocessor 8085 and microcontroller 8086- Memory and storage-Introduction to Microprocessors-Microprocessor 8085- Architecture, operation, memory, various registers and I/O devices- Core Architecture of the 8086 - Memory Segmentation, Minimum mode Operation and Maximum Mode Operation, Instruction Set of the 8086 processor - Simple Assembly Language Programs - Arithmetic operations-Addition, subtraction, multiplication and division using microprocessor.

UNIT III POWER SUPPLIES IN NUCLEAR INSTRUMENTATION 9

Rectifier – Half wave - Full wave rectifier- Centre Tapped Full wave Rectifier–Transformer-Regulation – AC Regulators- Power Supplies –Regulated Power Supplies using IC's – DC-DC Converter and RF Power Supplies – Switching mode Power Supplies- Voltage Multiplier – Regulating Systems in Nuclear Instrumentation.

UNIT IV ELECTRONICS FOR NUCLEAR DEVICES 9

Preamplifier – Types of Preamplifier -pulse shaper – isolator – circuit design – Noise and Resolution – Connection between detector and preamplifier – Analog Signal Processing – Base line restoration – Linear gating-Amplitude Analysis - Discriminator – Single Channel Analyser-Analog to Digital Conversion – Multi Channel Analyser – Circuits for Time measurement –Time to amplitude Conversion.

UNIT V BIOMEDICAL INSTRUMENTATION 9

Bioelectric Potentials – Action and Resting Potential – Propagation of Action Potential – Bioelectric Potential – Transducer – Transduction Principles – Active Transducer – Passive Transducers, Biopotential Electrode – electrical circuits – Bio Medical Equipment – ECG, EMG, EEG, Pace Maker, Defibrillator, Heart lung Machine, Dialysis, Diathermy Unit for surgery and therapy, Robotic Surgical Equipments – Biotelemetry – Application of Telemetry in Patient Care.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1: Gain knowledge on Electronics in medical instrumentation.
CO2: Understand the fundamentals of analog and digital electronics concepts.
CO3: Know about the construction and working principle of a few fundamental microprocessors, thereby able to apply it while in the hospital scenario.
CO4: Know the significance of power supplies in nuclear instrumentation.
CO5: Get an overview on the biomedical instrumentation safe handling of medical instruments.

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TEXT BOOKS:

1. T.L. Floyd, Electronic devices', (10th edition), Pearson Education Inc., New Delhi, 2017.
2. R. F. Coughlin and F.F. Driscoll, 'Operational amplifiers and linear integrated circuits', (6th edition), Pearson Education Inc., New Delhi, 2001.
3. T. L. Floyd, Digital Fundamentals, (11th edition), Pearson education Inc., New Delhi, 2015.
4. Khandpur, Handbook of Biomedical Instrumentation, McGraw Hill Education, 3rd Edition, 2014.

RERERENCES:

1. S. Brown and Z. Vranesic, Fundamentals of digital logic with Verilog design (Third Edition), Tata McGraw Hill PublCo.Ltd., New Delhi, 2013.
2. H. Skalsi, "Electronic instrumentation (Third edition), Tata McGraw Hill Publ. Co. Ltd., New Delhi, 2012. A.P. Malvino, "Electronic principles', (7th edition), Tata McGraw Hill Publication Co. Ltd., New Delhi, 2007.
3. Biomedical Instrumentation And Measurements- Leslie Cromwell, Fred J. Weibell, Erich A. PfeifferLeslie Cromwell, Prentice-Hall, 1990.
4. M. Arumugam, Biomedical Instrumentation, Anuradha Publishing Co., Kumbakonam, Tamilnadu, 2004.
5. S. Ananthi, A Textbook of Medical Instruments (Paperback), New Age International Private Limited, January 2005.

Mapping of CO with PO

CO	PO					
	1	2	3	4	5	6
1	1	2	3	2	2	3
2	2	3	3	2	3	3
3	2	3	3	2	3	3
4	2	3	3	2	3	3
5	2	3	3	2	3	3
Avg	**1.8**	**2.8**	**3**	**2**	**2.8**	**3**

MP3104 MATHEMATICAL PHYSICS AND BIO-STATISTICS **L T P C**
3 0 0 3

OBJECTIVES

- To educate the student with advanced mathematical concepts so that it can be used in future career as medical physicist or researcher.
- To know various vector theorem and matrix and their uses.
- To apply matrices and complex analysis for advanced problems.
- To be familiar with Fourier transforms and apply to medical imaging.
- To train the student with medical statistics and Monte-Carlo simulation for medical applications.

UNIT I VECTORS CALCULUS AND MATRICES 9

Scalar and vector fields – Gradient, Divergence, Curl and Laplacian – line, surface, volume integrals – Theorems of Gauss, Green and Stokes – Applications, Vector operators in curvilinear co-ordinates. Matrix, Eigen Value, problem.

UNIT II COMPLEX ANALYSIS 9

Analytic functions – Conformal mapping- Simple and Bilinear transformation- Applications-Cauchy's Integral Theorem and Integral formula – Taylor's and Laurent's series –Singularities – Zeros, Poles and Residues – Residue theorem.

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UNIT III FOURIER & LAPLACE TRANSFORMS 9

Fourier **Transform, Properties – Transform of simple function and derivatives – convolution theorem – Discrete Fourier Transform, Fast** Fourier transform- Applications of Fourier Transform in Medical imaging. Laplace's transform – Properties

UNIT IV PARTICAL DIFFERENTIAL EQUATIONS 9

Transverse vibration of string – Wave equation – Diffusion: **3-dimensional Fourier** equation – Laplace's equation – method of separation of variables- Fourier series solution in Cartesian coordinate.

UNIT V PROBABILITY, STATISTICS AND ERRORS 9

Laws of probability, conditional probability, **population, variates**, collection, tabulation and graphical representation of data. **frequency distributions-** measures of central tendency: **arithmetic** mean, median, mode, standard deviation, moments, skewness and kurtosis. Application to radiation detection – **uncertainty calculations,** error propagation, **time distribution between background and sample, minimum detectable limit.** Binomial, Poisson, Gaussian & exponential distribution, Correlation and Regression, Chi-Square distribution, t- distribution, F – distribution, Principle of Monte Carlo Simulation.

TOTAL: 45 PERIODS

OUTCOMES

CO1: The student will be able to apply advanced mathematics for practical solution.
CO2: Will learn fundamental and advanced concepts for applying in the medical and research field.
CO3: Will understand the application of transform in medical imaging.
CO4: apply partial differential equation to physical problems.
CO5: apply statistics and Monte Carlo simulation in medical diagnostics.

TEXTBOOKS

1. Pipes L.A. &Harvill L.R, Applied Mathematics for Engineers and Physicists (3rd edition), Dover Publications, 2014.
2. Butkov E. Mathematical Physics, Addison Wesley, New York, (2nd edition 2010) .
3. Satya Prakash, " Mathematical Physics with Classical Mechanics", Sultan Chand and Sons, 7th Edition, 2022
4. Gupta SP," Elementary Statistical Methods", Sultan Chand & Sons Edition 2017
5. Barbu, A., Zhu, S.C., Barbu, A. and Zhu, S.C., 2020. Sequential Monte Carlo. *Monte Carlo Methods*, pp.19-48.

REFERENCES

1. Walpole,E, Myers,R.M, Myers,S.L and Ye,K, "Probability & Statistics for Engineers and Scientists (9th edition), Pearson Education, 2013.
2. Arfken, Weber, and Harris, Mathematical Methods for Physicists, 7th edition, Elsevier, 2012.
3. S.C.Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand and Sons, 2020.
4. Newman, M.E. and Barkema, G.T., 1999. *Monte Carlo methods in statistical physics*. Clarendon Press.

CO	PO					
	1	2	3	4	5	6
1	3	1	3	2	3	3
2	3	1	3	2	3	3
3	3	1	3	2	3	3
4	3	1	3	2	3	3
5	3	1	3	2	3	3
Avg.	**3**	**1**	**3**	**2**	**3**	**3**

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MP3105 ANATOMY PHYSIOLOGY AND TUMOR PATHOLOGY

	L	T	P	C
	3	0	0	3

OBJECTIVES

This paper is designed in such a way that the student will

- Identify gross anatomical structure.
- Define the major organ and understand their function.
- Understand the physiological mechanism for repair maintenance and growth.
- Knowledge on physics and chemistry of different organs.
- Able to correlate with the imaging modalities used to view them.

UNIT I HUMAN ANATOMY OVERVIEW 9

Applications, History- Cells, structure and functions, sex cells, early development - The tissues - the systems - skin, cartilage and bone - Bacteria - Inflammation - injection - ulceration - neoplasm, bones - the skeleton - joints - The skeletal system - the skull - vertebral column, thorax etc. - the muscular system - the thoracic cage - the mediastinum, the diaphragm the abdominal cavity and abdominal regions - anatomy of the heart.

UNIT II DIGESTIVE AND CIRCULATORY SYSTEM 9

Functions of mouth, tongue, teeth, esophagus, stomach, small intestine, large intestine - digestion and assimilation of carbohydrates - Fats and proteins - Gastric juice - Pancreatic juice - Function of liver and spleen, blood and circulatory system, Blood and its composition, RBC and WBC - blood grouping - coagulation of blood, artery, vein, capillaries and heart structure and functions - Physiological properties of heart muscle, cardiac dynamics - ECG - blood pressure and its regulation.

UNIT III RESPIRATORY, REPRODUCTION AND EXCRETORY SYSTEMS 9

Physical laws of respiration - Trachea - lungs and its functions - oxygen transport - nervous regulation of respiration. Hormonal control over reproduction. Kidney and its functions - water and electrolyte metabolism.

UNIT IV ENDOCRINE SYSTEM AND NERVOUS SYSTEM 9

Pituitary glands and its functions - functions of adrenal, thyroid etc. secretion - chemistry - physiological actions, effect on removal effect on administration, hormonal assay detailed molecular mechanism of hormone action. Brain and spinal cord - its functions - central nervous system and Autonomic Nervous system functions - Physiology of special senses of hearing, taste vision etc.

UNIT V TUMOR PATHOLOGY 9

Cellular adaptation and cell death – Infection, Inflammation, Repair, and Immune defense – Genetics of disease – neoplasia – cell injury and adaptation – Atrophy, Hypertrophy, Metaphase, Hyperplasia – Classification of tumors, Premalignant lesion - Types of Inflammation and System Manifestations of Inflammation – Disorder of vascular flow and shock – oedema, Hyperemia or Congestion, Thrombosis, Embolism, Infarction shock, Ischemia, Over hydration, Dehydration - Response to infection - Categories of infectious agents, Host barriers to infection – Inflammatory response to infectious agents – Hematopoietic and Lymphoid System – Hemorrhage, Various type of Anemia, Leucopenia, Leukocytosis, Bleeding disorders coagulation mechanism.

TOTAL: 45 PERIODS

OUTCOMES

After completion of the course the student will be able to

CO1: Identify and describe the structure and function of different human systems

CO2: Obtain an overview on human anatomy.

CO3: Will understand the constituents and functions of digestive, circulatory and respiratory systems.

CO4: Will have the ability to indentify the physical and hormonal changes associated with cancer.

CO5: Will able to differentiate the various stages of Cancer.

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REFERENCES

1. C. H. Best and N. B. Taylor, A Test in Applied Physiology, Williams and Wilkins Company, Baltimore, 1999.
2. C. K. Warrick, Anatomy and Physiology for Radiographers, Oxford University Press, 2001.
3. Ross and Wilson, Anatomy and Physiology.
4. J. R. Brobek, Physiological Basis of Medical Practice, Williams and Wilkins, London, 1995.
5. Edward Alcamo, Barbara Krumhardt, Barron's Anatomy and Physiology the Easy Way, Barron's Educational Series, 2004.
6. Lippincott, Lippincott Williams & Wilkins, Anatomy and Physiology, 2002.
7. W. E. Arnould-Taylor, A textbook of anatomy and physiology, Nelson Thornes, 1998.
   K Swaminathan, Pathology and Genetics, 3rd edition, Jaypee Brothers Medical Publishers

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	3	2	2	3	2
2	3	3	3	2	3	2
3	3	3	2	3	3	3
4	3	3	2	3	3	3
5	2	2	3	2	2	3
Avg	**2.8**	**2.8**	**2.4**	**2.4**	**2.8**	**2.6**

MP3111 ELECTRONICS AND BIO MEDICAL INSTRUMENTATION LABORATORY **L T P C 0 0 4 2**

OBJECTIVES

- To design different analog electronic circuits and that can perform various arithmetic operations, amplification, oscillators, filters and power supplies etc.
- To design the digital electronic circuit and understand the functioning of logic gates, flip flop and register.
- To train the students to understand and write assembly language programs and executes it in the microprocessor kit 8085.
- To train students to design electronic circuits and verify the physical priniciples
- To familiarize on electronic circuits used in biomedical instrumentation and to design and characterize different sensors used for biomedical applications.

ANY FOURTEEN EXPERIMENTS

1. Dual-regulated power supply.
2. Astable Multivibrator design.
3. Implementation of Boolean Expressions using NAND and NOR Gates.
4. Operational Amplifier - Characteristics of Addition, Subtraction, integration and Comparator Circuit.
5. Filters - high pass, low pass and band pass.
6. Arithmetic operations: addition, subtraction, multiplication, division, 1s and 2s complement using Microprocessor 8085.

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7. Ordering (Ascending, Descending) and Finding operations using Microprocessor 8085
8. IC-regulated power supply.
9. Half & Full Adder.
10. Waveform generator: sine and square wave using Op-Amp
11. ECG Preamplifier.
12. Pacemaker.
13. Calibration of unknown resistance using a Bridge Amplifier circuit.
14. Ultrasonic Interferometer
15. Instrumentation Amplifier using Op-Amp.
16. Digital - Analogy & Analog-Digital Converter.
17. ECG pattern generation.
18. Acoustic Grating.
19. Flaw detection using an Ultrasonic flaw detector.
20. Dielectric Properties of bio-molecules.
21. Flip Flop, JK & RS using Logic Gates.
22. Characterization of temperature sensors: Thermistors. Band-gap determination by Bridge Amplifier.

TOTAL: 60 PERIODS

OUTCOMES

The student will gain practical knowledge on

CO1: Analog electronic circuit and devices.
CO2: Digital electronics and understand functioning of digital components and devices.
CO3: Programming using microprocessor 8085.
CO4: Implement physical laws through electronic circuits.
CO5: Construct their own circuits and characterize sensors for biomedical applications

CO	PO					
	1	2	3	4	5	6
1	3	2	3	1	3	3
2	3	2	3	1	3	3
3	3	2	3	1	3	3
4	3	2	3	1	3	3
5	3	2	3	1	3	3
Avg.	**3**	**2**	**3**	**1**	**3**	**3**

MP3112 ENGINEERING GRAPHICS LABORATORY L T P C
0 0 4 2

OBJECTIVES

Creating awareness to the students on

- fundamentals of graphics
- Engineering Drawing
- Handling Of Machine Tools Including CNC Machines

1. ENGINEERING GRAPHICS

Drawing Instruments and their uses, lines, lettering and dimensioning – orthographic projections – section of solids, Isometric projections – Isometric views of simple objects such as square, cube and rectangular blocks – Free hand sketching of nuts, bolts, rivets and washers with dimensions, from samples – BIS standards and codes (Elementary treatment).

TOTAL: 60 PERIODS

OUTCOMES

To make the students to understand the

CO1: Concept on basic drawing / graphics

CO2: Design the radiotherapy room

CO3: Visualization of the 3D images from 2D pictures

REFERENCE

1. N.D.Bhatt. Elementary Engineering Drawing.Charater Publishing Co. 1990.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	2	3	3	3	3
2	2	2	3	3	3	3
3	2	2	3	3	3	3
Avg	**1.2**	**1.2**	**1.8**	**1.8**	**1.8**	**1.8**

MP3201 RADIOBIOLOGY L T P C
3 0 0 3

OBJECTIVES

- To provide knowledge on the interaction of radiation at cellular and tissue level
- To educate the students about various Radiobiological models
- To impart knowledge on somatic effects of radiation
- To teach Biological impacts of Ionizing Radiations
- To learn about the TNM rational of fractionation

UNIT I ACTION OF RADIATION ON LIVING CELLS 9

Target theory - single hit and multi target theory – LQ model - other theories of cell inactivation - concepts of micro dosimetry - direct and indirect action - radicals and molecular products – cellular effects of radiations - in activations - division delay - DNA damage - depression of macromolecular synthesis - giant cells - chromosomal damage - point mutations.

UNIT II CELL RESPONSE TO IRRADIATION AND ITS RADIOSENSITIVITY 9

Cell survival parameters – in vitro and in vivo experiments on mammalian cell systems LQ model - RBE -response - modifiers - LET, oxygen, cell stage - recovery mechanism radio protective and radio sensitizing chemicals - radiometric substances - chemical mutagenesis - effects of UV, microwave and other non - ionizing radiations.

UNIT III SOMATIC EFFECTS OF RADIATION 9

Bergonis - Tribondeau law - radio sensitivity protocol of different tissues in human LD50/30 - effect of radiation on skin - blood forming organs, lenses of eyes, blood constituents, embryo, digestive tract, endocrine glands, gonads, dependence of effect on dose, dose rate, type and energy of radiation syndrome - effects of chronic exposure to radiation - radiation carcinogenesis- shortening of life span - risk estimates.

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UNIT IV GENETIC EFFECTS OF RADIATIONS 9

Threshold and linear dose - effect relationship - factors affecting frequency of radiation induced mutations recessive and dominant mutations - gene controlled hereditary diseases – human data on animals and lower species - doubling dose and its influence of genetic equilibrium.

UNIT V RADIOBIOLOGICAL BASIS OF RADIOTHERAPY 9

Tumor growth kinetics –TNM rational of fractionation - problem of hypoxic compartment and quiescent cells - radiobiology of malignant neoplasm - solution of hypoxic cell sanitizers, hyperthermia, recourse to high LET radiation - combination of chemotherapy and radiotherapy - chronoradiobiology and its applications to get better cure - problem of tumor regression- bioeffect models– Nominal standard dose(NSD) –Cummulative Radiation Effectiveness (CRE)–Time Dose Fractionation(TDF)–Linear Quadratic Model (LQ) –Extrapolated Response Dose (ERD).

TOTAL: 45 PERIODS

OUTCOMES

- Students will be able to decide the type of radiation for cancer treatment
- Know to identify the TNM Staging of cancer
- Design the dose and, fractionation with respect to different type of cancer and stage.
- Certain about genetic effects of radiation
- Know to analyse the cell survival curve

REFERENCES

1. E. J. Hall, Radiobiology for Radiologists, J. B. Lippincott Co., Philadelphia, 2000.
2. S. P. Yarmonenko, Radiobiology of Humans and animals, MIR, Publishers, Moscow, 1990.
3. Bushong, Stewart C, Radiological sciences for technologists- physics, biology and protection,1997, Mosby, St. Louis.
4. Late biological effects of ionizing radiation: proceedings of the Symposium on the Late Biological Effects of Ionizing Radiation held by the International Atomic Energy Agency in Vienna, 13-17 March 1978
5. H. Smith, J. W. Stather, Biological effects of ionising radiation, Landolt-Börnstein – Group VIII Advanced Materials and Technologies Volume 4, 2005, pp 5-40
6. Dr. Claus Grupen Biological Effects of Ionizing Radiation Graduate Texts in Physics 2010, pp 212-228
7. B. Kanyár, G. J. Köteles, Dosimetry and Biological Effects of Ionizing Radiation, Handbook of Nuclear Chemistry 2011, pp 2211-2257.

Mapping of CO with PO

CO	PO					
	1	2	3	4	5	6
1	3	3	2	3	3	3
2	2	3	3	2	3	3
3	3	3	2	3	3	3
4	2	3	2	2	3	3
5	3	2	3	2	2	2
Avg.	**2.6**	**2.8**	**2.4**	**2.4**	**2.8**	**2.8**

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MP3202 **NUMERICAL METHODS** **L T P C**
3 0 0 3

- Emphasizing the role of numerical methods for solving problems arising in different areas of applied physics and equip the students with the skill required for Biomedical application.
- Acquire knowledge on efficient numerical approaches to deal with discrete experimental data.
- To know the behavior of the approximation error as a function of integral evaluation. Utilize the numerical methods for handling large system of equation with different degrees of nonlinearities.
- To learn numerical computation approach in solving: integration, differentiation and differential equations.
- To acquire knowledge about different curve fitting methods and help them to develop empirical equation.

UNIT I SOLUTIONS OF EQUATIONS 9
Intoduction to numerical Methods, accuracy and errors on calculations – round off error, evaluation of formulae. Initial Approximation and Convergence Criteria, Roots of nonlinear equations - Methods of bisection & false position - Newton-Raphson method - Simultaneous Linear equations: - Gauss elimination – Gauss-Seidel iterative method

UNIT II NUMERICAL METHODS FOR MATRIX OPERATIONS 9
Characteristic equation of a matrix - Cayley Hamilton theorem - Reduction of a matrix to diagonal form –– Jacobi method, Sylvester's theorem, matrix inversion and LU decomposition method – Eigenvalues and Eigenvectors of matrices –Power method.

UNIT III INTERPOLATIONS 9
Finite differences- Forward –Backward- Central differences- operators -Newton-Gregory forward, backward interpolation Formulae for equal intervals- Missing terms- Lagrange's interpolation formula for unequal intervals-Inverse interpolations.

UNIT IV DIFFERENTIATION, INTEGRATION AND DIFFERENTIAL EQUATIONS 9
Numerical differentiation & integration - Trapezoidal rule and Simpson's **1/3 and 3/8** rule - Numerical solution of ordinary differential equations - Taylor series–- Picard's Method, Euler's method, modified Euler's methods – Runge Kutta methods- - Milne's predictor -corrector method

UNIT V CURVE FITTING 9
Curve fitting – principle of least squares, linear law – graphical method – method of group averages – with two and three constants -– straight line, parabola and exponential curve fitting – Estimation of residuals – method of moments.

TOTAL: 45 PERIODS

OUTCOMES
The students will be able to
- Gain knowledge on numerical methods for solving different problems in biomedical applications.
- Utilize the numerical methods in experiment data
- Understand the behavior of approximations and have capability to solve system of equations.
- Students can be trained to do numerical computation of integration, differentiation and differential equations.
- Aware about different curve fitting methods which leads to develop empirical equations.

TEXTBOOKS

1. M. K. Venkatraman, "Numerical Methods in Science and Engineering", National Publishing Company, Madras, 1996
2. Dr.P.Kandasamy,Dr.K.Thilagavathy and Dr.K.Gunavathi, "Numerical Methods", S.Chand,2006
3. S.Arumugam, A. Thangapandi Isaac, A. Somaasundaram, "Numerical Methods", Scitech Publications (India) Pvt Ltd, July 2015

4. Jain, M.K., Iyengar ,S R K, Jain, R K 2022. *Numerical methods for scientific and engineering computation*. New Age International.

REFERENCES

1. Bracewell, R. N, The Fourier Transform and its applications, McGraw Hill International Edition, 2000
2. S. S. Sastry, Introductory Methods of Numerical Analysis (5th edition), Prentice Hall of India, New Delhi, 2012.
3. Applied Numerical Analysis Using MATLAB, Laurene v. Fausett, Pearson, 2009.
4. Guest, P.G. and Guest, P.G., 2012. *Numerical methods of curve fitting*. Cambridge University Press.
5. Björck, Å., 2015. *Numerical methods in matrix computations* (Vol. 59). Cham: Springer.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	1	3	2	3	3
2	3	1	3	2	3	3
3	3	1	3	2	3	3
4	3	1	3	2	3	3
5	3	1	3	2	3	3
Avg.	**3**	**1**	**3**	**2**	**3**	**3**

MP3203 RADIATION DOSIMETRY AND STANDARDISATION **L T P C**
3 0 0 3

OBJECTIVES

To provide the knowledge on

- Quantification of radiation and radiation dose
- Radiation detection and detectors
- Calibrating teletherapy and brachytherapy machines
- Calibration protocols
- Absolute and relative dose measurements

UNIT I RADIATION DOSIMETRIC PARAMETERS 9

Build-up, central axis depth doses for different energies and their determination - Tissue Air Ratio, Tissue Maximum Ratio and Tissue Phantom Ratio - their relationship - Back scatter factor – Phantom scatter factor – Collimator scatter factor - Source to surface distance –dependence of SSD

UNIT II DOSIMETRIC CONCEPTSAND QUANTITIES 9

ICRU (International Commission on Radiation Units and Measurements) definitions of dosimetry quantities and units - Vector radiometric quantities – Cavity theory- Bragg-Gray theory – Spencer–Attix cavity theory – Burlin cavity theory - Applications and limitations of cavity theory - Quantities and units used for describing radiation fields - Interaction coefficients – Mass attenuation coefficients, mass energy transfer coefficients, mass energy absorption coefficient - Kerma, collisional kerma, radiative kerma, and converted energy per unit mass - Absorbed dose - Exposure/air kerma - Relationships between exposure, kerma, and absorbed dose

UNIT III DOSIMETERS AND CALIBRATING INSTRUMENTATION 9

Principles of radiation detection/radiation detection mechanisms - Types and general characteristics of detectors and dosimeters - Basic characteristics of ionization chambers - Standard free air ionization chamber - Cavity (thimble) ionization chamber - Plane parallel chamber/extrapolation chamber - Ion chamber survey meters - Measurement of chamber current (differential mode) and charge (integral mode) and operation of electrometer - Dosimeters based on condenser chambers – Pocket dosimeters – dosimeter based on current measurement – Gas filled detectors - different type of electrometers –Secondary standard therapy level dosimeters –Neutron detectors - Radiation field analyzer (RFA)-Radioisotope calibrator – Water phantom dosimetry systems – Phantom materials - Brachytherapy dosimeters – TLD readers for medical applications

UNIT III CALIBRATION AND QUALITY ASSURANCE OFTELETHERAPY UNITS 9

Calibration and maintenance of dosimeters - IAEA TRS 398 protocol for the calibration of teletherapy units - Definition of calibration coefficients -N_x, N_k,$N_{D,air}$,$N_{D,w}$ - Calibration of the cobalt telegamma units - Cross calibration of the chambers – Calibration of high energy photon beams - Calibration for electron beams. IAEA TLD postal dose inter-comparison. AAPM Task Group 40 and 142 reports: Quality Assurance of medical accelerators

UNIT V BEAM DATA MEASUREMENTS AND ELECTRON BEAM DOSIMETRY 9

Measurements of percentage depth dose and profiles – photon beams and electron beams-use of various detectors in relative dosimetry–measurements of conventional and dynamic wedge profiles Basic Characteristics: Depth-dose/Isodose characteristics, Electron interactions, CSDA and range, Dose versus depth, Isodoses, Oblique incidence, AAPM TG-25 – energy specification – electron energy selection for patient treatment–depth dose characteristics (D_s,D_x,R_{100},R_{90},R_{50},$R_p$etc) beam flatness and symmetry – penumbra–isodose plots–monitors unit calculations – output factor formalisms – effect of air gap on beam dosimetry effective SSD.

OUTCOMES:

After the completion of the course

- Students will be able carry out the dosimetry independently
- Will be able to perform Calibration effectively.
- Student will Perform absolute and Relative Dosimetry
- Can do both 2D and 3D Dosimetry for practicing radiation therapy
- Can demonstrate the calibration protocols

L:45;T:15,TOTAL:45PERIODS

REFERENCES

1. FM Khan-Physics of RadiationTherapy,5Th Edition, 2003.
2. W.R. Hendee ,Medical Radiation Physics, ,2003.
3. K N Govindarajan Advanced Medical Radiation Dosimetry 2004
4. Edward C.Halperin,Carlos A.Pérez, Luther W..Brady,Perez and Brady's principles and practice of radiation oncology, 2008
5. Frank Herbert Attix Introduction to radiological physics Radiation dosimetry 1986

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Mapping of CO with PO

CO	PO				
	1	2	3	4	5
1	3	3	3	2	2
2	3	3	2	3	3
3	2	3	3	3	2
4	2	2	2	3	3
5	3	2	3	3	3
Avg	**2.6**	**2.6**	**2.6**	**2.8**	**2.6**

MP3204 PHYSICS OF MEDICAL IMAGING **L T P C**
3 0 0 3

OBJECTIVES

- Explain the Physical principles behind the diagnostic X-Ray and CT
- To impart knowledge about radioisotopes and their application in diagnostic application
- Explain the physics of radiowaves and their influence on diagnostics application using magnetic resonance.
- Physical principles behind the diagnostic ultrasound and their limitations
- To explain the use of non-ionizing radiation such as IR and Visible light in medical imaging.

UNIT I X-RAY IMAGING SYSTEMS 9

Production of X-ray – Bremsstrahlung & characteristic X-Rays- factors affecting the x-ray spectrum- Focal spot - Heel Effect - X ray generators - Attenuation of heterogeneous and homogenous x-rays — Attenuation coefficients- Attenuation mechanisms –X-ray film - Characteristic curve for X-ray film - Intensifying Screens - Computed Radiography - Digital Radiography - Radiographic image quality-factors affecting image quality- Filters — Grids - Diagnostic applications of X-rays- - Fluoroscopy - mammography - dental x- ray unit - Basic Principle - Generation of CT- Helical CT – Slip ring Technology - Single slice and Multi slice CT scan system - Image reconstruction - post processing technique - CT image quality, artifacts- Radiation dose.

UNIT II MAGNETIC RESONANCE IMAGING: 9

Basic principles – Spin – Precession – Relaxation time – Free induction decay – T1, T2 proton density weighted image – Pulse sequences - Basic and advance Pulse sequences – MR instrumentation –– Image formation – Localization of the signal –K space data acquisition and Factors influencing signal intensity- contrast and resolution – Perfusion and diffusion contrast imaging-magnetization transfer contrast MR Spectroscopy- **PET-MRI -** fMRI – BOLD-MR Artifacts – safety aspects in MRI

UNIT III DIAGNOSTIC ULTRASOUND 9

Ultrasonic waves - characteristics of sound–- interaction of ultrasound with matter- tranIsducers- beam properties- attenuation of ultrasound - Specific acoustic impedance - reflection at body interfaces-Coupling medium- Interaction ultrasound with tissues –A scan B scan and M mode- real time scanners Image clarity - Resolution –axial and lateral resolution - Artifacts-Pulse echo imaging- Obsterics abdominal investigations Echo cardiograph(UCG) – The Doppler Effect- Doppler Shift- continuous wave Doppler system-pulsed wave Doppler systems - duplex scanning - display devices for ultrasonic imaging.

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UNIT IV NUCLEAR IMAGING TECHNIQUES 9

Radioactivity and nuclear transformation - Radionuclide production and their characteristics - internal dosimetry - radiation detection and measurement-types of detector and Basic principle - Scintillation Camera – Nuclear imaging- emission tomography -Single Photon Emission computed Tomography (SPECT), Positron Emission Tomography (PET). Physics of PET and Cyclotron: Principles of PET, PET Instrumentations, Annihilation Coincidence Detection, PET Detector and scanner Design – fusion imaging: PET-CT.

UNIT V THERMOGRAPHY AND OPTICAL IMAGING TECHNIQUES 9

Physics of thermography - infrared detectors –thermo graphic equipment - quantitative medical thermography - pyro electric video camera - applications of thermography - tomography (EIT) – Electrical Source Imaging (ESI) – Magnetic Source Imaging (MSI). Quantum dots for medical imaging – Nanobots - Digital Image processing fundamentals - grey scaling and pseudo colour imaging - Image reconstruction.

TOTAL: 45 PERIODS

OUTCOMES

On completion, students will be able to:

- The student can be able to discuss the principle and working of State of the Art imaging techniques Viz., MRI,CT PET ,SPECT
- Identify the suitable medical imaging method for clinical and biomedical research
- Describe Methods For Generating 2D And 3D Medical Images.
- Learn About the importance of image fusion such as PET-CT
- Understand about applications of Fluorescence and Thermographic imaging

REFERENCES

1. Christensen',s Physics of Diagnostic Radiology by Thomas S Curry, IV Edition, LippincottWilliams & Wilkins, 1990.
2. The Essential Physics for Medical Imaging-2nd Edition-Jerrold T Bushberg, LippincottWilliams & Wilkins 2002.
3. Medical Physics: Imaging, Jean A. Pope, Heinemann Publishers, 2012
4. MRI - Perry Sprawls - Medical Physics Publishing, Madison, Wisconsin-2000.
5. Advances in Diagnositc Medical Physics - Himalaya Publishing House-2006.
6. Diagnositc Ultrasound applied to OBG - Sabbahaga - Maryland -1980.
7. Essentials of Nuclear Medicine Imaging. F A Mettler,MJ Guibertau,Saunders, 2005.
8. Molecular Imaging FRET Microscopy and Spectroscopy Edit by AmmasiPeriasamy and Richard N Day, Oxford Press 2005
9. Diagnostic radiological physics, IAEA.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	3	3	2	3	3
2	2	3	3	3	3	3
3	3	3	3	2	3	3
4	2	3	3	2	2	3
5	2	3	3	2	2	3
Average	**2.4**	**3**	**3**	**2.2**	**2.6**	**3**

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MP3205 **PYTHON AND MATLAB** **L T P C**
3 0 0 3

OBJECTIVES

- To understand the basic concepts of programming using Python.
- To develop skills in writing Python code for data analysis and visualization.
- To learn techniques for image processing using Python.
- To apply programming skills and solve problems relevant to medical physics applications.
- To understand MATLAB programming applied to medical physics.

UNIT I Introduction to Python 9

Installation of Python and development environment, Basic syntax and data types, Control flow statements, Functions and modules, Python Interpreter and Interactive Mode, Object-oriented programming in Python.

UNIT II Data Analysis & Visualization 9

NumPy and SciPy libraries for numerical analysis, Pandas library for data analysis, Matplotlib library for data visualization, Plotting profiles, Statistics, hypothesis testing, case studies.

UNIT III Python in Medical Physics 9

Python libraries used in medical physics, Basic image processing operations using OpenCV, Image filtering and segmentation, Digital image processing concepts, DICOM image file format, PyDICOM library for DICOM file handling, Handling DICOM images and DICOM RT datasets, case studies.

UNIT IV GUI Development & Machine Learning 9

GUI development using Python libraries (Tkinter, PyQt, etc.), Event-driven programming, User interface design principles, Overview of machine learning algorithms (supervised, unsupervised learning, Application of machine learning in medical physics.

UNIT V MATLAB 9

Introduction of MATLAB, data types and variables – operators – flow control – functions – input-output – array manipulation –Executing Matlab programs – Data Reading, Manipulation, Displaying & Plotting, DICOM File Functions in MATLAB, Medical Image Display,Processing and analysis, Machine Learning and Fuzzy logic.

TOTAL: 45 PERIODS

OUTCOMES

The students will be able to

- Gain knowledge about the basic concepts of programming using Python.
- Develop skills in writing Python code for data analysis and visualization.
- Learn techniques for image processing using Python.
- Apply programming skills and solve problems relevant to medical physics applications.
- Familiarize MATLAB programming applied to medical physics.

TEXTBOOKS

1. Shaw, Zed A. *Learn More Python 3 the Hard Way: The Next Step for New Python Programmers*. Addison-Wesley Professional, 2017.
2. Downey, Allen B. *Python for software design: how to think like a computer scientist*. Cambridge University Press, 2009.
3. Matthes, Eric. *Python crash course*. no starch press, 2023.
4. VanderPlas, Jake. *Python data science handbook: Essential tools for working with data*. " O'Reilly Media, Inc.", 2016.
5. Theobald, Oliver. *Statistics for Absolute Beginners: A Plain English Introduction*. Scatterplot Press, 2017.
6. MATLAB: An Introduction with Applications, Amos Gilat, Wiley, 2012.

Attested

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	3	3	3	3
2	2	3	3	3	3	3
3	2	3	3	3	3	3
4	2	3	3	3	3	3
5	2	3	3	3	3	3
Average	**2**	**3**	**3**	**3**	**3**	**3**

MP3206 SOLID STATE PHYSICS L T P C
3 0 0 3

OBJECTIVES:

- To make the students understand the basics of crystal structures, bonding of solids and the lattice energy calculations.
- To expose the students to the concept of thermal energy, its generation and correlation between lattice and thermal conductivity
- To provide fundamental knowledge on the application of quantum mechanics for solids and electronic band formation.
- To provide basic understanding on the different types of magnetism and their quantum-mechanical origin
- To provide an overview on the superconductivity, its salient features and applications in medical field.

UNIT I CRYSTAL PHYSICS 9

Types of lattices - Miller indices - simple crystal structures - Crystal diffraction - Bragg's law - Reciprocal lattice (SC, BCC, FCC) - Laue equations - Structure factor - Atomic form factor - Types of crystal binding - Cohesive energy of ionic crystals - Madelung constant - Inert gas crystals - Vander Waal - Landon equation - Metal crystals - Hydrogen bonded crystals

UNIT II LATTICE DYNAMICS 9

Monoatomic lattices - Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons – electron-phonon Coupling-Debye's theory of lattice heat capacity - Einstein's model and Debye's theory of lattice heat capacity – Einstein's model and Debye's model of specific heat - thermal expansion - Thermal conductivity - Umklapp processes.

UNIT III BASIC QUANTUM MECHANICS AND ELECTRONIC BANDS 9

Schrodinger Equation – Particle in 1D & 3D potential well – Quantization of Energy (Explanation) - Molecular Orbitals - Formation of bands – Free electron gas in three dimensions – Electronic heat capacity – Wiedmann-Franz law – Bloch theorem – Kronig - Penny Model – Fermi surfaces and construction – Experimental methods in Fermi surface studies – de Haas Van Alphen effect – Semiconductor – intrinsic carrier concentration – Hall effect – Mobility – Impurity conductivity.

UNIT IV MAGNETISM 9

Elementary ideas of dia, para and ferro magnetism - quantum theory of Para magnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - ferromagnetic domains - Bloch Wall - Spin waves - Quantization - Magnons - thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of Anti ferromagnetism - Neel temperature.

UNIT V SUPERCONDUCTIVITY 9

Experimental facts-occurrence - Effect of magnetic fields - Meissner effect - Entropy and heat capacity - Energy gap - Microwave and infrared properties - Type I and II superconductors - theoretical explanation - thermodynamics of super conducting transition - London equation - Coherence length - BCS Theory - single particle tunnelling - Josephson tunnelling - DC and AC Josephson effects - High temperature super conductors – Room temperature Nano Superconductors - SQUIDS. – Application in Medical imaging.

OUTCOMES

Upon completion of this course, the students will be able to:

- Appreciate different types of crystal structure, bonding, structure-property relationships
- Understand the theoretical background of solids and their electronic band formation
- Classify materials based their electronic band structure
- Obtain a fundamental understanding on the magnetic of materials
- Gain a basic knowledge on the theory of superconductivity and get an overview on its application areas.

REFERENCES:

1. M.A.Wahab. Solid State Physics: Structure and Properties of Materials. Narosa Book Distributors Pvt. Ltd., 2009.
2. Charles Kittel. Introduction to Solid State Physics. Wiley, 2021.
3. M.Ali Omar. Elementary Solid State Physics. Pearson Education, 2002.
4. N.W.Ashcroft and N.D.Mermin. Solid State Physics, India edition IE, Thomsom books, Reprint, 2014.
5. A.J Dekker. Solid State Physics. Macmillan India, 2000.
6. The Physics of Semiconductors – Marius Grundmann – Springer 3rd Edition 2016.
7. The Physics of Solids- Essentials and Beyond – Eleftherios N. Economou, Springer 2010.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	3	3	3	3
2	2	3	3	3	3	3
3	2	3	3	3	3	3
4	2	3	3	3	3	3
5	3	3	3	3	3	3
Average	**2.2**	**3**	**3**	**3**	**3**	**3**

MP3211 PROGRAMMING LABORATORY –PYTHON & MATLAB L T P C
0 0 4 2

OBJECTIVE:

- To develop skills in writing MATLAB code for data analysis and visualization
- To learn MATLAB programming for Numerical methods and curve fitting
- To acquire programming knowledge in medical image applications.

ANY FIFTEEN EXPERIMENTS

PYTHON

1. Write a Python program that takes a user's input as a string and then displays the number of characters, words, and lines in the string.
2. Create a Python program that calculates the average of a list of integers. Use the following list for testing: [2, 5, 8, 13, 21, 34, 55, 89].

3. Write a Python program that takes a number as input and prints whether the number is even or odd using an if-else statement.
4. Create a Python program that prints the first 20 numbers of the Fibonacci sequence using a while loop.
5. Define a class named Car with attributes for the make, model, and year of the car. Create a method named start engine() that prints "Engine started.
6. Write a Python program that demonstrates inheritance by creating a Vehicle class with attributes for the number of wheels and the type of fuel (e.g., petrol, diesel, electric). Define a Motorcycle class and a Truck class that inherit from the Vehicle class.
7. Using the NumPy library, create a 4x4 array of random integers between 1 and 100. Calculate the mean, median, and standard deviation of the elements in the array.
8. Use the SciPy library to solve the following linear system of equations:

   $3x + 2y - z = 1$

   $2x - 2y + 4z = -2$

   $-x + y/2 - z = 0$
9. Load a CSV file into a Pandas DataFrame and perform the following operations:
   a. Display the first 5 rows.
   b. Display the last 5 rows.
   c. Display the summary statistics (count, mean, std, min, 25%, 50%, 75%, max) for all numerical columns.
   d. Filter the DataFrame to display only rows where a specific column value meets a certain condition.
10. Create a bar chart and a pie chart using the Matplotlib library for the following data:
    Categories: A, B, C, D, E
    Values: 23, 45, 12, 67, 30
11. Plot a scatter plot using the following data:
    X: [2, 4, 6, 8, 10, 12, 14, 16, 18, 20]
    Y: [3, 7, 11, 15, 19, 23, 27, 31, 35, 39]
12. Plot the temperature profile of an object over time using the following data:
    Time (minutes): [0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60]
    Temperature (°C): [20, 22, 24, 26, 28, 30, 31, 32, 33, 34, 34.5, 35, 35.5]
13. Calculate the Pearson correlation coefficient for the following two datasets:
    X: [1, 3, 5, 7, 9, 11, 13, 15, 17, 19]
    Y: [2, 4, 6, 8, 10, 12, 14, 16, 18, 20]
14. Perform a linear regression on the following dataset and plot the regression line:
    X: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
    Y: [3, 4, 6, 9, 11, 15, 18, 20, 22, 25]
15. Use the PyDicom library to read a DICOM file and perform the following operations:
    a. Display the Patient's Name, ID, Modality, and Study Description.
    b. Save the pixel data as a PNG image.
16. Use the SimpleITK library to read a medical image in the NIfTI format and perform the following operations:
    a. Display the image dimensions, spacing, and origin.
    b. Apply a Gaussian smoothing filter with a specified standard deviation.
    c. Save the filtered image as a new NIfTI file.
17. Read an image file using the OpenCV library and perform the following operations:
    a. Convert the image to grayscale.
    b. Resize the image to half its original dimensions.
    c. Save the modified image as a new file.
18. Use OpenCV to create a program that captures a video from the webcam and saves it as an output video file. The video should be recorded for 10 seconds.
19. Apply the following filters to an image using OpenCV:
    a. Gaussian blur filter with a kernel size of 5x5.

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b. Median blur filter with a kernel size of 7.

c. Bilateral filter with a diameter of 15, a sigma value of 75 for the color space, and a sigma value of 75 for the coordinate space.

20. Use OpenCV to perform the following segmentation tasks on an image:
    a. Convert the image to grayscale and apply the Otsu's binarization method to create a binary image.
    b. Apply the watershed segmentation algorithm to segment the image into different regions.
    c. Save the segmented images as new files.
21. Write a Python program using Tkinter that demonstrates event-driven programming by performing the following tasks:
    a. Create a canvas widget that allows the user to draw lines by clicking and dragging the mouse.
    b. Create a button to clear the canvas and start over.
22. Design a Tkinter GUI application that follows user interface design principles (clarity, feedback, consistency, and flexibility) and includes the following features:
    a. A text entry widget for the user to input a task.
    b. A button to add the task to a list.
    c. A listbox to display the added tasks.
    d. A button to remove the selected task from the list.
23. Create a PyQt5 GUI application that adheres to user interface design principles (clarity, feedback, consistency, and flexibility) and includes the following features:
    a. A QLineEdit widget for the user to input a search query.
    b. A QPushButton to initiate the search.
    c. A QListWidget to display the search results.
    d. A QLabel to display the status of the search (e.g., "Searching...", "No results found.", "Displaying results 1-10 of 50.", etc.).
24. Use the Scikit-learn library to perform a supervised classification task on the Iris dataset:
    a. Split the dataset into training and testing sets (80% training, 20% testing).
    b. Train a K-Nearest Neighbors (KNN) classifier with K=3.
    c. Test the classifier on the testing set and calculate its accuracy.
    d. Visualize the confusion matrix for the classification results.
25. Perform an unsupervised clustering task using the K-Means algorithm from Scikit-learn on the following dataset:
    X: [[1, 2], [1.5, 1.8], [5, 8], [8, 8], [1, 0.6], [9, 11], [8, 2], [10, 2], [9, 3]]
    a. Determine the optimal number of clusters using the elbow method.
    b. Cluster the data points using the optimal number of clusters.
    c. Visualize the clustered data points on a scatter plot.
26. Use the Scikit-learn library to develop a logistic regression model that predicts the presence of breast cancer based on the Breast Cancer Wisconsin Diagnostic) dataset:
    a. Preprocess the dataset (normalize, handle missing values, etc.).
    b. Split the dataset into training and testing sets (80% training, 20% testing).
    c. Train the logistic regression model.
    d. Evaluate the model's performance using accuracy, precision, recall, and F1- score.
27. Use the TensorFlow and Keras libraries to create a convolutional neural network (CNN) for classifying chest X-ray images as either normal or pneumonia cases:
    a. Preprocess the dataset (resizing, normalization, data augmentation, etc.).
    b. Split the dataset into training, validation, and testing sets.
    c. Design and compile the CNN model.
    d. Train the model on the training set, and validate it on the validation set.
    e. Test the model on the testing set and report its performance using accuracy and other relevant metrics.

MATLAB:

1. To find DFT / IDFT of given DT signal
2. Study of basic matrix operations
3. Determination of Eigen values and Eigen vectors of a Square matrix.
4. Find Solution of Differential Equations using Euler & Modified Method.
5. Find Solution of differential equation using 4th order Runge- Kutta method.
6. Determination of polynomial using the method of Least Square Curve Fitting
7. To study the Image Processing concept.
8. To obtain a histogram equalization image.
9. To Implement smoothing or averaging filter in the spatial domain.
10. Program for opening and closing of the image.
11. Program of sharpen image using gradient mask

TOTAL: 60 PERIODS

OUTCOME

The students will be able to

- develop skills in writing MATLAB code for data analysis and visualization
- learn MATLAB programming for Numerical methods and curve fitting
- acquire programming knowledge in medical image applications.

TEXTBOOK:

1. Shaw, Zed A. *Learn More Python 3 the Hard Way: The Next Step for New Python Programmers*. Addison-Wesley Professional, 2017.
2. Downey, Allen B. *Python for software design: how to think like a computer scientist*. Cambridge University Press, 2009.
3. Matthes, Eric. *Python crash course*. no starch press, 2023.
4. VanderPlas, Jake. *Python data science handbook: Essential tools for working with data*. " O'Reilly Media, Inc.", 2016.
5. Theobald, Oliver. *Statistics for Absolute Beginners: A Plain English Introduction*. Scatterplot Press, 2017.
6. MATLAB: An Introduction with Applications, Amos Gilat, Wiley, 2012.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	3	3	3	3
2	2	3	3	3	3	3
3	2	3	3	3	3	3
4	2	3	3	3	3	3
5	2	3	3	3	3	3
Avg	**2**	**3**	**3**	**3**	**3**	**3**

MP3212 RADIATION DIAGNOSTICS AND THERAPEUTIC LABORATORY **L T P C**
0 0 4 2

OBJECTIVES:

- G.M counter and Gamma spectroscopy techniques for clinical application purpose.
- To give hands-on training to students on fundamental radiation detecting equipments
- To train the students to study characteristic of radioactive sources and to study its energy spectrum.

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1. Verification of inverse square law - Variation of gamma intensity as a function of distance.
2. Determination of HVT and TVT
3. Study of characteristics of GM tube and determination of operating voltage and plateau length.
4. Gamma Ray Spectrometer (GRS)- Strength of the source
5. To study the energy spectrum of Cs-137 and Co-60 using GRS.
6. Variation of energy resolution characteristics using GRS.
7. Estimation of efficiency of gamma source and beta source.
8. To study the back scattering of beta particle using GM Counter.
9. To study the production and attenuation of Bremsstrahlung using GM Counter.
10. To study the short half-life of radioisotopes using GM Counter.
11. To study Cs-137 spectrum, calculation of FWHM and resolution for a given scintillation detector using GRS.
12. To study the unknown energy of a radioactive isotopes using GRS.
13. Calibration of TL phosphor and TLD reader and its used in dose distribution measurements
14. QA (kVp, mAs and output) of a diagnostic X-ray machine
15. Radiation Protection survey of diagnostic X-ray equipments.
16. Analysis of PDD & Profile using software for IEC and Varian protocols.
17. Determination of Wedge factor and shielding tray factor.
18. Air kerma strength measurement of an HDR brachytherapy source using well type and cylindrical ionization chamber
19. Radiation protection survey of Teletherapy Installations
20. QA tests of Teletherapy Units.

OUTCOMES

Students will be able to

- carryout verification of physical principles and study strength of radioactive sources
- to measure attenuation coefficient of various materials ,use various radiation detecting equipments and able to study physical characteristics of radioactive source.
- determine energy spectrum analysis of different radioactive sources.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	3	3	3	3	3
2	3	3	3	3	2	3
3	3	2	3	3	3	3
Avg	**3**	**2.7**	**3**	**3**	**2.7**	**3**

MP3301 BRACHYTHERAPY PHYSICS **L T P C**
3 0 0 3

OBJECTIVES

To develop the knowledge on

- The Physics of Brachytherapy
- Brachytherapy Planning
- Brachytherapy dosimetry.

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UNIT I DEFINITIONS AND CLASSIFICATION 9

Definitions and classification of brachytherapy based on the dose rate, (LDR, MDR, HDR, PDR)based on techniques (Intracavity, interstitial, intraluminal and surface mould) – Applicators used in Brachytherapy - temporary and permanent implants. AAPM and IEC requirements for remote afterloading HDR Brachytherapy equipment. Acceptance, commissioning and QA of HDR brachytherapy equipments.

UNIT II RADIONUCLIDES AND THEIR PROPERTIES 9

Introduction – properties of ideal radionuclide – production and construction of sealed source – Radium (needles), Cobalt -60(HDR and LDR), Cesium -137(LDR), Gold-198(LDR seeds), Iridium-192(HDR and LDR), Iodine-125 (LDR seeds), Cesium- 131(LDR seeds)- ISOrequirements and QA of Brachytherapy sources.

UNIT III DOSIMETRY 9

Source specification – concept of exposure rate constant, reference air kerma rate airkermastrength, Primarystandard, watercalorimetry,Nk factor for Iridium 192 HDR calibration,room scatter correction–Stockholm System-. Manchester system- Paris System – Point and linesource dosimetry formalisms, Sievert integrals TG43/TG43 U1 dosimetry formalism. IAEA TECDOC 1274.

UNIT IV CLINICAL PRACTICE 9

Applicator reconstruction and treatment planning- Model based dose calculation algorithms optimization methods- intracavitary& Interstitial HDR Brachytherapy - ICRU38 and ICRU89-ICRU58 Recommendations.

UNIT V ADVANCED BRACHYTHERAPY SYSTEMS 9

Accelerated Partial breast irradiation using balloon catheter –Intraoperative Mesh Brachytherapy -Integrated Brachytherapy unit-electronic brachytherapy – IMBT-micro Brachytherapy -Image guided adaptive brachytherapy. Diffusion Alpha Emiiters Radiotherapy

TOTAL: 45 PERIODS

OUTCOMES

Students will be able to decide and use

- Different Types of Radioisotopes
- Different dose delivery techniques in Brachytherapy.
- Various Reconstruction techniques
- Advanced techniques in Brachytherapy

TEXTBOOKS

1. D Baltas, Taylor and Francis , The physics of modern brachytherapy for oncology,. 2007.
2. F.M.Khan, The Physics of Radiation Therapy, 5th Edition, Lippincott Williams and Wilkins, U.S.A., 2015.
3. Phillip.Devlin Brachytherapy: Applications and Techniques1 edition Lippincott Williams and WilkinsU.S.A. 2010.
4. D. Baltas, Taylor and Francis, The physics of modern brachytherapy for oncology, 2007.

REFERENCES:

1. Principles and Practice of Brachytherapy, CAJoslin, Flynn, EJhall, Arnold Publications, 2001
2. ESTRO handbook of brachytherapy, 2002 .
3. AAPM summer school, Brachytherapy physics, 2005.
4. Peter Hoskin, Catherine Coyle, Radiotherapy in Practice, Oxford University Press,2011
5. Brachytherapy devices and applications: Report of AAPM TG167. 2016.
6. Recommendations for intraoperative mesh brachytherapy: Report of AAPM Task Group No. 222.AAPM.2021

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Mapping of CO with PO

CO	PO					
	1	2	3	4	5	6
1	3	2	3	2	2	2
2	2	3	3	2	3	3
3	3	3	2	3	3	3
4	3	3	2	3	3	3
5	2	3	2	2	3	3
Avg	**2.6**	**2.8**	**2.4**	**2.4**	**2.8**	**2.8**

MP3302 NUCLEAR MEDICINE **L T P C**
3 0 0 3

OBJECTIVES

- Designed to impart knowledge about the production of Radioisotope
- To provide knowledge on the use of unsealed radioactive isotopes in diagnosis and radiationmedicine.
- To impart knowledge on radionuclide imaging and dosimetry
- To learn details of therapeutic radiopharmaceuticals & Corresponding imaging
- To understand the appropriate nuclear medicine therapy study that the patient will undergo.

UNIT I RADIO NUCLIDE AND RADIOPHARMACEUTICALS 9

Basic Physics of Nuclear Medicine - Atom- Nuclear structure- Nuclear nomenclature- Nuclear stability curve — Radioactivity- Natural and artificial radioactivity- Specific activity-Specific concentration-Effective half-life -Radioactive decay- Law of successive disintegration –Types of equilibrium. Historical developments of radionuclide -Production of radionuclides- Radionuclide generators- Method of preparation - Toxicity of radionuclides- Radiopharmaceuticals- Ideal characteristics- Mechanism of localization of radiopharmaceuticals- List of radionuclides and radiopharmaceuticals - Quality control of radiopharmaceuticals.

UNIT II INSTRUMENTATION IN NUCLEAR MEDICINE 9

Historical developments of equipment's-Single head- Dual head scanner/Camera- PET — Detectors- Gas filled, scintillation& semiconductor - Properties, Design ,Principle –Construction, working-Annihilation coincidence detection-Attenuation correction – Scatter correction, Resolution correction – sources of error- Acquisition, SPECT, Processing, Reconstruction technique, Attenuation correction, Filters, Algorithm, SUV calculation, Display – Grey scale – comparison between black and white & color - Applications- Limitations .

UNIT III QUALTIY CONTROL OF EQUIPMENTS IN NUCLEAR MEDICINE 9

Quality Control of Dose Calibrator/Activity meter- Calibration sources, Survey meter- contamination monitor- importance of survey and limits – hand foot cloth monitor – zone monitor – fume hood – Protective apron – Thyroid uptake probe – Gamma probe –Well counter - Gamma camera/SPECT — PET/CT.

UNIT IV CLINICAL RADIONUCLIDE IMAGING PROCEDURES AND TECHINQUES 9

Clinical radio isotopes/Radiopharmaceuticals, In vivo non-imaging and imaging procedures - In vitro technique – RIA - Thyroid uptakes ,procedures, calculation, measurement - Few imaging procedures — Bone scan, Thyroid scan, Liver scan., Pre and Post instructions, Absorbed dose, equivalent dose, effective dose, limitations, Pregnancy and breast feeding, children, Newer radiopharmaceuticals and developments - MIRD technique for dose calculations – diagnostic and therapeutic, problems related to the Dose calculations – Limitations of MIRD technique - Post therapy (planar and SPECT images) – Complex therapeutic dosimetry based on pre-therapy PET CT scan and post-therapy SPECT CT images.

UNIT V NUCLEAR MEDICINE THERAPY AND APPLICATIONS 9

Theranostics - same molecule used for diagnosis and therapy-targeted therapy, alpha, beta emitters (e.g. AC225, Bi213 and Lu177). Therapeutic application of radionuclides and radiopharmaceuticals –Targeted therapies- α and β therapy- Treatment of thyroid cancer I-131- Treatment of palliative cancer P-32, Sm-153, Lu-177- SIRT- Monoclonal antibodies- Pre and post therapy instructions –AERB discharge limits.

TOTAL: 45 PERIODS

OUTCOMES

Students will be able to,

- Prepare Dilute the radioisotope with suitable tracer
- Learn about the QA of equipments in nuclear Medicine
- Safely administer the radioisotope to the patients
- Aware of the Radiation emergency preparedness
- Therapeutic application of radionuclides and radiopharmaceuticals

REFERENCES

1. Ramesh Chandra, Nuclear Medicine Physics 5th edition, Lea & Fibiger, Philadelphia.
2. Gopal B.Saha, Fundamental of Nuclear Pharmacy 5th edition 3rd edition, spinger.
3. Patil J.Early.M.A. Razzak and D.Bruces Sodee Text book of Nuclear Medicine Technology, The C.V. Mosby Company.
4. Principles of Nuclear medicine, Second edition, Henry Wagner.
5. Textbook of Nuclear medicine, Second edition, RobertE.Henkin.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	2	3	2	3	3
2	2	3	3	2	3	3
3	3	2	3	3	3	3
4	3	2	3	3	3	3
5	3	3	2	2	2	2
Average	**2.6**	**2.4**	**2.8**	**2.4**	**2.8**	**2.8**

MP3303 RADIOTHERAPY TREATMENT PLANNING ALGORITHM L T P C
3 0 0 3

OBJECTIVES:

The Course is designed

- To enable students to become knowledgeable and Technically Proficient Medical Physicist
- To Educate the students in Basic Treatment planning concepts.
- To provide knowledge on manual dose calculation
- To familiarize the students in Treatment planning calculation
- To provide knowledge on the treatment planning algorithms

UNIT I CONCEPTS OF TREATMENT PLANNING 9

Mould Room Procedures, making of casts, compensators and shields - Simulation of patients on conventional and CT Simulator -DICOM CT –Other Imaging Modalities(FUSION)- Target volume definition and dose prescription criteria- ICRU 50 and 62 - contouring - SSD and SAD set ups - two- and three-dimensional localization techniques- Translation of Planning to Calculations - Beam Parameters - field arrangements - single, parallel opposed and multiple fields - corrections for tissue inhomogeneity, contour shapes and beam obliquity - integral dose. Arc/ rotation therapy, Conventional and conformal radiotherapy.

UNIT II CONVENTIONAL TREATMENT PLANNING AND CALCULATIONS IN PRACTICE 9

Weighted Radiation Fields- Opposing Weighted Fields-Multiple Weighted Fields- -Irregular field calculations-Weighted Fields-Correction for sloping surface –Interpolating an isodose distribution for an intermediate field Size-Two field isodose summation in SSD&SAD Planning-Treatment planning with wedge filters- - Treatment time and Monitor unit calculations

UNIT III SURFACE CORRECTIONS, HETEROGENEITIES AND CLINICAL ASPECTS 9

Corrections for Surface Obliquities, Corrections for Inhomogeneities, Linear(1-D) Attenuation Method, 2-D Methods, Volumetric Methods, Dose Perturbations at Interfaces Adjoining fields Two - Field Problem, Three-Field Problem- Plan optimization – direct aperture optimization - beamlet optimization - simulated annealing - dose volume histograms – differential DVH, Cumulative DVH-Indices used for plan comparisons - beam & source library generation-Define Conventional and different types of Conformal techniques. Steps in conventional and conformal radiation planning, Beam modification and beam shaping in radiotherapy. Radiation techniques used for treatment of various sites of malignancies.

UNIT IV ELECTRON BEAM TREATMENT PLANNING AND QA OF PLANNING SYSTEMS 9

Treatment Planning with Electron: Rules of Thumb, Selection of energy, field size, Electron Skin Dose, Electron Bolus, Electron Field Shaping. Electron-electron Gapping, Electron photon Gapping, Electron Back scatter, Inhomogeneities, Internal shielding, Particulate beam therapy– Relative merits of electron, neutron, X-ray and gamma ray beams- Quality Assurance of treatment planning systems IAEA TRS 430 protocol. AAPM TG 53 and TG 106 protocols.

UNIT V TREATMENT PLANNING ASPECTS AND ALGORITHMS 9

Treatment positioning -immobilization -Patient data acquisition from CT and MRI -Image registration and fusion- contouring –- O'cono's density scaling theorem, Batho and modified batho methods. TAR, effective TAR, Effective Path length differential TAR and delta volume method. Photon beam algorithm -Pencil Beam Algorithm, Collapsed Cone Convolution, Analytical Anisotropic Algebraic Algorithm – MonteCarlo –Comparison of algorithms – generalized pencil beam algorithms and electron Monte Carlo algorithms-dose calculation algorithms in brachytherapy.

TOTAL: 45 PERIODS

OUTCOMES

After completion of the course

- Students will able to perform the Manual treatment planning calculation
- Will able to perform computerized treatment planning
- They can demonstrate the effectiveness of optimization
- Can calculate the dose manually
- They can properly apply the algorithms required

REFERENCES

1. Khan, Faiz M. Treatment Planning in Radiation Oncology.
2. Siamak Shahabi, Blackburn's Introduction to clinical radiation physics, 1989
3. R.F.Mould,RadiotherapyTreatmentPlanning,Medical Physics Hand Book Series No.7, 1981.
4. FM Khan-Physics of RadiationTherapy.
5. Edward C. Halperin, Carlos A. Pérez, Luther W..Brady,Perez and Brady's Principles and Practice of radiation Oncology.
6. GunillaC.Bentel,CharlesE.Nelson,K.ThomasNoell,Treatment planning and dose calculation in radiation Oncology,McGraw-Hill,1989

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Mapping of CO with PO

CO	PO				
	1	**2**	**3**	**4**	**5**
1	2	3	2	2	3
2	2	3	3	2	3
3	3	3	2	3	3
4	3	3	2	3	3
5	3	2	3	2	2
Avg	**2.6**	**2.8**	**2.4**	**2.4**	**2.8**

MP3311 RADIATION DOSIMETRY AND TREATMENT PLANNING LABORATORY

L T P C
0 0 4 2

OBJECTIVES

The experiments are designed to gain practical knowledge

- About the use of manual treatment planning system and computer treatment planning for various types of cancer
- on calibration and QA test procedures for linear accelerator, telecobalt, brachytherapy, diagnostic equipments and computer TPS.
- On dosimetry and characteristic studies of radiation equipments with Radiation field analyzer.

1. To draw a Manual dose distribution for a parallel and opposing fields (SSD, SAD and Grid point method).
2. To draw a Manual dose distribution for a Ca. Esophagus using three field technique.
3. To draw a Manual dose distribution for a Wedge field technique.
4. To draw a Manual dose distribution for a Ca. Cervix using four field technique.
5. 3D CRT-Three dimensional conformal radiation therapy treatment planning
6. IMRT-Intensity Modulated Radiation Therapy treatment planning
7. VMAT-Volumetric modulated arc therapy planning
8. SBRT-Stereotactic body radiation therapy planning
9. To measure dose output measurements of Telecobalt unit
10. To study the calibration of photon beam energies using IAEA TRS 398 protocol
11. To study the calibration of electron beam energies using IAEA TRS 398 protocol.
12. To measure and analyze beam characteristics of photon beams using RFA.
13. To measure and analyze beam characteristics of electron beams using RFA.
14. Determination of Wedge factor and shielding tray factor.
15. Air kerma strength measurement of an HDR brachytherapy source using well type ionization chamber
16. Radiation protection survey of teletherapy Machines - Telecobalt, Linear accelerator and HDR Bracytherapy units
17. QA tests of Teletherapy Units (Telecobalt, high energy X-ray).
18. QA of Treatment Planning system as per IAEA TRS 430 Protocol
19. Application of TG106 using RFA set up. Measuring PDD and profiles using optical detector.
20. Manual FFF analysis and comparing with software.

OUTCOMES

Students will be able to

- carryout the plan independently treatment planning for various field techniques by both manually and using computerized treatment planning systems.
- carryout the quality assurance tests and able to calibrate of radiation generating equipment accurately.
- Will be able to do all clinical beam characteristics measurements for teletherapy, brachytherapy and diagnostic equipments.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	3	3	3	3	3
2	3	3	3	3	3	3
3	3	3	3	3	3	3
Avg	**3**	**3**	**3**	**3**	**3**	**3**

MP3401 RADIATION HAZARDS, EVALUATION AND CONTROL **L T P C**
3 0 0 3

OBJECTIVES

The topics in this paper is designed

- to minimize the health effects due to radiations exposure during radiation therapy.
- Will able to understand radiation protection standards and regulatory aspects
- will develop competence in evaluation of both external and internal radiation hazards.
- Students can effectively do layout planning and shielding calculations for radiation source and generating equipment installations.
- to motivate the medical physicists to dispose the radioactive waste as per regulatory safety guidelines.

UNIT I RADIATION PROTECTION STANDARDS & REGULATIONS 9

National legislation – Regulatory framework – Atomic Energy Act – Atomic Energy (Radiation Protection) Rules – Applicable Safety Codes, Standards, Guides and Manuals – Regulatory Control - Radiation dose to individual from Background radiation- philosophy behind radiation protection and Basic concepts of radiation protection standards - ICRP and its recommendations – the system of radiological protection – Justification of practices, Optimization of protection and individual dose limits – equivalent dose, effective dose, committed equivalent dose, committed effective dose – concepts of collective dose – Types of exposures - occupational, public and medical exposures – Normal exposures - Potential exposures - Dose limits national and international scenario for occupational workers, general public, comforters and trainees. Overview of UNSCEAR recommendations.

UNIT II EVALUATION OF EXTERNAL AND INTERNAL HAZARDS 9

Evaluation of external radiation hazards - Effects of time, distance, shielding - shielding materials- shielding calculations- different barrier thickness calculations - definition of working conditions - personnel and area monitoring rules and instruments – - radio toxicity of different radionuclide and classifications of laboratories – control of contamination – bioassay and air monitoring – chemical protection – radiation accidents – disaster monitoring -

UNIT III SITE LAYOUT PLANNING AND SHIELDING CALCULATIONS 9

Planning of medical radiation installations – Layout design and shielding of x-ray diagnostic, deep therapy, telegamma and accelerator installations, brachytherapy facilities - Nuclear

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Medicine (Gamma camera, SPECT, PET) facilities, Radioiodine therapy facilities - Particle accelerators for therapy and isotope production medical cyclotron facilities - protective equipment - Radiation safety during source transfer operations Special safety features in accelerators – General considerationsand evaluation of work load - shielding calculation parameters- workload (W), use factor (U), occupancy factor (T); primary and secondary protective barriers, design and shielding requirements.

UNIT IV RADIOACTIVE WASTE DISPOSAL ANDTRANSPORT OF RADIONUCLIDES 9

Radioactive wastes – sources of radioactive wastes - Classification of waste - Treatment techniques for solid, liquid and gaseous effluents - Permissible limits for disposal of waste - Disposal of radioactive wastes - General packing requirements - Transport documents - Labeling and marking of packages - Regulations applicable for different modes of transport - Exemptions from regulations – Shipment approval – Shipment under exclusive use – Transport under special arrangement – Consignor's and carrier's responsibilities.

UNIT V MANAGEMENT OF RADIATION EMERGENCIES 9

Radiation accidents and emergencies in the use of radiation sources in medicine - Loss of radiation sources and their tracing - Typical accident cases. Radiation injuries, their treatment and medical management - Responsibilities of Employers, Licensees, Radiological Safety Officers and Radiation Workers – National inventories of radiation sources – Import, Export procedures - Emergency preparedness - Emergency response plan - Incident reporting - Security plan -- Incident reporting - Security plan - Lessons learned from accidents in Radiotherapy - INES - The International Nuclear and Radiological Event Scale overview and reported incidents from medical installations.

TOTAL: 45 PERIODS

OUTCOMES

The following are the students learning outcome after completing the course

- students will demonstrate safe radiation protection practices.
- will able to justify all radiotherapy practices results in benefit to human beings.
- will develop competence in optimizing safe use of radiation sources.
- students will be able to ensure that occupational radiation dose limits will be kept within permissible limit.
- students will be educationally prepared and practically competent in handling radiation emergency situations in hospitals.

REFERENCES

1. Dr. K N Govindarajan, Radiation Safety in Radiation Oncology -, CRC Press, Taylor & Francis group, 2018.
2. A. Martin and S. A. Harbisor, An introduction to Radiation Protection, 1981, John Wiley & sons Inc., New York,.
3. Radiation Safety codes Atomic Energy Act 1962.
4. 10. ICRP Publications, 1990.
5. AERB/RF-MED/SC-1 (Rev. 1) Radiation therapy sources, equipment and installations 2011.
6. AERB/RF-MED/SC-2 Nuclear Medicine Facilities 2011.
7. Report No. 108 - **AAPM Task Group 108**: PET and PET/CT Shielding Requirements (2006)
8. AERB, Safety code for medical diagnostic X-ray equipment and installations AERB Code No. SC/MED-2, 1986, Publisher AERB. and AERB/NRF-TS/SC-1 (Rev.1), Safe Transport of Radioactive Materials, 2016, Publisher, AERB.

Mapping of CO with PO

CO		PO				
	1	2	3	4	5	6
1	3	3	2	2	3	3
2	3	3	3	3	3	3
3	3	3	3	3	3	3
4	3	2	2	3	2	3
5	3	2	3	3	2	2
Avg	**3**	**2.6**	**2.6**	**2.8**	**2.6**	**2.8**

MP3402 ADVANCED RADIATION THERAPY TECHNIQUES **L T P C**
3 0 0 3

OBJECTIVES

The topics in this advanced radiation therapy techniques paper is designed

- To enable the students to understand the basics of conformal therapy
- To understand the IMRT concepts
- To study special techniques in Radiotherapy
- To ensure students have an update 4D Radiotherapy knowledge.
- To make students understand knowledge on the VMAT technique

UNIT I CONFORMAL RADIOTHERAPY WITH MULTILEAFCOLLIMATOR 9

Basics of conformal therapy-ICRU Definitions-ICRU 83-Modern developments in MLC – Different categories of MLC – Leaf position detection – commercially available MLC systems –– MLC acceptance testing, commissioning and safety assessment – Tongue and groove effect–Dosimetric leaf gap measurement-MLC Quality assurance.

UNIT II INTENSITY MODULATION RADIATION THERAPY 9

Introduction to IMRT – physical optimization – Biological models for evaluation and optimization of IMRT – Target and critical structure definitions for IMRT – Static MLC IMRT- Dynamic MLC IMRT–potential problems with IMRT – Commissioning and QA for IMRT treatment planning – patient specific quality assurance– IMRT measurement based verification QA –AAPM TG 218.

UNIT III SPECIAL TECHNIQUES IN RADIATION THERAPY 9

Total Body Irradiation, Total Skin Electron Therapy-Stereotactic radiosurgery- X knife-gamma knife - dosimetry and planning procedures. QA protocols-Physical, clinical and planning aspects of stereotactic body radiotherapy-AAPM-TG101- tomotherapy and cyberknife based therapy-IAEA technical report series 483: Dosimetry of small static fields used in External Beam Radiotherapy

UNIT IV IMAGE GUIDED RADIATION THERAPY 9

Concept of 4DCT imaging -4D planning- 4DRT Delivery. Mechanics of breathing – problems of breathing motion-Methods to manage respiratory motion in radiation treatment –Gating methods–Effect of motion on the total dose distribution – x-ray imaging techniques for guidance in Radiation therapy .4DCBCT

UNIT V RECENT ADVANCES IN RADIOTHERAPY 9

VMAT Commissioning and Quality Assurance- Treatment Planning- Patient Specific Quality Assurance.-Electronic Portal Imaging device -its clinical applications including QA. Patient specific quality assurance in VMAT and gamma index analysis. Magnetic Resonance guided Radiotherapy-Surface guided Radiotherapy -Biological Guided Radiotherapy-Flash Radiotherapy.

TOTAL: 45 PERIODS

OUTCOMES

- Knowledge of clinical applications of MLC, Commissioning and QA
- will develop competence in Optimizing Treatment Planning in IMRT
- will gain Knowledge of TBI, TSET, SRS, SBRT techniques.
- Clinical and research update on 4DRT
- will develop clinical competence in VMAT planning, patient specific QA

TEXTBOOKS

1. Steve Webb, The Physics of Three–Dimensional Radiotherapy, Institute of Physics Publishing, Bristol and Philadelphia, 2002.
2. Faiz M Khan, The Physics of Radiation Therapy, 5th Edition, Lippincott Williams & Wilkins,USA, 2003.
3. Jatinder R Palta and T. Rockwell Mackie, Intensity Modulation Radiation Therapy, Medical Physics publishing, Madison, Wisconsin, 2003.
4. AAPM Report No: 91, Management of Respiratory motion in radiation oncology, 2006.
5. IAEA technical report series 483: Dosimetry of small static fields used in External Beam Radiotherapy, IAEA, 2017.

REFERENCES

1. AAPM Report No:218, IMRT measurement based verification QA,2018.
2. AAPM Report No. 72 , Basic Applications of Multileaf collimators, AAPM, USA, 2001
3. AAPM Task Group 155: Megavoltage photon beam dosimetry in small fields and non-equilibrium conditions.AAPM.2021
4. AAPM task group report 302: Surface-guided radiotherapy.AAPM.2021

Mapping of CO with PO

CO		PO				
	1	**2**	**3**	**4**	**5**	**6**
1	2	2	2	3	2	3
2	2	2	3	3	2	3
3	3	3	2	3	3	3
4	3	3	2	3	3	3
5	3	2	3	2	3	2
Avg	**2.6**	**2.4**	**2.4**	**2.8**	**2.6**	**2.8**

MP3403 PROFESSIONAL ETHICS FOR MEDICAL PHYSICISTS L T P C
1 0 0 1

Course Description:

This course explores various ethical theories, principles, and decision-making frameworks in the context of medical physics. The course will also examine the moral and legal responsibilities of medical physicists in various clinical, research, and industry settings.

Course Objectives:

Upon completion of this course, students will be able to:

1. Understand the basic principles and theories of ethics as they relate to medical physics.
2. Apply ethical decision-making frameworks to real-life scenarios in medical physics.
3. Analyze the moral and legal responsibilities of medical physicists in various settings.
4. Recognize potential ethical dilemmas and conflicts of interest in medical physics practice.
5. Develop communication skills to effectively discuss and resolve ethical issues with patients, colleagues, and other stakeholders.

Week 1: Introduction to Ethics & Medical Physics
Elements of ethical theory & principles
Importance of ethics in Medical Physics
Week 2: Ethical Decision-Making Frameworks
Theories and models of ethical decision-making
Applying ethical decision-making frameworks to medical physics scenarios
Week 3: Patient Rights and Responsibilities
Informed consent
Confidentiality and privacy
Non-maleficence and beneficence
Week 4: Workplace ethics for Medical Physics
Professional codes of ethics
Roles and Responsibilities of Medical Physicists
Ethical challenges encountered by Medical Physicists in clinical practice or workplace
Week 5: Research Ethics
Ethical Considerations in Medical Physics Research
Ethics Governance and institutional review boards
Data Management and Scientific Integrity
Week 6: Advanced Technologies and Ethics
Ethical Considerations in AI and Machine learning applications
Radiation Protection and Patient Safety
Week 7: Communicating ethical dilemmas and resolutions
Effective communication strategies
Case studies

TOTAL: 15 PERIODS

Reference Materials

1. Code of ethics for the American Association of Physicists in Medical (Revised): Report of Task Group 109
2. Standards of conduct, performance and ethics-consultation document
3. Ethics for the Working stiff
4. Code of ethics

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	3	3	3	3
2	2	3	3	3	3	3
3	2	3	3	3	3	3
4	2	3	3	3	3	3
5	2	3	3	3	3	3
Avg	2	3	3	3	3	3

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MP3001 NON-IONIZING RADIATION PHYSICS IN MEDICINE

L	T	P	C
3	0	0	3

OBJECTIVES

This paper provides a broad knowledge on the

- Interaction of Non-Ionizing Radiation
- Applications of Laser in Medicine
- Optical Properties of Tissues
- Ultrasound in tissues and their use in medicine.
- Application of radio waves and microwaves in medicine.

UNIT I REVIEW OF NON-IONISING RADIATIONPHYSICS IN MEDICINE 9

Different sources of Non Ionising radiation- their physical properties Various types of optical radiations-UV, Visible and IR Sources-First law of photochemistry- Law of reciprocity- Electrical Impedance and Biological Impedance - Principle and theory of thermography - Applications.

UNIT II OPTICAL SOURCES AND LASER TISSUE INTERACTIONS 9

Lasers: Theory and mechanism- Surgical lasers: CO_2 –Nd-YAG-ArF lasers-Measurement of fluence from optical sources – Tissue Optics: Absorption and scattering in turbid media– Theory and experimental techniques-interaction of laser radiation with tissues –Photo thermal –photo chemical – photo ablation – electromechanical effect- Bio simulation.

UNIT III MEDIPHOTONICS 9

Lasers in ophthalmology, dentistry, dermatology, oncology- Photo dynamic therapy(PDT) and laser thermos therapy and cell biology - Application of ultrafast pulsed lasers in medicine and biology- Fiber optics in medicine – Principles of optical microscopy-Fluorescence microscope - confocal microscope - Hazards of lasers and their safety measures.

UNIT IV MEDICAL ULTRASOUND 9

Production, properties and propagation of ultrasonic waves- Bioacoustics – Acoustical characteristics of human body- Ultrasonic Dosimetry - Destructive and non-destructive tests - Cavitation - Piezo electric receivers, thermoelectric probe – Lithotropy - High power ultrasound in therapy- Ultrasonic guided procedures - Biological effects of ultrasound and safety.

UNIT V RADIO FREQUENCY AND MICROWAVES 9

Introduction to RF and Microwaves- Frequency and wavelength ranges- Production and properties – Relaxation, Resonance, and Dispersion- Exposure to radiation- radiation hazards-Microwave measurement and quantity- Thermography-Heating Principle-Hyperthermia-Method of thermometry-RF/Microwave delivery systems for therapeutic applications – SAR –Safety standards – Interaction of radio waves/microwaves with biological systems – Thermal effects – non-thermal effects –Applications – Treatment of cancer cells.

TOTAL: 45 PERIOD

OUTCOMES:

Students will be able to understand

CO1: Various sources of Non Ionizing Radiations and their interaction mechanism
CO2: The type of laser to be employed for various applications
CO3: Tissue Optical Properties and apply them for the disease diagnosis and therapy.
CO4: The use of Ultrasound and its application in Medicine
CO5: The use of thermography and its application in Medicine

REFERENCES:

1. André Vander Vorst, Arye Rosen, Youji Kotsuka, “RF/Microwave Interaction with Biological Tissues”, Wiley Publications, 2006.
2. Paras N. Prasad, “Introduction to Bio photonics”, Wiley Interscience publications, 2003.
3. Markolf H. Niemz, “Laser Tissue Interactions- Fundamentals and Applications”, Springer Publications, 2007.
4. William T. Silfvast, “Laser Fundamentals”, Cambridge University Press, 2004.

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Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	3	2	3	3
2	2	3	3	2	3	3
3	2	3	3	2	3	3
4	2	3	3	2	3	3
5	2	3	3	2	3	3
Avg	**2**	**3**	**3**	**2**	**3**	**3**

MP3002 MATERIALS FOR RADIATION DOSIMETERS L T P C
3 0 0 3

OBJECTIVES:

- To provide fundamental concepts of electronic band structure and semiconductor-based dosimeters
- To make students aware of the role of impurities on the properties of materials.
- To provide an insight on the different types of materials used in dosimeters
- To make students understand different synthetic techniques and their influence on the dosimeter properties.
- To give an overview on the various dosimeters used in medical field.

UNIT I ENERGY BAND IN SOLIDS 9

Electrons in periodic potential, Origin of energy bands in solids, classification of solids as metals , insulators and semiconductors on the basis of the band picture, Origin of the energy gap (qualitative discussions). Bloch's theorem in one dimension, nearly free electron approximation - formation of energy bands and gaps - Brillouin zone. Charge carriers in Semiconductors: electrons and holes - Concept of effective mass of electrons and holes. Density of states for electrons in band. Mobility of charge carriers.

UNIT II FUNDAMENTALS OF DOSIMETRY: DEFECTS IN SOLIDS 9

Defects in Crystals: Point defects, line defects and planar (stacking) faults. The observation of imperfections in crystals. Introduction to Doping - Colour centres, F-centre and aggregate centres in Semiconductors. Types of Impurities – Substitutional impurities, Donors and acceptors, Isoelectronic impurities, vacancies, Defect complexes – Interstitial defect and anti-site defects. Mobility and conductivity – Characterizing defects: Hall-effect measurement.

UNIT III TYPES OF DOSIMETERS 9

Thermoluminescence Dosimeters – Optically Stimulated Luminescence (OSL) Dosimeters – Principles and materials used – Role of dopants on luminescence - Absorption and Emission Wavelengths – OSL measuring technology - Compound semiconductor dosimeters – GaAs detectors – HgI2 detectors - CdTe dosimeters - Role of impurities: Zn-doped CdTe detectors – Other novel dosimeter and detector materials : Hybrid Perovskites, Neutron detectors.

UNIT IV MATERIAL SYNTHESIS TECHNIQUES 9

Powder synthesis method; hydrothermal synthesis of ceramic oxide powders, chemical methods. – Classification of crystal growth methods Nucleation –Melt Growth techniques - Bridgman method – Czochralski pulling method –- Growth by restricted evaporation of solvent, slow cooling of solution and temperature gradient methods – Vapour phase crystallization in a closed system – Gas flow crystallization. Thin Film synthesis techniques: CVD, PLD.

UNIT V MEDICAL APPLICATIONS OF DOSIMETERS IN MEDICINE AND OTHER AREAS 9

Radiation dosimeters – pMOS and direct ion storage (DIS) dosimeters - In-vivo dosimetery – Materials and methods – Thermoluminescent (TL) materials: CaSO4:Dy, and LiF:Mg, Cu, P, - Characteristics of TL - Spintronic Neutron detectors for enhanced signal-to-noise ratio – Effect of different synthetic techniques on radiation detection. Measurement techniques of doses – Radiopharmaceuticals and semiconductors used in nuclear medicine. Radiation detectors used in national security – Detectors in industrial safety – Background radiation detectors.

TOTAL: 45 PERIOD

OUTCOMES

CO1: The student will obtain fundamental knowledge on the working principle of dosimeters.
CO2: Will be able to distinguish different types of dosimeters and their applications.
CO3: Will get an overview on different synthesis techniques and their influence on the properties of dosimeters.
CO4: Will be able appreciate the structure-property relationships of dosimeter materials
CO5: Will know various materials used in medical applications.

REFERENCES:

1. Frank Herbert Attix, *Introduction to Radiological Physics and Radiation Dosimetry,* Wiley 2007.
2. Elementary Solid State Physics,M.Ali Omar – Pearson Education
3. Charles Kittel.,“ Introduction to Solid State Physics”, John Wiley, 8th edition, 2013.
4. Ashcroft/ Mermin, Solid State Physics, India edition IE, Thomsom books, Reprint, 2014
5. Advanced Materials and Techniques for Radiation Dosimetry, Khalil Arshak and Olga Korostynska, Artech House Publishers, 2017
6. **S.W.S. McKeever**, “Thermoluminescence Dosimetry Materials: Properties and Uses”, Ramtrans Publishing (December 1995)

Additional Books:

1. H.P.Myers, Introductory Solid State Physics, 2nd edition, Viva Books Pvt. Ltd (1998)
2. S. O. Pillai,“ Solid State Physics”, New age International Pvt Ltd, 6th edition, 2005.

Mapping of CO with PO

CO	PO					
	1	2	3	4	5	6
1	2	3	2	2	3	3
2	2	3	2	2	3	3
3	2	3	2	2	3	3
4	2	3	2	2	3	3
5	2	3	2	2	3	3
Avg	**2**	**3**	**2**	**2**	**3**	**3**

MP3003 ARTIFICIAL INTELLIGENCE IN MEDICAL PHYSICS L T P C 3 0 0 3

OBJECTIVES

- To enable students to learn the application of AI in health care.
- To study the fundamental concepts Machine Learning
- To aware about deep learning and its basics.
- To learn different types of neural networks.
- To teach the application of reinforcement deep learning in health care

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PREREQUISITE
Knowledge of Python script

UNIT I MEDICAL IMAGE PROCESSING VISUALIZATION AND AI IN HEALTH CARE 9

Dicom Image visualization & reconstruction methods - CT, MRI, PET-CT, SPECT, Ultrasound - Public Data Sources - Open source tools for Medical Physics Applications - Machine Learning & Deep Learning - Metrics for Machine learning & Deep Learning - AAPM TG 273 - Best Practices for AI and Machine Learning.

UNIT II BASICS OF MACHINE LEARNING AND EVALUATION 9

Machine Learning in Medicine - Machine Learning for Medical Physicists - Machine learning on the cloud - Machine learning & Big Data - Supervised, Unsupervised & Reinforcement learning - Data & Variables - Data preparation & cleaning - Radiomics workflow - Feature Extraction & Selection - Wrapper methods, Filter Methods & Embedded Methods - Machine learning models - Classification, Regression, Clustering, Decision Making - Linear Regression, Logistic Regression, Naïve Bayes, Decision Trees, Random Forest, Support Vector Machines, k-Means clustering, Q&R learning.

UNIT III INTRODUCTION TO DEEP LEARNING AND ITS BASICS 9

Introduction to neural networks - Deep learning in Medicine - Deep learning for Medical Physicists - Feed-forward and Backpropagation in simple neural networks - Optimization Algorithms - Activation Functions - Loss Function - Hyperparameters - Data Augmentation.

UNIT IV CONVOLUTIONAL NEURAL AND GENERATIVE ADVERSARIAL NETWORKS 9

Convolution and pooling operations - Convolution Neural Networks for image classification - Transfer learning - U-Net Architecture - Generative Adversarial Networks Architectures - CGAN

UNIT V REINFORECEMENT LEARNING BIG DATA IN HEALTH CARE 9

Q-Learning & Deep Q-networks - Source of Big Data - Big Data tools - Big Data Analytics - Regulatory & ethical frameworks - Ethics Governance - Data Privacy & Security frameworks - Cybersecurity Challenges

TOTAL: 45 PERIODS

OUTCOMES

The following are the student's learning outcome after completing the course

CO1: Knowledge in concepts of Machine Learning and Artificial Intelligence
CO2: Quantitative and qualitative data analysis
CO3: Understanding the role of AI and ML in Radiation Oncology
CO4: Processing of image using Convolution Neural networks. Gain knowledge in Radiomics to extract predictive informatics
CO5: Aware of Ethics, Quality Assurance of AI tools.

REFERENCES

1. Handbook of Medical Image Processing and Analysis by Isaac Bankman
2. AAPM task group report 273, AAPM
3. Machine Learning and Artificial Intelligence in Radiation Oncology - A Guide for Clinicians by Barry Rosenstein, Tim Rattay, John Kang
4. Pattern Recognition and Machine Learning by Christopher Bishop
5. Radiomics and Radiogenomics - Technical Basis and Clinical Applications by Ruijiang Li, Lei Xing, Sandy Napel, Daniel L. Rubin
6. Neural Networks and Deep Learning by Charu C. Aggarwal
7. Deep learning by Ian Goodfellow and Yoshua Bengio and Aaron Courville
8. Reinforcement Learning: An Introduction by Richard S. Sutton and Andrew G. Barto
9. Dive Into Data Science: Use Python To Tackle Your Toughest Business Challenges by Bradford Tuckfield.

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Mapping of CO with PO

CO	PO					
	1	2	3	4	5	6
1	3	3	3	3	3	3
2	2	2	2	2	2	2
3	2	2	2	2	2	2
4	2	2	2	2	2	2
5	3	3	3	3	3	3
Avg	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**

MP3004 PRECISION CONFORMAL RADIOTHERAPY **L T P C**
3 0 0 3

OBJECTIVES

- To teach students in detail about the knowledge of conformal radiotherapy aspects.
- To impart knowledge on three dimensional radiation therapy
- To learn about treatment planning, treatment optimization, conformal therapy with multileaf collimators,
- to learn treatment machine features for conformal radiation therapy.
- designed to teach the treatment plan for CRT of malignant tumor.

UNIT I 3D RADIATION THERAPY TREATMENT PLANNING 9

Conformal radiotherapy treatment planning-Registration of two image datasets for 3D treatment planning –Summary and the NCI study of 3D therapy planning — Stages of Treatment Planning Dosimetry-Beam data Acquisition, Dosimetry with special detectors, data analysis and Input into 3D planning system – Dose verification with Phantom measurements.

UNIT II TREATMENT OPTIMIZATION 9

General Considerations –The case of circularly- symmetric dose distribution –Primitive blocked rotation therapy. Methods for 2D and 3D optimization – Evaluation of Plans-Dose Volume Histograms.

UNIT III CONFORMAL THERAPY WITH MULTI LEAF COLLIMATORS 9

MLC - different categories - commercial MLC systems - MLC acceptance testing - commissioning and safety assessment - quality assurance of MLCs - Brahme's theory of orientation — Optimization of Beam Profiles, Dynamic Wedge of Linac Wedges with MLC. Linac with Independent Collimators — Instrumentation — Radiation Detectors-ion chamber, Diode, Film, TLD - Electronic Portal Imaging Devices.

UNIT IV TREATMENT MACHINE FEATURES FOR CONFORMAL THERAPY 9

Machine for conformal therapy with different radioactive isotopes –Tracking Units- tracking LINAC with MLC and CT combination –Universal Wedge-Dynamic Wedge- Wedges with MLC's- Linear Accelerators with asymmetric collimators –Two Dimensional tissue Compensators.

UNIT V IMAGING FOR CONFORMAL RADIOTHERAPY PLANNING 9

Principles of imaging by computed tomography – Signal/Noise ratio considerations - Physical factors affecting Image Quality – Parallel Beam and Fan beam systems – Magnetic Resonance Imaging- NMR theory – Relaxation times. Image reconstruction techniques – Ultrasound Imaging – Single photon emission Computed tomography (SPECT) – PET CT – CT Simulator.

TOTAL: 45 PERIODS

OUTCOMES

On completion of this course

CO1: students will be able to Prepare 3D and Intensity modulated radiation therapy plans.
CO2: will be able to learn about MLC in conformal radiation therapy
CO3: able to plan clear imaging for CRT.
CO4: Quantify the 3D planning for various sites
CO5: Will be able to effectively deliver sharp radiation beams to tumors.

REFERENCES

1. Ashton Acton. Q, “Advances in conformal radiotherapy research and application”, 2013, Scholarly edition,.
2. Podogorsak. E B, “Radiation Physics for Medical Physicist”, 2006, Springer – Verlag Berlin Heidelber.
3. Steve Webb, “Physics of 3D Radiation Therapy”, 2002, Institute of Physics Publishing,.
4. Thomas F. DeLaney, Hanne M. Kooy, “Proton and charged particle radiotherapy”, 2008, Lippincott Williams & Wilkins,.
5. Gunnila G. Bentel, “Radiation Therapy Planning”, Macmillan Publishing Company, 1992.
6. Khan F.M, The Physics of Radiation Therapy , 2014,., Lippincott Williams and Wilkins,.
7. Jatinder R Palta and T. Rockwell Mackie, 2003, “Intensity Modulation Radiation Therapy”, Medical Physics publishing.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	3	3	3	3	3
2	3	3	3	3	3	2
3	2	3	3	3	3	3
4	2	2	2	3	2	3
5	3	2	3	2	3	2
Avg	**2.6**	**2.6**	**2.8**	**2.8**	**2.8**	**2.6**

MP3005 MATERIALS FOR RADIOLOGICAL APPLICATIONS **L T P C**
3 0 0 3

OBJECTIVE

To provide knowledge on

- various classes of biomaterials and their importance in radiological applications.
- the essential characterisation properties of materials for medical applications.
- the different methods of 3D printing technology and its medical needs.
- the design and materials used for radiation oncology
- the design and materials used for radio opaque brachytherapy applicators.

UNIT I CLASSES OF MATERIALS USED IN MEDICINE 9

Biomaterials Definition – Structural Hierarchy in Materials and Biology – Classes of materials used in medicine – Metals, Ceramics, Synthetic polymers, Composites – Hydrogels, Bioresorbable and Biodegradable materials – Natural materials – Structure and properties relationships of biological materials – Self-assembling peptides – Polymers for drug delivery – Nanomaterials for therapy and diagnostic applications.

UNIT II CHARACTERIZATION OF MATERIALS AND THEIR BIOLOGICAL PERFORMANCE 9

Properties of biomaterials – Physical, Thermal, Electrical and Optical, Surface properties – adhesion of bio-materials Biocompatibility – -Bio functionality, Hemocompatibility – Blood coagulation and Blood-materials Interactions, Tumorigenesis – Degradation of Materials in Biological Environment

UNIT III 3D PRINTING OF MATERIALS 9

Additive manufacturing- Lithography- Microfluids- Design considerations for 3D printed medical devices and anatomical models – 3D printing materials for patient-specific implants and prosthetics – Properties of 3D printing materials – Biocompatibility of 3D printing materials in medical applications – Applications of 3D printing in medicine – 4D printing

UNIT IV MATERIALS IN RADIATION ONCOLOGY 9

Materials used in radiation shielding and patient immobilization – Radiation Shielding – Lead, Concrete, Steel & other materials used for radiation shielding – Patient Immobilisation – Thermoplastics – Vacuum bags – Headrests and neck supports – Treatment Planning Devices Custom blocks – Cerrobend, Lead – Multileaf collimators, Jaws

UNIT V MATERIALS USED IN BRACHYTHERAPY SOURCES 9

Radioactive sources – Applicators – Shielding materials – Imaging Devices – CT/MRI-compatible materials – Contrast agents – Markers – Materials used for Dosimetry Devices – Ionisation chambers, Films, Diodes, MOSFETs, TLDs, OSLDs, Scintillators – Materials for Cardiac implantable electrical devices (CIEDs) – Type of CEIDs – MR-Safe, MR-Conditional & MR-Unsafe devices

TOTAL: 45 PERIODS

OUTCOMES:

From this syllabus the students,

CO1: can learn about the different classification in materials and its properties used of medical applications.
CO2: can understand the principal and working of the characterization tools used to study the biomaterials
CO3: Know about the fabrication techniques used for developing nanostructured materials.
CO4: Will learn about the importance of the choice of materials for radiation oncology
CO5: Will learn about different types of materials used for brachytherapy applications

TEXTBOOK:

1. Buddy Ratner, Biomaterials Science: An Introduction to Materials in Medicine, Academic Press, 3rd edition, 2012.
2. T.S. Sampath Kumar, Characterization of Biomaterials, Elsevier Science, 2013
3. Aleksandr Ovsianikov, James Yoo, Vladimir Mironov, 3D Printing and Biofabrication. Austria: Springer International Publishing, 2018.
4. Faiz M. Khan, John P. Gibbons, Khan's the Physics of Radiation Therapy, Lippincott Williams & Wilkins Publishing, 2014.
5. Muhammad Maqbool, An Introduction to Medical Physics. Germany, Springer International Publishing, 2017.

REFERENCES:

1. Sujata V. Bhat, Biomaterials, Naraosa Publishing House, 2002
2. Marc J. Madou., Manufacturing Techniques for Microfabrication and Nanotechnology, CRC Press, Taylor & Francis Group, USA, 2011.
3. Niemeyor, christober M. Mirkin, Nanobiotechnology: concepts, applications and perspectives, Kluwer publications , USA, 2004.
4. Andrew Godley, PhD, Ping Xia, Physics in Radiation Oncology Self-Assessment Guide. United States, Springer Publishing Company, 2015.

Attested

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	3	3	3	3	3
2	2	3	3	3	3	3
3	3	3	3	3	3	3
4	3	3	3	3	3	3
5	3	3	3	3	3	3
Avg	**2.8**	**3**	**3**	**3**	**3**	**3**

MP3006 PHYSICS OF DIAGNOSTIC RADIOLOGY **L T P C**
3 0 0 3

OBJECTIVES

- Topics in this paper is designed to
- Teach the detailed information about the physical aspects diagnostic X-ray units.
- Familiarize about the various accessories and QA aspects used to produce high quality radiographic image.
- To impart knowledge on fluoroscopic and soft tissue imaging systems.
- To teach basic diagnostic aspects of computed tomography and MRI device.

UNIT I DIAGNOSTIC RADIOLOGY 9

Diagnostic X-ray machine: X-ray tube: Construction, Working Principle , Stationary anode, Rotating anode, Grid controlled and Metal-Ceramic X-ray tubes, Line – Focus principle, Heel effect, Processes of x-ray generation: General and Characteristic, X-ray spectrum, X-ray tube rating. X-ray generators: Single phase generators: Self, Half-wave and Full-wave rectification, Three phase generators: 6 pulse – 6 rectifier, 6 pulse – 12 rectifier, 12 pulse – 12 rectifier circuits, High Frequency Generators

UNIT II RADIOLOGY ACCESSORIES AND DETECTORS 9

Accessories: X-ray beam restrictors: Cones, Cylinders & Collimators, X-ray beam Filters: Inherent, added and k-edge filters. Grids: Types, grid-ratio, grid cut-off and moving grids, Air-gap technique.

Detectors : X-ray films and Intensifying screens: Construction, properties and types, Screen-film radiography, Latent image formation and processing of films, Automatic Film Processor, Laser camera: Wet and Dry, Characteristic curve of x-ray films, Computed Radiography, Digital Radiography: Acquisition, Process and Display of digital images, Picture Archiving and Communication System (PACS). **Care, Maintenance and Testing**: Functional checks and Quality Assurance tests of x-ray machine, Assessment of results, Acceptable limits, Corrective actions and Preventive measures.

UNIT III SPECIALIZED IMAGING SYSTEMS 9

Fluoroscopy : Principle of Fluoroscopy, Construction and Working Principle of Image Intensifier tube. Image characteristics, Image display and recording devices, Radiographic/Fluoroscopic table, Remote controlled table - vascular and interventional radiology- mobile fluoroscopes - Automatic brightness control - image quality - contrast - spatial resolution - noise - dosimetric consideration in fluoroscopy - radiation safety consideration. **Mammography -** Introduction and radiological requirements for mammography - x-ray equipment - tubes, filters and spectra , compression, grids, AEC - image receptors - display of mammograms - scattered radiation and magnification – **Digital Breast Tomosynthesis**

Attested

UNIT IV BASICS OF COMPUTED TOMOGRAPHY (CT) 9

Basic principle and Physics of Computed Tomography , CT Instrumentation , Generations of CT scanner, Helical CT: Slip-ring technology, **MDCT, CBCT** : Principle & Instrumentation, Image reconstruction - Hounsfield Unit, Windowing-- post processing technique -CT image quality: Noise, Spatial resolution & contrast resolution, Factors influencing CT Image Quality, Common and Specific CT artifacts: Causes, Manifestation and Rectification - CT Dose & QA: CT Dose Descriptors: CTDI, DLP & Effective Dose, CT Dose issues, CT dose reduction options, Care, Maintenance and Quality Assurance tests of CT scanner.

UNIT V BASICS OF MAGNETIC RESONANCE IMAGING (MRI) 9

Basic Principles: Spin – precession – resonance – MR Signal – Free Induction Decay- relaxation time –Contrast Mechanism - T1 weighted image – T2 weighted image – proton density image. MR Instrumentation: Types of magnets – RF transmitter – RF receiver – Gradient coils – shim coils – RF shielding – Fringe field shielding – Basic Pulse Sequences - Magnetic & RF Safety.

TOTAL: 45 PERIODS

OUTCOMES

On completion of this course students will be:

CO1: able to demonstrate the application of diagnostic equipments in imaging purpose.
CO2: able to obtain high quality radiographic images.
CO3: able to use various devices to visualize the patients anatomy during special procedures
CO4: Specialized in taking good radiographic pictures with less radiation to persons involved
CO5: able to understand the basic aspects of new imaging modalities.

TEXTBOOKS

1. Christensen's Physics of Diagnostic Radiology - 1990– 4 th edition, Thomas S. Curry, Lippincott Williams & Wilkins,.
2. The Essential physics of medical imaging- 2002 – Jerrold T. Bushberg, 2nd edition, Lippincott Williams & Wilkins.
3. Euclid Seeram Computed Tomography -2009 – Physical principles, Clinical applications and Quality Control, 3rd edition, Saunders Elsevier.
4. MRI in Practice by Catherine Westbrook Walter Huda, Review of Radiology Physics, 2010, 3rd Edition, Lippincott Williams & Wilkins.

Mapping of CO with PO

CO	PO					
	1	2	3	4	5	6
1	2	2	2	2	3	3
2	3	3	3	3	3	3
3	2	3	3	3	3	2
4	3	2	3	2	3	3
5	3	2	3	2	2	2
Avg	**2.6**	**2.4**	**2.8**	**2.4**	**2.8**	**2.6**

MP3007 BIOPHOTONICS L T P C
3 0 0 3

OBJECTIVES

- To impart knowledge about various Lasers and their interaction Mechanism with tissues
- To gain knowledge about optical properties of turbid media
- To explain light transportation in biological system
- Designed to provide the knowledge for use of different laser spectroscopic methods in bioanalysis

Attested

UNIT I TISSUE OPTICS 9

Light and matter interaction-Absorption-Scattering—absorption length- Mean Free optical path length-Turbid Media- Optical albedo- Optical depth- Photon Transport theory- First orderscattering- Kubelka-Munk theory- Diffusion Approximation- Monte Carlo Simulations- Inverse Adding Doubling Method- Tissue optical properties- Integrating sphere Method

UNIT II LASER – TISSUE INTERACTION & MEDICAL LASER 9

Laser tissue interaction - photophysical process - photobiological process - absorption by biological systems - different types of interactions - thermal - photochemical (one photon and multiphoton) - electro mechanical photo ablative process. Laser systems for biophotonics- CO_2Laser- Nd-YAG Laser - Ar Ion Laser - Excimer laser- Diode lasers- Ti :Sapphire Laser- Beam Characteristics and Radiometry – 12

UNIT III THERAPEUTIC APPLICATIONS 9

Evaporation and excision techniques - sterilization - hemostasis - - cancer surgery - liver surgery - stomach surgery - gynecological surgery - urological surgery - cardiac surgery- lasers in Ophthalmology – Dermatology and Dentistry – cosmeticsurgery – Laser – Tissue Welding and Regeneration- Femto laser surgery- Photodyanmic therapy- LLLT

UNIT IV SPECTROSCOPY & IMAGING 9

Electronic Abosortion – Emission spectropscopy _ Diffuse Reflection – Vibrational Spectroscopy - Fluorophores: Endogeneous – Exogeneous Near IR – IR Fluorophores- Nanoflorophores- Fluorescence Microscopy – Multiphoton Confocal Microscope – Cellular & Tissue Imaging – FRET- FLIM- Fundamentals of OCT

UNIT V NANOPHOTONICS & LASER SAFETY 9

Nano Materials- Quantum Dots – Nano Rods - Up converting nanomaterials - Nano Imaging and PDT- Laser hazards – Eye Hazards – Skin Hazards – Other Associated Hazards – Safety Measures & Standards.

TOTAL: 45 PERIODS

OUTCOMES

CO1: The student can able to design different laser spectrometers

CO2: With the knowledge of Laser –Tissue interactions they can choose laser of right wavelength with optimum power for various therapeutic applications

CO3: Learn about the use of various devices for spectroscopic analysis and imaging of cells and tissues

CO4: Apply suitable lasers for various clinical Applications

CO5: Can handle lasers with care and precautions

TEXTBOOKS

1. Markolf H Niemz, Laser-Tissue Interactions Fundamentals and Applications, Springer-Verlag Berlin Heidelberg New York,1996.
2. Paras N Prasad, Introduction to Biophotonics , Wiley Interscience, 2003
3. A.J.Welch, M. Van Germet, Optical Thermal Responseof Laser-Irradiated Tissue, Plenum press, NY,1995.

REFERENCES

1. Joseph RLakowitz, Principles ofFluorescencespectroscopy, Plenum press, NY,2002.
2. William W .Parson, Modern Optical Spectroscopy: W ithExercises and Examples from Biophysics and Biochemistry, Springer,2009.
3. Nikolai V. Tkachenko, Optical Spectroscopy: Methods and Instrumentations, Elsevier,2006.

Attested

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Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	2	2	3	3
2	2	3	2	2	3	3
3	2	3	2	2	3	3
4	2	3	2	2	3	3
5	2	3	2	2	3	3
Avg	**2**	**3**	**2**	**2**	**3**	**3**

MP3008 BIOSENSORS L T P C
3 0 0 3

OBJECTIVES

The objective of this course is to

- Link engineering principles to understand biosystems in biosensor and bioelectronics.
- To provide fundamental knowledge on type and function of biosensors.
- To educate the students on various types of fabrication techniques.
- To provide knowledge on various biomolecules and their response to external stimuli.

UNIT I INTRODUCTION 9

Introduction to biosensors – Biosensor classification – Main elements in biosensors – Biomolecules in biosensors: DNA, enzyme, antibody, antigen, protein, peptide, aptamer – Amplification Techniques (PCR) – ELISA (enzyme-linked immunosorbent assay) – Biocatalysis based biosensors – Bioaffinity based biosensors & Microorganisms based biosensors, Biologically active material and analyte – Cell-based biosensors – Biochips and biosensor arrays – Types of membranes used in biosensor constructions.

UNIT II TRANSDUCERS IN BIOSENSORS 9

Transducers and its types – Electrochemical transducers (amperometric- potentiometric, conductimetric) – redox processes, electron transfer, processes at electrode surface, and mass transport of material to the electrode surface – Semiconductor transducers(ISFET, ENFET) – Optical transducers (absorption, fluorescence bio/ chemiluminescence, SPR)-Thermal transducers – Piezoelectric and acoustic-wave transducers – Limitations & problems to be addressed – An Overview of Performance and Applications.

UNIT III BIOSENSOR FABRICATION 9

Methods for biosensors fabrication – self-assembled monolayers – screen printing - photolithography– soft lithography– micro contact printing – Deposition and selective etching – thin film growth and deposition - MEMS – Engineering concept

UNIT IV DETECTION IN BIOSENSORS/ BIORECOGNITION SYSTEM 9

Enzymes- Oligonucleotides and Nucleic Acids – Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes) – Membrane receptors and transporters; Microbial metabolism – Tissueand organelles (animal and plant tissue) – Cell culture; Immunoreceptors – Chemoreceptors – Limitations.

UNIT V BIOSENSORS FOR MEDICAL APPLICATIONS 9

Bio recognition elements and transduction technology – Point-of-care sensing: microfluidics and paper-based diagnostics – Biosensors for diabetes applications – Glucose as diabetes biomarker - Biosensors for glucose measuring - Biomarker & Biosensors for cardiovascular diseases applications - Biomarker & Biosensors for cancer applications.

TOTAL: 45 PERIODS

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OUTCOMES

Upon successful completion of this course, students will be able to

CO1: Understand the different components of Biosensor.

CO2: Explain biosensing and transducing techniques.

CO3: Understand the different types of biosensors and methods of fabrication.

CO4: Appreciate the uses of biosensors in medical imaging and diagnostics.

CO5: Able to design and construct novel biosensor instrumentation.

TEXTBOOKS

1. Brian R Eggins - Biosensors an Introduction, First edition, John Wiley & Sons Publishers, 1996.
2. Tatsuo Togawa,Toshiyo Tamura, P. Ake Oberg, Biomedical Transducers and Instruments, CRC Press, New York, 1997.
3. Jacob Kline, Handbook of Bio Medical Engineering, Academic press Inc., Sandiego, Oxford University Press, 2004.
4. Smart Biosensor Technology, G. K. Knoff, A. S. Bassi, CRC Press, 2006.

REFERENCES

1. Biosensors and Modern Biospecific Analytical Techniques, Edited by L. Gorton 1st Edition, 2005
2. Jiri Janata, Principles of Chemical Sensors, Plenum Press, 1989
3. Frontiers in Biosensors, Edited by: F. Schellr, F. Schubert, J. Fedrowitz, Birkhauser Verlag,1995.
4. Optical Biosensors. Present & Future. Editors: F. Ligler, C. Rowe Taitt, Elsevier,2002.
5. Biosensors for Health, Environment and Biosecurity, Edited by Prof. Pier Andrea Serra, Intech 2011.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	2	2	3	3
2	2	3	2	2	3	3
3	2	3	2	2	3	3
4	2	3	2	2	3	3
5	2	3	2	2	3	3
Avg	**2**	**3**	**2**	**2**	**3**	**3**

MP3009 INDUSTRIAL RADIOGRAPHY L T P C

3 0 0 3

OBJECTIVES

The topics in this paper are framed

- to enable the students to gain knowledge on various radioactive sources used in NDT methods
- to understand the how image formation is taking place during industrial radiography procedure.
- to develop practical experience in radiographic exposure techniques.
- to make students learn various methods of NDT and its applications in various fields.
- to understand basic knowledge on neutron radiography.

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UNIT I RADIATION SOURCES 9

X-Ray source - Coolidge tube- equipment controls - kV and mA and their influence - attenuation of radiation - photoelectric effect - Rayleigh scattering - Compton effect - pair production - focal spot, optical focus - radiography equivalence - gamma ray sources - characteristics - curie, roentgen, Gray, rhm, Sievert - natural and artificial sources - advantages and disadvantages of artificial sources.

UNIT II IMAGE FORMATION 9

Recording mediums - structure of a film - theory of image formation - characteristics of films - characteristic curves - film processing - effect of temperature, concentration of developer, developing time etc., on film development , contrast and density - types of film - selection of a film for a specific application

UNIT III EXPOSURE AND EXPOSURE TIME ESTIMATION 9

Density of a radiograph - X-ray exposure charts - preparation of charts - its applications - gamma ray exposure charts and their preparation - contrast and definition - factors affecting contrast and definition - screens for radiographs, types, applications of screens - care of screens - percentage sensitivity and its meaning - image quality indicators - different types - sensitivity and equivalent sensitivity calculations.

UNIT IV TESTING METHODS FOR DIFFERENT APPLICATIONS 9

Inspection of flat plates, curved plates, complex shapes - inspection of welds - arc welds -fillet (single, double) - corner, lap joints - resistance welds - tubular sections - DWDI, DWSI, SWSI techniques - motion radiography - types of flaws and their appearance in castings and welds

UNIT V NEUTRON RADIOGRAPHY 9

Sources of neutron - nuclear reactors, radioactive sources and accelerators - characteristics of sources and their capabilities - flux density, energy range and applications - classification of neutrons - thermal, slow and fast neutrons - neutron radiography methods - direct exposure, transfer methods and real time methods - applications - difference between neutron radiography and X-ray radiography and gamma radiography.

TOTAL: 45 PERIODS

OUTCOMES

Upon completing the course on industrial radiography course, students

CO1: will be able to effectively use different radiations from various sources with appropriate quantities and units.
CO2: will have competence in making proper adjustments as needed to obtain radiography, with correct parameters.
CO3: will be well versed in obtaining high quality image with optimal radiation exposures.
CO4: Students will demonstrate radiographic positioning knowledge to obtain diagnostic images.
CO5: will demonstrate knowledge of the principles of radiation safety and protection of self and others.

TEXTBOOKS

1. McGonnagle," Non destructive testing", McGraw Hill, New York, 1984
2. B. Hull and V.John, "Non destructive testing" McMillan Education LTD., London, 1988.

REFERENCES

1. R. Halmshaw, Industrial Radiology: Theory and Practice, Springer, 1995.
2. S V Rainey, H. W. Hogben, The Elements of Industrial Radiography, Association of Engineering and Shipbuilding Draughtsmen, 1956.
3. Ancel St. John, Herbert Rudolf Isenburger, Industrial Radiography, Wiley, 1934.

MP3010 MONTE CARLO TECHNIQUES IN DOSIMETRY L T P C
3 0 0 3

OBJECTIVES

- To understand the fundamentals of modeling ionizing and non-ionizing radiation transport.
- To appreciate the role of Monte Carlo in terms of making measurement dosimetry more accurate.
- To provide knowledge for the evaluation of dosimetry using statistical approach.
- To expose the students to different computer codes used for dosimetry.
- To provide knowledge on the transport of radiation in Tissue

UNIT I ELEMENTS OF MONTE CARLO TECNHIQUE 9

Generation of random numbers - uniformity - auto correlation coefficient - time of generation - period. Solving simple integrals using Monte Carlo techniques - different Monte Carlo techniques - sampling from distribution - cosine - exponential - Gaussian distribution. Monte Carlo means, variances and standard deviation - precision and accuracy - the central limit theorem - variance of the variance - variance reduction techniques - particle weight - exponential biasing-forced collision - weight window - Russian roulette. Geometry description - Boolean operators-intersections - unions – complement.

UNIT II MONTE CARLO TECHNIQUES FOR PHOTONAND NEUTRON TRANSPORT 9

Simulating the physical processes - difference between charged and uncharged particle transport - Neutron transport in tissue 1-D problem - Photon transport - Cross section for Photon/Neutron transport - Structure of a general purpose computer code - Tallies - flux to dose conversion factors.

UNIT III MONTE CARLO TECHNIQUES FOR ELECTRON TRANSPORT 9

Interaction of electron with matter - continuous slowing down model - condensed random walk method –class I and class II model - electron transport - flow chart - discrete & continuous energy loss - energy loss in a thin slab of water - step size - energy straggling - tally/scoring.

UNIT IV MONTE CARLO MODELING OF LIGHTTRANSPORT IN TISSUES 9

Introduction - sampling random variables - rules of photon propagation : conventions, launching the photon, photon step size moving a photon - photon absorption - terminating a photon - scattering a photon - multilayered and complex tissues. Data analysis: Basic idea - conversion techniques. Varieties of sources : distributing photons at launch and convolution of impulse response.

UNIT V DIFFUSION THEORY OF LIGHT TRANSPORT IN TISSUE 9

Introduction - Ficks' law - energy conversion and the diffusion equation - boundary conditions. Diffusion approximation in transport theory - transport equation - diffusion theory derived from the transport equation - phase functions. Diffusion theory in simple geometries: planar, spherical and cylindrical geometry. Diffusion approximation in three dimensions - finite beam profiles - green's function - diffuse radiant fluence rates for finite beams.

TOTAL: 45 PERIODS

OUTCOMES

Apply various Monte Carlo techniques in solving various mathemetical and physical problems.

CO1: The student will be able to use Monte Carlo code to design the source and evaluate the dosimetric parameters and doses.
CO2: To interpret and evaluate the results of statistical nature.
CO3: To master the theory behind the Monte Carlo simulation of ionizing and non-ionizing radiation.
CO4: The student should be able to create a mathematical model of tumor in tissue.
CO5: The student will be able to understand diffusion theory of radiation.

Attested

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TEXTBOOKS

1. K. P. N. Murthy, Monte Carlo Basics, Indian Society for Radiation Physics, India, 2000.
2. Judith F. Briesmeister, A General Monte Carlo N-Particle Transport Code, Report No. LA-12625-M version 4B (1997) Web Address. http://www.Xdiv.alnl.gov/XTM/Xtm1/world1/docs/mcnp-anual/pdf/mcnp4b_man.pdf/

REFERENCES

1. D. W . O. Rogers and A. F. Bielajew, Monte Carlo Techniques of Electron and Photon transport for Radiation Dosimetry, The Dosimetry Radiation by Attix, Vol III, Academic Press, London, 1992.
2. M. J. Berger, Monte Carlo Calculation of the penetration and diffusion of fast charged particles, Computational Physics, Vol. 2, 1965.
3. W. R. Nelson, H. Hirayam and D. W. O. Rogers, The EGS4 code system, Stanford Linear Accelerator Centre report, SLAC-265, Web Address
4. http://www.slac.stanford.edu/oubs/slarcreports/slac-r-265.html.

Mapping of CO with PO

CO	PO				
	1	**2**	**3**	**4**	**5**
1	2	2	2	3	3
2	3	3	3	3	3
3	2	3	3	3	2
4	3	2	3	3	3
5	3	2	3	2	2
Avg	**2.6**	**2.4**	**2.8**	**2.8**	**2.6**

MP3011 NANOSCIENCE FOR MEDICAL APPLICATIONS **L T P C**
3 0 0 3

OBJECTIVES

To provide knowledge on
Understand the basic concepts of quantum mechanics and theoretical concepts of basics of materials

- To educate the student with basic concepts of nanomaterials
- To educate the students on the various preparation techniques of nanomaterials
- To provide knowledge on characterization techniques of nanomaterials.
- To make the student to understand the medical applications of nanoparticles

UNIT I INTRODUCTION TO QUANTUM MECHANICS 9

Comparison between classical and quantum mechanics; Photoelectric effect – Time dependent equation – Heisenberg uncertainty principle – Time independent equation - Postulates of quantum mechanics; Quantum mechanics of free particle confined to one, two and three dimensional box. Schrodinger – Heisenberg and Dirac representation – momentum representation. Infinite square well in one, two, and three dimensions – Density of states – Confined carriers – Electron wave propagation in devices – Quantum confinement – Penetration of a barrier – Tunnel effect – Band gap of nanomaterials - band gap tuning.

UNIT II BASICS OF MATERIALS 9

Crystal Systems – Unit Cells – Bravias Lattices – Crystallographic Planes – Miller Indices – Space Groups – Crystalline and Amorphous Materials Bonds in the Materials: Metallic, Ionic-Covalent and Van-der-Waals Bonds – Crystal Defects – Basics of Nanoscience and Nanotechnology – Scientific Revolutions – Nanosized Effects – Surface to Volume Ratio – Energy at the Nanoscale - Quantum Confinement Effects –Size Dependent Properties of Nanomaterials.

UNIT III PREPARATION OF NANOMATERIALS 9

Top down approach:Chemical Vapor Deposition- High-energy balling- Mechano chemical reactions – Mechanical alloying –Nanostructure through Lithography. Bottom up approach: Polyol route – Colloidal precipitation – Sol-Gel process– Chemical precipitation Sonochemical – Microbial routes – Biosynthesis – Electrospining method - Special Nanostructures - Quantum dots - Magnetic NPs – metal nanoparticles- Carbon Nanomaterials – Nanocomposites.

UNIT IV CHARACTERIZATION TECHNIQUES 9

Characterization of electrical- optical- mechanical and magnetic properties of nanomaterials. Electrical conductivity and permittivity- magnetic permeability- Structural characterization: X-ray diffraction- Electron microscopy- FTIR- XPS. Surface characterization: scanning electron microscopy- atomic force microscopy. Characterization of porous structures. Characterization of quasi-static and dynamic elastic properties. Mechanical testing.

UNIT V BIOMEDICAL NANOPARTICLES 9

Development of nano medicines – Nanoshells – Nanopores – Liposome's – Dentrimers – Different types of drug loading and release – Biodegradable polymers – Applications Nano biotechnologies for Single-Molecule Detection Nanoparticle drug system for oral administration - Nanotechnology in diagnostic application-Protease-Activated Quantum Dot Probes –Nano diagnostics for Integrating Diagnostics with Therapeutics-Nanorobots.

OUTCOMES:

CO1: The student will learn the basic physics concept of nanoscience.
CO2: The student will obtain fundamental knowledge on physics of materials
CO3: The student will learn the synthesis techniques of nanomaterials.
CO4: The student will learn the various techniques of nanomaterials.
CO5: The student will gain knowledge on the present and futuristic applications of nanomaterials for medical applications.

TOTAL: 45 PERIODS

TEXTBOOKS

1. A Textbook of Nanoscience and Nanotechnology Paperback, T. Pradeep,2017.
2. Springer Handbook of Nanotechnology, Edited by Bharat Bhushan, Springer-Verlag (2004)
3. Nanostructures & Nanomaterials: Synthesis, Properties &Applications, G. Cao, Imperial College Press, 2004.
4. Introduction to Quantum Mechanics, David J. Griffiths, Pearson Prentice Hall, New Delhi, 2005
5. Nanomaterials for medical diagnosis and therapy, Challa Kumar, Wiley-VCH, 2007.

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1. A Text Book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, Tata McGraw Hill, 2010.
2. Introduction to Nanotechnology, Poole Jr, 2004
3. Quantum Mechanics, G. Aruldhas, Prentice Hall of India, 2006
4. Nanomedicine Design of Particles, Sensors, Motors, Implants, Robots, and Devices, Yeoheung Yun , Artech House, 2009.

Mapping of CO with PO

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1	2	3	2	2	3	3
2	2	3	2	2	3	3
3	2	3	2	2	3	3
4	2	3	2	2	3	3
5	2	3	2	2	3	3
Avg	**2**	**3**	**2**	**2**	**3**	**3**

MP3012 FABRICATION TECHNIQUES OF NANOBIOSENSOR **L T P C**
3 0 0 3

OBJECTIVES

- Provides knowledge on the various synthesis techniques for preparing nanomaterials.
- To provide knowledge about the micro and nanofabrication techniques.
- To give insights on the application of nanomaterials to targeted biological applications.
- To give a knowledge on the basics of device fabrication for nanomaterials based biosensors.
- To make the students understand the concept of nanomaterial and biomateiral interaction

UNIT I FUNDAMENTALS OF MICRO FABRICATION 9

Photolithography- Deposition, and Selective Etching - Thin Film Growth and Deposition-Diffusion and Dopants - Atomic Layer Epitaxy - Soft Lithography. Self- assembled organized systems: Dendrimers, Liposomes, Vesicles, Supramolecular Complexes, Langmuir Blodgett films. Atomic Force Microscopy (AFM)

UNIT II MICRO FLUIDIC PATTERNING AND BIOPOLYMER PATTERNING 9

Micro fluidic Processes: Fundamentals of Laminar Fluids Micro fluidic Processes: The Role of Micro-Scale Fluid Dynamics in BioMEMSNeuro MEMS - Microelectrodes and Neuronal Interfaces, Microstereolithography.

UNIT III NANOFABRICATION 9

Molecular Engineering and Quantum Dots, Nanoscale Structures as Biological Tags and as Functional Interfaces with Biological Systems

UNIT IV NANO-BIOTECHNOLOGY 9

Nanoparticles and Microorganisms, Nano-materials in Bone Substitutes and Dentistry, Nanoparticles in Food and Cosmetic applications, Drug delivery and its applications.

UNIT V NANOBIOSENSORS 9

Biochips and analytical devices, Biosensors Nanomedicine, Nanobiosensor, Nanofluidics, Nanocrystals in Biological Detection, Electro-chemical DNA Sensors, Integrated Nanoliter Systems. Clean rooms practice and environmental issues; Applications

TOTAL: 45 PERIODS

OUTCOMES

CO1: From this syllabus, the students can understand the fabrication techniques used for developing nanostructured materials.
CO2: Students can avail the knowledge of fabrication of sensors for biomedical applications.
CO3: Students can obtain the knowledge on some of the important biomolecule tagging with nanomaterials.

CO4: Nanomaterials applications in the field of research, industrial and fulfilling human therapeutic needs.
CO5: Students will learn about the biomolecule and nano surface interaction for disease diagnosis ant therapeutic applications.

TEXT BOOKS

1. Michael Koch, Alan Evans, Arthur Brunnschweiler, Micro fluidic Technology and Applications (Micro technologies and Microsystems Series) , CRC Press; London, 2001.
2. Niemeyor, christober M. Mirkin, Nanobiotechnology: concepts, applications and perspectives, Kluwer publications , USA, 2004.
3. Robert A. FreitasJr ,Nanomedicine , FreitasJr.Kluwerpublications, USA, 1998.

REFERENCES

1. Richard Coombs, Dennis W. Robinson, Nanotechnology in medicine and the biosciences, Gordon and Breach Publishers, 1996.
2. Eugene J. Koprowski, Gene Koprowski, Nanotechnology in medicine: Emerging applications, Mcgraw-Hill Education, 2011.
3. Tuan Vo-Dinh, Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, CRC Press, 2007
4. Gabriel A. Silva, Nanotechnology for biology and medicine, Springer, 2012.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	2	3	2	2	3	3
2	2	3	2	2	3	3
3	2	3	2	2	3	3
4	2	3	2	2	3	3
5	2	3	2	2	3	3
Avg	**2**	**3**	**2**	**2**	**3**	**3**

MP3013 ULTRASONICS IN MEDICINE L T P C
3 0 0 3

OBJECTIVES
- To impart knowledge about sound and their method of production and detection
- Educate about the mechanism and signal processing to visualize sound interactions
- Educate them the applications of Ultrasound within the safety limits for medical applications

UNIT I GENERATION AND DETECTION OF ULTRASOUND 9
Propagation of ultrasound in biological materials - Piezoelectric effect - intensity changes by reflection, scattering, refraction, absorption and attenuation – impedance – transducer probes.

UNIT II PULSE ECHO AND NIC DIAGNOSTIC TECHNIQUES 9
Principles of Echo ranging - A scan - detection, smoothing and filtering - time gain compensation - application of A, B, and M mode scan – Doppler ultrasound - Ultrasound in Tomography: Ultrasonic microscope - ultrasonic holography.

Attested

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UNIT III SIGNAL PROCESSING, DISPLAY AND SAFETY: 9

Signal processing in ultrasonic imaging apparatus (qualitative ideas only) - processing of Doppler signals - Gray scale test object - Resolution test object - safety of diagnostic ultrasound.

UNIT IV ULTRASOUND IN OBSTETRICS AND GYNAECOLOGYVASCULAR SYSTEM ` 9

Identification of early pregnancy - foetal malformation - foetal anatomy - foetal growth - multiple pregnancy - foetal activity - ultrasound assessment of gynecological pathology
– Vas lab – arterial occlusion measurements.

UNIT V ULTRASOUND IN OPHTHALMOLOGY ANDECHOCARDIOGRAPHY 9

The normal eye in B-scan section - Diagnosis of posterior vitreous detachment - intra ocular tumors - assessment of rheumatic mitral valve, aortic murmur and calcified aortic valve - malfunction of prosthetic valve - estimation of acute myocardial infarction- assessment of left ventricular heart disease.

TOTAL: 45 PERIODS

OUTCOMES

Students can able to understand

CO1: Propagation of ultrasonic waves through tissues,
CO2: Know the limitations of ultrasound energy for various organs
CO3: Can operate the flaw detector for Scanning the defects
CO4: Can carryout the signal processing and noise reduction for better imaging
CO5: Know the conditions of defects in gynecology ophthalmology and echocardiography

TEXTBOOKS

1. M. Hussey, Basic Physics and Technology of Medical Diagnostic Ultrasound, 2nd Edition, McMikkan, London 1990.
2. W. M. McDicken, Diagnostic Ultrasonic principles and use of Instrument, 2ndedition, JohnWiley and Sons, New York, 1992.
3. D. H. Evans and J. P. Wood Cock, Doppler ultrasound Physics Instrumentation and Clinical applications, John Wiley, Chichester, 1998.

REFERENCES

1. C. R. Hill, J. C. Bamber, G. R. terHaar, Physical Principles of Medical Ultrasonics, John Wiley & Sons, 2005.
2. George L. Gooberman, Ultrasonics: Theory and Application, Hart Publishing Company, 1969.
3. MichielPostema, Fundamentals of Medical Ultrasonics, Taylor & Francis, 2011
4. Francis A. Duck, A.C Baker, H.C Starritt, Ultrasound in Medicine, CRC Press, 2002

MP3014 LASERS FOR MEDICAL APPLCIATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To guide the students in the fundamentals of laser-tissue interaction.
- To educate the students in different types of lasers used in medicine.
- To teach the students about diagnostic laser methods
- To teach therapeutic applications of laser radiation
- To make the students aware of safety regulations.

UNIT I LASER – TISSUE INTERACTION 9

LASER introduction - principle & characteristics- Biological tissue composition, morphology and optical properties, LASER –Tissue interaction, Light penetration and reflectance, light scattering in tissues, speckle formation, Photodynamic therapy (PDT).

UNIT II LASERS IN MEDICINE 9

Solid State laser, Gas lasers, Liquid and Solid State tunable organic dye lasers and semiconductor lasers, applications of lasers in medicine.

UNIT III LASERS IN DIAGNOSTICS 9

Optical Coherence Tomography (OCT), optical biopsy, Spectroscopy: Absorption, scattering, Fluorescence: FRET, FLIM, Raman, polarization and GASMAS

UNIT IV LASER THERAPY AND SURGERY 9

Ophthalmology, dermatology, cardiology, urology, gynaecology, neurology, dentistry, Orthopaedic surgery and otorhinolaryngology (ORL) and head and neck surgery

UNIT V LASER SAFETY REGULATIONS 9

Classification of Lasers, Laser use risk management, Types of Hazard: eye hazards, skin hazards, electrical hazards – Protection standards for lasers, safety regulations - specific precautions Audit for safety program monitoring.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: The students will learn about laser-tissue interaction and its associated processes.
CO2: The students will be trained in different types of lasers used in medicine.
CO3: The students will acquire knowledge about diagnostic laser methods
CO4: The students will acquire knowledge about therapeutic and surgical applications of laser radiation.
CO5: The students will be aware of safety regulations while using lasers like protection standards, specific precautions.

Mapping of CO with PO

CO	PO					
	1	**2**	**3**	**4**	**5**	**6**
1	3	2	3	1	3	3
2	3	2	3	1	3	3
3	3	2	3	1	3	3
4	3	2	3	1	3	3
5	3	2	3	1	3	3
Avg.	**3**	**2**	**3**	**1**	**3**	**3**

Attested

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