ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M. Sc. MEDICAL PHYSICS (2 YEARS)

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- Train students in the understanding of human physiology ,to impart knowledge on the normal structure and function of the body and its major organ systems with emphasis on content applicable to clinical diagnostic imaging and/or radiation oncology.
- Teach the principles of radiation, radioactivity, its properties, units of measure, dosimetry, measurement concepts and methods as used in clinical diagnosis and treatment.
- Teach students in the principles of operation of medical imaging and physiological monitoring equipment to impart knowledge of the biological effects of radiation and its application for radiation safety and for radiation treatment.
- Train students in engineering methods as applied to medicine, to equip them to perform healthcare and medical research using engineering principles, and to be able them to design and understand the use of medical equipment
- To impart knowledge on the radiation safety practices and procedures including the determination of radiation shielding

PROGRAMME OUTCOME (POs):

After two years of completing the M.Sc., Medical Physics course the students

- Will have the ability to perform the clinical support procedures required of a medical physicist.
- Will have the ability to practice all aspects of clinical medical physics for an accurate, safe and effective delivery of radiotherapy treatment for the cancer patients'
- Can pursue a broad range of translational clinical research projects in radiotherapy.
- Can teach medical physics courses to graduate students/medical residents / dosimetry & Radiotherapy students.

Attested

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ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M. Sc. MEDICAL PHYSICS (2 YEARS)

REGULATIONS – 2015
CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

SEMESTER - I

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MP7101	Electronic Circuits and Microprocessor	PC	4	4	0	0	4
2.	MP7102	Mathematical Physics and Biostatistics	PC	4	4	0	0	4
3.	MP7103	Non Ionizing Radiation Physics in Medicine	PC	4	4	0	0	4
4.	MP7104	Radiological Physics	PC	4	4	0	0	4
5.	ME7151	Engineering Graphics and Workshop Practice	PC	4	2	0	2	3
PRACTICAL								
6.	MP7111	Electronics and Instrumentation Laboratory	PC	6	0	0	6	3
			TOTAL	**26**	**18**	**0**	**8**	**22**

SEMESTER - II

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MP7201	Anatomy and Physiology	PC	3	3	0	0	3
2.	MP7202	Numerical Methods and Programming in C	PC	4	4	0	0	4
3.	MP7203	Radiation Dosimetry and Treatment Planning	PC	4	4	0	0	4
4.	MP7204	Radio Therapy Equipments	PC	3	3	0	0	3
5.		Elective I	PE	3	3	0	0	3
PRACTICAL								
6.	MP7211	Diagnostic and Therapeutic Laboratory - I	PC	6	0	0	6	3
			TOTAL	**23**	**17**	**0**	**6**	**20**

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SEMESTER - III

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MP7301	Biomedical Instrumentation	PC	4	4	0	0	4
2.	MP7302	Brachytherapy Physics	PC	3	3	0	0	3
3.	MP7303	Materials for Implant Applications	PC	4	4	0	0	4
4.		Elective II	PE	3	3	0	0	3
5.		Elective III	PE	3	3	0	0	3
PRACTICAL								
6.	MP7311	Diagnostic and Therapeutic Laboratory - II	PC	6	0	0	6	3
7.	MP7312	Seminar	EEC	2	0	0	2	1
			TOTAL	**25**	**17**	**0**	**8**	**21**

SEMESTER - IV

Sl.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Elective IV	PE	3	3	0	0	3
2.		Elective V	PE	3	3	0	0	3
PRACTICALS								
3.	MP7411	Project Work	EEC	24	0	0	24	12
			TOTAL	**30**	**6**	**0**	**24**	**18**

TOTAL NO. OF CREDITS: 81

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PROFESSIONAL CORE (PC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Electronic Circuits and Microprocessor	PC	4	4	0	0	4
2.		Mathematical Physics and Biostatics	PC	4	4	0	0	4
3.		Non Ionizing Radiation Physics in Medicine	PC	4	4	0	0	4
4.		Radiological Physics	PC	4	4	0	0	4
5.		Electronics and Instrumentation Laboratory	PC	6	0	0	6	3
6.		Engineering Graphics and Workshop Practice	PC	4	2	0	2	3
7.		Anatomy and Physiology	PC	3	3	0	0	3
8.		Numerical Methods and Programming in C	PC	4	4	0	0	4
9.		Radiation Dosimetry and Treatment Planning	PC	4	4	0	0	4
10.		Radio therapy Equipments	PC	3	3	0	0	3
11.		Diagnostic and Therapeutic Laboratory – I	PC	6	0	0	6	3
12.		Biomedical Instrumentation	PC	4	4	0	0	4
13.		Brachytherapy Physics	PC	3	3	0	0	3
14.		Materials for Implant Applications	PC	4	4	0	0	4
15.		Diagnostic and Therapeutic Laboratory – II	PC	6	0	0	6	3

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PROFESSIONAL ELECTIVES (PE)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MP7001	Advanced Clinical Radiation Therapy Physics	PE	3	3	0	0	3
2.	MP7002	Biological Effects of Ionizing Radiation	PE	3	3	0	0	3
3.	MP7003	Biomedical Optical Spectroscopy	PE	3	3	0	0	3
4.	MP7004	Biosensors	PE	3	3	0	0	3
5.	MP7005	Industrial Radiography	PE	3	3	0	0	3
6.	MP7006	Medical Applications of Laser	PE	3	3	0	0	3
7.	MP7007	Medical Imaging Techniques	PE	3	3	0	0	3
8.	MP7008	Monte Carlo Techniques in Dosimetry	PE	3	3	0	0	3
9.	MP7009	Nano Technology for Biomedical Applications	PE	3	3	0	0	3
10.	MP7010	Nuclear Medicine	PE	3	3	0	0	3
11.	MP7011	Radiation Hazards Evaluation and Control	PE	3	3	0	0	3
12.	MP7012	Ultrasonics in Medicine	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Seminar	EEC	2	0	0	2	1
2.		Project Work	EEC	24	0	0	24	12

MP7101 ELECTRONIC CIRCUITS AND MICROPROCESSOR L T P C
4 0 0 4

OBJECTIVE

- To foster friendly and stimulating learning environment in which students are motivated to reach high standards, to acquire real insight into Electrical and Electronic Engineering and to become self-confident, committed and adaptable graduates towards biomedical engineering aspects.

UNIT I ANALOG ELECTRONICS I: 12

Op-amp – introduction – input modes and parameters – op-amps with negative feedback – open-loop response – Differential Amplifier-Addition-subtraction- Intergration–analog simulation-OTAs – CFOAs –active filters –oscillator circuits – oscillator with RC feedback circuits (RC and LC) –relaxation oscillators – linear and nonlinear oscillators –555 timer as an oscillator –IC voltage regulators –Semiconductor diodes-JFET-MOSFET-Evolution of ICs –CCDs.

UNIT II ANALOG ELECTRONICS II: 12

Op-amp –comparators and controls-noise in comparator circuits –zero –crossing detectors with hysteresis –half wave rectifier-full wave rectifier-Power supplies- Regulated power supplies using IC's-DC –DC converter and RF power supplies switching mode power supplies-AC regulators--clipping and clamping circuits

UNIT III TRANSDUCER: 12

Classification – selection of a transducer – Strain gauge –Displacement transducer (Capacitive, inductive, differential transformer, photo electric and Piezoelectric transducers) – Strain flow measurements – Thermistor and thermo couple based thermometers for measuring temperature.

UNIT IV DIGITAL ELECTRONICS 12

Introductory digital concepts-overview of logic functions – fixed function integrated circuits-programmable logic devices – functions of combinational logic – flip flops and related devices – counters – shift registers – memory and storage – Introduction to microprocessors – Architecture of 8085 / 8086 – Assemble Language Programming – Peripherals – integrated circuit technologies.

UNIT V ELECTRONICS FOR NUCLEAR DEVICES 12

Preamplifier – pulse shaper – isolator – high range gamma survey meter circuit – scintillation dose rate meter – scintillator photodiode x-ray detector – pocket monitor – general purpose contamination monitor – discriminator – single channel analyzer – linear gate – time to amplitude converter.

OUTCOME

To learn the internal architecture and working principle of various instruments used in medical field.

TOTAL: 60 PERIODS

TEXTBOOKS

1. P.Horowitz and W.Hill, "The art of electronics', (2nd edition), Cambridge university press, Cambridge, 1995.
2. A.P.Malvino, "Electronic principles', (6th edition), Tata McGraw Hill Publ.Co.Ltd., New Delhi, 1999.
3. T.L.Floyd, Electronic devices', (6th edition), Pearson Education Inc., New Delhi, 2003.

REFERENCES

1. R.F.Coughlin and F.F.Driscoll,'Operational amplifiers and linear integrated circuits', (6th edition), Pearson Education Inc., New Delhi, 2001.
2. T. L. Floyd, Digital Fundamentals, (8th deition), Pearson education Inc., New Delhi, 2003.
3. S.Brown and Z.Vranesic,'Fundamentals of digital logic with Verilog design', Tata McGraw Hill Publ Co.Ltd., New Delhi, 2003.
4. H.Skalsi, "Electronic instrumentation (2nd edition), Tata McGraw Hill Publ. Co. Ltd., New Delhi,2004

MP7102 MATHEMATICAL PHYSICS AND BIOSTATISTICS L T P C
4 0 0 4

OBJECTIVE

- To educate the student with the useful applications of statistics in medicine and to enable the student to recognize those applications

UNIT I VECTOR CALCULUS AND MATRICES 12

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 Eigen Value, problem, diagonalisation and similarity transformation.

UNIT II COMPLEX ANALYSIS 12

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- Contour integration with circular and semicircular contours.

UNIT III FOURIER AND LAPLACE TRANSFORMS 12

Fourier series – Harmonic analysis, Fourier transform- Properties – transforms of simple functions and derivatives- Convolution theorems – Laplace's transform – Properties – Transforms of simple functions and derivatives – periodic functions – Convolution theorem – Applications of Fourier Transform in Medical imaging.

UNIT IV PARTICAL DIFFERENTIAL EQUATIONS 12

Transverse vibration of string – Wave equation – One dimensional heat conduction – diffusion equation – two dimensional heat flow – Laplace's equation – method of separation of variables- Fourier series solution in Cartesian coordinate.

UNIT V PROBABILITY, STATISTICS AND ERROR 12

Laws of probability, conditional probability, collection, tabulation and graphical representation of data. measures of central tendency, mean, median, mode, , dispersion, standard deviation, root mean square deviation, moments, skewness and kurtosis. Application to radiation detection – error propagation,. Binomial distribution, poisson distribution, gaussian distribution, exponential distribution, Bivariate distribution, Correlation and Regression-Chi-Square distribution- t- distribution- F – distribution.

TOTAL: 60 PERIODS

OUTCOME

- The student with an overview of statistical thought and their respective models and methods can do some of the basic computations.

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TEXTBOOKS

1. Pipes L.A. & Harvil, Applied Mathematics for Engineers and Physicists, Mc Graw- Hill Book Co., New York, 1980.
2. Mary.L.Boas, Mathematical methods in the Physical Science (2^{nd} edition), John Wiley & Sons., New York, 1983.
3. Butkov E. Mathematical Physics, Addison Wesley, New York, 1973.

REFERENCES

1. Walpole,E, Myers,R.M, Myers,S.L and Ye,K, "Probability & Statistics for Engineers and Scientists", Pearson Education, 2002.
2. Sathyapraksh, Mathematical Physics, Sultan chand & Co., New Delhi, 1994.
3. M.K. Venkatraman, Advanced Mathematics for Engineers & Scientists, National Publishing co., Madras, 1994.
4. G. Arfken and H.H. Weber, Mathematical Methods for Physicists, 4^{th} edition, Prism Books, Bangalore, 1995.
5. Fundamentals of Mathematical Statistics,S.C.Gupta and V.K. Kapoor, S.Chan and Co:2007.

MP7103 NON IONIZING RADIATION PHYSICS IN MEDICINE L T P C
4 0 0 4

OBJECTIVE

- This paper provides a broad knowledge on the interaction of Non-Ionizing radiation and ultrasound in tissues and their use in medicine.

UNIT I REVIEW OF NONIONISING RADIATIONPHYSICS IN MEDICINE 12

Different sources of Non Ionising radiation-their physical; properties-first law of photochemistry-Law of reciprocity- - Electrical Impedance and Biological Impedance - Principle and theory of thermography - applications -

UNIT II TISSUE OPTICS 12

Various types of optical radiations - UV, visible and IR sources - Lasers: Theory and mechanism-Laser Surgical Systems-Measurement of fluence from optical sources - Optical properties of tissues – theory and experimental techniques-interaction of laser radiation with tissues – photothermal -photochemical – photoablation – electromechanical effect

UNIT III MEDIPHOTONICS 12

Lasers in dermatology, oncology and cell biology - Application of ultrafast pulsed lasers in medicine and biology-Lasers in blood flow measurement - Fiber optics in medicine - microscopy in medicine - birefringence - Fluorescence microscope - confocal microscope - Hazards of lasers and their safety measures.

UNIT IV MEDICAL ULTRASOUND 12

Production, properties and propagation of ultrasonic waves- Bioacoustics - Acoustical characteristics of human body- Ultrasonic Dosimetry - Destructive and nondestructive tests - Cavitation - Piezo electric receivers, thermoelectric probe – Lithotropy - High power ultrasound in theraphy

UNIT V RADIO FREQUENCY AND MICROWAVE 12

Production and properties - interaction mechanism of RF and mirocwaves with biological systems: Thermal and non-thermal effects on whole body, lens and cardiovascular systems -tissue characterization and Hyperthermia and other applications-Biomagnetism - Effects - applications.

TOTAL: 60 PERIODS

OUTCOME

Students will be able to use Laser,Ultra sound and microwaves for different diagnosis and Therapeutic applications

TEXTBOOKS

1. S. S Martellucci and A. N. Chester, Laser Photobiology and Photomedicine, Plenum Press, New York, 1985.
2. Markolf H. Neimz, Laser-Tissue Interactions, Springer Verlag, Germany, 1996.

REFERENCES

1. J. P. Woodcock, Ultrasonic, Medical Physics Handbook series 1, Adam Hilger, Bristol, 2002.
2. J. R. Greening, Medical Physics, North Holland Publishing Co., New York, 1999.
3. R. Pratesi and C. A. Sacchi, Lasers in Photomedicine and Photobiology, Springer Verlag, West Germany, 1980.
4. Harry Moseley, Hospital Physicists' Association, Non-ionising radiation: microwaves, ultraviolet, and laser radiation, A. Hilger, in collaboration with the Hospital Physicists' Association, 1988

MP7104 RADIOLOGICAL PHYSICS L T P C
4 0 0 4

OBJECTIVE

- The material in this section is designed to teach the basics of radiological physics, interaction of radiation with matter, basic dosimetric concepts and radiation detectors.

UNIT I ATOMIC PHYSICS AND NUCLEAR TRANSFORMATION 12

Structure of matter - atom - nucleus -atomic mass and energy units -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 - natural and artificial radioactivity - reactor and cyclotron produced isotopes - fission products – fusion - Criticality conditions – four factor formula.

UNIT II INTERACTION OF RADIATION WITH MATTER 12

Interaction of electromagnetic radiation with matter, Thomson scattering, Rayleigh scattering, Compton scattering (Klein-Nishina differential cross section), Photoelectric absorption, Pair production – Interaction of light (electrons and positrons) and heavy charged particles with matter –specific ionization – Cerenkov radiation-mass-energy- attenuation and absorption coefficient - 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, CSDA range (continuous slowing down approximation) - Interaction of neutron with matter.

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UNIT III DOSIMETRIC PRINCIPLES QUANTITIES AND UNITS 12

Introduction -exposure-Roentgen - photon fluence and energy fluence -KERMA-Kerma and absorbed dose -CEMA -Absorbed dose -stopping power - relationship between the dosimetric quantities - cavity theories – Bragg gray cavity– spencer- Attix cavity – Burlin cavity theory – stopping power ratio. Bremsstrahlung radiation, Bragg's curve.

UNIT IV PRINCIPLES OF RADIATION DETECTION AND DOSIMETERS 12

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

UNIT V RADIATION MONITORING INSTRUMENTS 12

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 - Radiophtoluminesce glass dosimetry system - OSLD.

TOTAL: 60 PERIODS

OUTCOME

Students will be able to understand the interaction of radiation with matter with emphasis on energy transfer and dose deposition and will understand exponential attenuation under narrow and broad beam conditions, to better understand shielding design.

TEXT BOOKS

1. E.B. Podgorsak (Technical Editor), Radiation oncology physics: A Handbook for teachers and students. International Atomic Energy Agency publications, STI/PUB/1196, July 2005.
2. F.M.Khan, The Physics of Radiation Therapy, Fifth Edition, Lippincott Williams and Wilkins, U.S.A.,2015.
3. D.R. Dance S. Christofides A.D.A. Maidment I.D. McLean K.H. Ng (Technical Editors), Diagnostic radiology physics: A handbook for teacher and students, International Atomic Energy Agency Publications, STI/PUB/1564, September 2014.
4. E.B.Podgorsak, Radiation Physics for Medical Physicists, , 2nd Edition, Springer, 2010.
5. Frank Herbert Attix, Introduction to Radiological Physics and Radiation Dosimetry, Wiley-VCH Verlag, 2007.

REFERENCES

1. H. E. Johns, J. R. Cunningham, The Physics of Radiology, Charles C. Thomas, New York, 2002
2. W. J. Meredith and J. B. Massey, Fundamental Physics of Radiology, John Wright and Sons, U. K., 2000.
3. W. R. Hendee, Medical Radiation Physics, Year Book Medical Publishers Inc., London, 2003.
4. Donald T. Graham, Paul J. Cloke, Principles of Radiological Physics, Churchill Livingstone, 2003
5. Walter Huda, Review of Radiological Physics, , Lippincot, 2010

TOTAL: 90 PERIODS

Attested

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ME7151 ENGINEERING GRAPHICS AND WORKSHOP PRACTICE L T P C
2 0 2 3

OBJECTIVE

- Creating awareness on fundamentals of graphics, engineering drawing and handling of machine tools including CNC machines with the following objectives.

1. ENGINEERING GRAPHICS 30

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)

2. WORKSHOP PRACTICE 30

a) Demonstration of basic manufacturing process like Welding, Frundry and sheet metal
b) Lathe: Apron mechanism, different work holding devices, different operation, Machining time calculations.
c) Milling machine: Mechanism - different work holding devices, different operation, calculations part
d) Drilling machine: Mechanism – Operations – Calculation part
e) Shaper Machines: Quick return mechanism – Different work holding Devices – Different operations – Calculation part.
f) Process planning and cost estimation of simple components – Elementary treatment.
g) Introduction to CNC Machines – Machining centres and turning centres.

TOTAL: 60 PERIODS

OUTCOMES

To make the students to understand the

- Concept on basic drawing / graphics
- Concept on CNC To provide
- on hand exposure on CNC and various machine tools usage

REFERENCES

1. N.D.Bhatt. Elementary Engineering Drawing. Charater Publishing Co. 1990.
2. H.Choudhry. Elements of Workshop Technology. Vol. I and II, Media Promoters and publishers Pvt. Ltd., Mumbai, 2001.
3. R.K.Jain and S.C.Gupta. Production Technology. Khanna Publishers, 2001.
4. S.Kalpajion and S.R.Schmid. Manufacturing Engineering and Technology, Prasson Education, Inc., 2002.
5. Radhakrishnan. C.N.C. Machines. New Central Book Agency, 1992
6. B. Hodges. CNC Part programming work book, City and Guilds. MacMillan, 1994
7. S.K.Hajra Choudry. Elements of Workshop Teaching, Vol.I and II. Tata McGraw Hill Publishing Co., New Delhi, 1992.

MP7111 ELECTRONICS AND INSTRUMENTATION LABORATORY L T P C
0 0 6 3

OBJECTIVE

- To understand the importance of electronics today, which provides the world with an infinite amount of information at a much faster speed than that information would ever have been available before.

ATLEAST FIFTEEN EXPERIMENTS

1. RC, LC Oscillator Design.
2. Dual regulated power supply
3. Astable & Monostable multivibrator design
4. Implementation of Boolean Expressions using Universal Gates.
5. Operational Amplifier - Characteristics of summer, difference amplifier and integrator, Comparator Circuit, Schmitt Trigger
6. Filters - high pass, low pass and band pass
7. G. M. Counter
8. Microprocessor 8085 / 8086
9. Waveform Generator Sin wave & Square wave using Op-Amp
10. Gamma ray spectrometer
11. IC regulated power supply
12. Flip Flop, JK & RS using Logic Gates.
13. Half Adder & Full Adder
14. Data Transfer using Shift Register
15. Digital to Analog and Analog to Digital conversion
16. Digital circuits for measurements
17. Interfacing and Programming using 8279, 8259 & 8253
18. Digital Clock Programming

OUTCOME

The information gained can make the student involve in designing process and presentation tools.

MP7201 ANATOMY AND PHYSIOLOGY L T P C
3 0 0 3

OBJECTIVE

- Designed to identify gross anatomical structures, define the major organ systems, the physiologic mechanisms for repair, maintenance and growth, in order 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 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.

UNIT V NERVOUS SYSTEM 9

Brain and spinal cord - its functions - central nervous system and Autonomic Nervous system functions - Physiology of special senses of hearing, taste vision etc.

TOTAL: 45 PERIODS

OUTCOME

- Student will be able to identify and describe the structure and the function of different Human System.

TEXTBOOKS

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.

REFERENCES

1. J. R. Brobek, Physiological Basis of Medical Practice, Williams and Wilkins, London, 1995.
2. Edward Alcamo, Barbara Krumhardt, Barron's Anatomy and Physiology the Easy Way, Barron's Educational Series, 2004
3. Lippincott, Lippincott Williams & Wilkins, Anatomy and Physiology, Lippincott Williams & Wilkins, 2002
4. W. E. Arnould-Taylor, A textbook of anatomy and physiology, Nelson Thornes, 1998

MP7202 NUMERICAL METHODS AND PROGRAMMING IN "C" L T P C
4 0 0 4

OBJECTIVE

- Emphasis on problem solving and its coverage of most areas of fundamental physics equip the students with the skills required for biomedical applications

UNIT I SOLUTIONS OF EQUATIONS 12

Roots of equations - Methods of bisection & false position - Newton-Raphson method - Simultaneous equations - Gauss elimination - Gauss Jordan methods - matrix inversion and LU decomposition method - Gauss-Seidel iterative method - Eigenvalues of matrices - Power method, Jacobi's method.

UNIT II INTERPOLATIONS 12

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

UNIT III DIFFERENTIATION, INTEGRATION AND DIFFERENTIAL EQUATIONS 12

Numerical integration - Trapezoidal rule and Simpson's rule - Numerical solution of ordinary differential equations - Taylor series - Euler's method, improved and modified methods - Runge-Kutta methods - Milne's predictor -corrector method

UNIT IV CURVE FITTING 12

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

UNIT V C-PROGRAMMING 12

Types of variables-arrays-functions (intrinsic and user defined) – arithmetic operations and shorthand notations – loops (do, for, if loops) – Structure – pointers elementary examples of programs (three programs at least from each of the above units)

TOTAL: 60 PERIODS

OUTCOME

- To use the tools that mathematics supplies to predict , conclude and actualize.

TEXTBOOKS

1. M. K. Venkatraman, "Numerical Methods in Science and Engineering", National Publishing Company, Madras, 1996
2. Dey,P and Ghosh,M, " Programming in C", Oxford University Press, 2007

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", Prentice Hall of India, New Delhi, 1992.
3. Programming in ANSI C, E.Balagurusamy, Tata McGraw Hill publication, 2008.
4. J.B. Dixit, Comprehensive Programming in C and Numerical Analysis, Laxmi Publications, 2006

MP7203 RADIATION DOSIMETRY AND TREATMENT PLANNING L T P C 4 0 0 4

OBJECTIVE

- To provide the knowledge on the importance of treatment efficacy quality and accuracy of radiation therapy treatments through improved clinical dosimetry.

UNIT I DOSIMETRIC CONCEPTS AND QUANTITIES 12

Introduction -exposure-Roentgen - photon fluence and energy fluence –fluence rate – Vector radiometric quantities – absorbed dose – KERMA - CEMA - stopping power - relationship between the dosimetric quantities - cavity theory- Bragg gray theory – spencer – attrix cavity theory – Burlin cavity theory - Interaction coefficients – mass attenuation coefficients, mass energy transfer coefficients, mass energy absorption coefficient, stopping power (collision and radiative), Linear Energy Transfer (LET).

UNIT II CALIBRATING, MEASURING AND QUALITY ASSURANCE OF TELETHERAPY UNITS **12**

Dosimeters based on condenser chambers – dosimeter based on current measurement – different type of electrometers – MOSFET – secondary standard therapy level dosimeters – farmer dosimeters – radiation field analyzer (RFA)– Radioisotope calibrator – water phantom dosimetry systems – brachytherapy dosimeters – TLD readers for medical applications – 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 inter comparison. AAPM Task Group 142 report: Quality Assurance of medical accelerators.

UNIT III RADIATION TREATMENT PLANNING PARAMETERS **12**

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 IV BEAM DATA MEASUREMENTS and QA OF PLANNING SYSTEMS **12**

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-Quality Assurance of treatment planning systems IAEA TRS 430 protocol.AAPM TG 53 and 106 protocols.

UNIT V TREATMENT PLANNING ASPECTS AND ALGORITHMS **12**

Treatment positioning - immobilization -Patient data acquisition from CT and MRI - Image registration and fusion - contouring – Introduction to ICRU 50/62. correction for contour irregularities - correction for body inhomogenities- 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 – Monte carlo –Comparison of algorithms – generalized pencil beam algorithms and electron montecarlo algorithms - dose calculation algorithms in brachytherapy

TOTAL: 60 PERIODS

OUTCOME

- At the end the Students will be able to independently do the radiation dosimetric evaluation in both 2D and 3D for practicing clinical radiation therapy.

TEXTBOOKS

1. F M Khan-Physics of Radiation Therapy, 5th Edition, Liippincott Williams & Wilkins,USA, 2015.
2. W. R. Hendee, Medical Radiation Physics, Year Book Medical Publishers Inc., London, 2003.

REFERENCES

1. R. F. Mould, Radiotherapy Treatment Planning, Medical Physics Hand Book Series No. 7, Adam Hilger Ltd., Bristol, 1981.
2. Khan, Faiz M. Treatment Planning in Radiation Oncology, 2nd Edition Lippincott Williams & Wilkins, 2007
3. Edward C. Halperin, Carlos A. Pérez, Luther W.. Brady, Perez and Brady's principles and practice of radiation oncology, Lippincott Williams & Wilkins, 2008
4. Gunilla C. Bentel, Charles E. Nelson, K. Thomas Noell, Treatment planning and dose calculation in radiation oncology, McGraw-Hill, 1989.

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MP7204 **RADIO THERAPY EQUIPMENTS** **L T P C**
3 0 0 3

OBJECTIVE

- This subject is aimed to teach the construction and working principles of telecobalt, linear accelerator, simulator, stereotactic radiotherapy equipment, for conventional and IMRT treatments.

UNIT I TELEGAMMA MACHINES **9**

Co^{60} and Cs^{137} as teletherapy sources - source containers - international source capsule - effect of penumbra- Types of collimators - beam directing devices – Different Source Shutter Systems-Quality Assurance of telegamma units.

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

UNIT III LINEAR ACCELERATORS **9**

Components of modern linear accelerator-Standing and travelling wave guides, Magnetrons and Klystrons. Bending Magnet, Target, Flattening filter, Collimators Need for high quality portal imaging - Fluoroscopic, diode, crystal, - Diagnostic imaging on a linear accelerator - portal dose images, Portal Dosimetry. Telecobalt Vs Linacs.

UNIT IV RADIOTHERAPY SIMULATORS **9**

Conventional simulators - CT simulators - cone beam CT simulators (CBCT) - comparison and quality assurance of simulators - different simulation techniques - Orthogonal, Semi-orthogonal, Isocentric, Variable angle and Stereo-Shift.

UNIT V ADVANCED RADIOTHERAPY EQUIPMENTS **9**

Superficial X-ray therapy units - Gamma knife - cyber knife - Intra operative radiation therapy units-Tomotherapy -Neutron therapy - (BNCT)- proton therapy.

TOTAL: 45 PERIODS

OUTCOME

- Upon completion of the subject, students will be able to understand the construction and Working of telecobalt unit, Linear accelerator, simulator, CT-simulator and treatment planning system and LDR and HDR equipments.

TEXTBOOKS

1. Radiation oncology physics: A Handbook for teachers and students. IAEA publications 2005.
2. F. M. Khan, The Physics of Radiation Therapy, Fifth Edition, Lippincott Williams and Wilkins,U.S.A.,2015

REFERENCES

1. Samantha Morris, Radiotherapy physics and equipment, Churchill Livingstone, 2001
2. Pam Cherry, Angela Duxbury, Practical Radiotherapy: Physics and Equipment, John Wiley & Sons, 2009
3. David Greene, P.C Williams, Linear Accelerators for Radiation Therapy, Second Edition, CRC Press, 1997
4. David M. Hailey, Australian Institute of Health, High Energy Radiotherapy Equipment: A Discussion Paper, Australian Institute of Health, 1989

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MP7211 DIAGNOSTIC AND THERAPEUTIC LABORATORY- I L T P C
0 0 6 3

OBJECTIVE

- It is concerned with the use of various imaging modalities to aid in the diagnosis of disease. Interventional radiology uses these imaging modalities to guide minimally invasive surgical procedures.

(Any FIFTEEN experiments only)

1. Field congruence test for telecobalt and the linear accelerator.
2. External Beam Treatment Planning -conventional
3. Brachytherapy planning for manual after loading applicator using CS-137
4. Brachytherapy planning for HDR remote after loading treatment
5. Cross calibration of the ionization chamber.
6. Percentage depth dose and profile measurements using RFA.
7. ECG preamplifier
8. Bridge amplifier
9. Ultrasonic diffraction instruments
10. Pacemaker I
11. Pacemaker II
12. Absorption characteristics using UV Visible spectrophotometer
13. Fluorescence spectrum using spectrofluorometer
14. GM Counter characterisitcs
15. Estimation of pH value for different physiological fluids
16. Bio Amplifiers
17. Calibration of survey instruments and pocket dosimeters
18. Calibration of TL Phosphor and TLD reader and its use in dose distribution measurements
19. Recording of Bio signals and analysis (ECG, EMG)
20. Analysis of safety aspects of surgical diathermy

TOTAL: 90 PERIODS

OUTCOME

- To make the students enable to get the hand on experience to draw the contours for planning effective treatment of cancer.

MP7301 BIOMEDICAL INSTRUMENTATION L T P C
4 0 0 4

OBJECTIVE

- To enable the student to understand the physics and theory behind the bio electric signal recording, physiological assist devices, operation theater equipments and biotelemetry and their safety measures.

UNIT I BIOPOTENTIAL ELECTRODES AND TRANSDUCERS 12

Cell structure-nature of cancer cells - Transport of ions through cell membrane - Resting and action potential - half cell potential - bioelectric potential - design and co;mponents of medical insturments - electrodes - surface, needle, depth electrodes - electrical circuits.

UNIT II BIOELECTRIC SIGNAL RECORDING 12

Introduction - characterstics of recording systems - Electrodcardiography (ECG) - Electroencephalograph (EEG)- Electromyograph (EMG)- Electroneurograph (ENG) - recoring units.

UNIT III PHYSIOLOGICAL ASSIST DEVICES 12

Cardiac pacemakers - natural and artificial pacemakers - pacemaker batteries - defibrillator - A. C./D. C. synchronized defibrillator - stimulators - bladder stimulators - Heart lung machine - Various types of oxygenators - kidney machine - hemodialysing units - peritoneal dialysis.

UNIT IV CLINICAL AND OPERATION THEATER EQUIPMENTS 12

Flame Photometer - Spectroflurometer - pH meters - Audiometer - endoscopes - Electromagnetic and laser blood flow meters - ventilators - diathermy units - ultrasonic, microwave and short wave diathermy – Types and their applications – Surgical diathermy.

UNIT V BIOTELEMETRY AND SAFETY INSTRUMENTATION 12

Principles of a biotelemetry system: radiotelemetry with subcarrier - multiple channel telemetry systems - problems in implant telemetry - uses of biotelemetry – physiological effects of 50Hz current - microshock and macroshock - electrical accidents in hospitals – devices to protect against electrical hazards.

TOTAL: 60 PERIODS

OUTCOME

- To make the students to familiarize physical design, Maintenance of different biomedical instrument used in medical field.

TEXTBOOKS

1. M. Arumugam, Biomedical Instrumentation, Anuradha Publishing Co., Kumbakkonam, Tamilnadu, 2004.
2. Jacobson and Webster, Medicine and clinical Engineering, Prentice Hall of India, New Delhi, 1979.

REFERENCES

1. R. S. Khandpur, Handbook of Biomedical Instrumentation, Tata McGraw Hill, New Delhi, 1990.
2. Richad Aston, Principles of Biomedical Instrumentation and measurement, Merrill Publishing Co., London, 1990.
3. Marvin D. Weiss, Biomedical instrumentation, Chilton Book Co., 1973
4. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Prentice-Hall, 1980.

MP7302 BRACHYTHERAPY PHYSICS L T P C
3 0 0 3

OBJECTIVE

- To develop the knowledge on the physics of Low dose rate and high dose rate brachytherapy and their dosimetry.

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) - temporary and permanent implants. Advantages and disadvantages of manual and remote afterloading techniques. Stepping source –different types of applicators-AAPM and IEC requirements for remote afterloading Brachytherapy equipment. Acceptance , commissioning and Quality Assurance of HDR units.

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)-Californium-252. ISO requirements and QA of Brachytherapy sources.

UNIT III DOSIMETRY AND DOSAGE SYSTEMS 9

Source specification – concept of exposure rate constant,reference air kerma rate,apparent activity,airkerma strength,Primary standard,water calorimetry,N_k factor for Iridium 192 HDR calibration,room scatter correction– shadow cone method,multiple distance method. Paris system-Manchester system-Paterson Parker dosage –Point and line source dosimetry formalisms, Sievert integrals TG43/TG43 U1 dosimetry formalism. IAEA TECDOC - 1274 and ICRU 72 recommendations.

UNIT IV CLINICAL PRACTICE 9

HDR Brachytherapy for treating cervix cancer-Interstitial HDR Brachytherapy in the treatment of carcinoma of the cervix. Brachytherapy in the treatment of head and neck cancer. brachytherapy in cancer of the head and neck. brachytherapy for breast cancer-– ICRU38 and 58-optimization methods.

UNIT V ADVANCED BRACHYTHERAPY SYSTEMS 9

Partial breast irradiation using balloon catheter –Intra-operative Brachytherapy - Integrated Brachytherapy unit-electronic brachytherapy –micro Brachytherapy .AAPM TG60 Protocol for intravascular brachytherapy

TOTAL: 45 PERIODS

OUTCOME

- Students will be able to decide and use different types of radioisotopes, different dose delivery techniques in brachytherapy.

TEXTBOOKS

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

REFERENCES

1. AAPM summer school, brachytherapy physics, 2005.
2. ESTRO handbook of brachytherapy, 2002
3. Principles and Practice of Brachytherapy, CA Joslin,Flynn,EJ hall,Arnold publications,2001.
4. Peter Hoskin, Catherine Coyle, *Radiotherapy in Practice*, Oxford University Press,2011

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MP7303 MATERIALS FOR IMPLANT APPLICATIONS L T P C
4 0 0 4

OBJECTIVE

- To provide knowledge on preparation, Characterization and use of biocompatible metals and non metals for bio implant application.

UNIT I BIOLOGICAL PERFORMANCE OF MATERIALS AND CHARACTERIZATION TECHNIQUES 12

Biofunctionality and biocompatibility – material response – deformation and failure – friction and wear – Host response – Inflammatory process – capsule formation – coagulation and hemolysis – approach to thromboresistant material development – chemical and foreign body carcinogenesis- Electron microscopic methods – SEM, TEM, spectroscopic methods – IR, visible, UV and X-ray methods, differential thermal analysis, differential thermogravimetric analysis, NDT methods.

UNIT II CLASSES OF MATERIALS USED IN MEDICINE 12

Metals and alloys; stainless steel, cobalt based alloys, titanium based materials – ceramics – bioinert ceramics – carbon, alumina, zircona and titania – bioactive ceramics – bioactive glass and glass ceramics, calcium phosphate ceramics – polymers, grouting materials – PMMA bone cement, articulating component – UHMWPE – composites, matrix and filter components Surface properties and Bulk mechanical properties.

UNIT III OPHTHALMOLOGIC APPLICATIONS AND DRUG DELIVERY SYSTEMS 12

Materials for ophthalmology – contact lens and intraocular lens materials – Corneal Implants-Implants for Glaucoma-Implants for Retinal Detachment surgery- drug delivery systems - Diffusion Controlled-Water penetration controlled –Chemically Controlled-Regulated Systems-Sutures materials-categories and Characteristics.

UNIT IV ARTIFICIAL ORTHOPEADIC AND DENTAL MATERIAL 12

Materials for bone and joint replacement –dental metals and alloys – ceramic – bioinert – bioactive ceramics – polymers - dental restorative materials – dental amalgams-Burn dressing–Principles of wound coverage and healing-Nano Biomaterials.

UNIT V CARDIOVASCULAR MATERIALS 12

Artificial organs – cardiovascular materials – cardiac prosthesis; vascular graft materials – cardiac pacemakers – cardiac assist devices – Extra corporeal Artificial organs –Dialysis-Heamofiltration-Apheresis-Lung Substitutes and Assists.

TOTAL: 60 PERIODS

OUTCOME

- To design and develop a new abutments that may be comparable to currently available esthetic implant abutments.

TEXTBOOKS

1. Buddy D.Ratner and Allan S.Hoffman Biomaterials Science “An Introduction to Material in Medicine” Third Edition, 2013.
2. Jonathan Black, Biological Performance of materials, Fundamentals of Biocompatibility, Marcel Dekker Inc., New York, 1992.

REFERENCES

1. D. F. Williams (editor), Material Science and Technology - A comprehensive treatment, Vol. 14, Medical and Dental Materials, VCH Publishers Inc., New York, 1992.
2. Sujatha.V..Bhat II Edition Alpha Science 2005
3. H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, Instrumental Methods of Analysis, CBS Publishers, New Delhi, 1986.
4. Amit Bandhyopadhya, Susmita Bose, Characterization of Biomaterials, Newnes, 2013

MP7311 DIAGNOSTIC AND THERAPEUTIC LABORATORY- II

L	T	P	C
0	0	6	3

OBJECTIVE

- It is concerned with the use of various imaging modalities to aid in the diagnosis of disease. Interventional radiology uses these imaging modalities to guide minimally invasive surgical procedures.

(Any FIFTEEN experiments only)

1. Quality assurance of a diagnostic x-ray machine.
2. Evaluation of characteristics of a radiographic image.
3. Study and calibration of thyroid uptake measurement unit.
4. Dose output measurement of photon (^{60}Co gamma rays and high energy x-rays) beams used in radiotherapy treatment.
5. Dose output measurement of electron beams used in radiotherapy treatment.
6. Determination of percentage depth dose of photon and electron beams.
7. Integrity check and calibration of low activity brachytherapy sources.
8. AKS/ RAKR measurement of an HDR brachytherapy source using well type and cylindrical ionisation chambers.
9. In-phantom dosimetry of a brachytherapy source.
10. Familiarisation with treatment planning procedure using a computerised radiotherapy treatment planning system.
11. Survey of a radioisotope laboratory and study of surface and air contamination.
12. Protection survey of neutron installations - Calibration and evaluation of neutron badge.
13. Protection survey of industrial radiography camera.
14. Absorption and backscattering of gamma rays - Determination of HVT.
15. Radiation protection survey of teletherapy installations.
16. Radiation protection survey of diagnostic radiology installations
17. Treatment planning of parallel opposing techniques
18. Treatment planning of three field techniques
19. Treatment planning of four field box techniques
20. Treatment planning of four field cross field technique
21. Treatment planning of wedge field techniques

TOTAL: 90 PERIODS

OUTCOME

- To make the students enable to get the hand on experience in quality assurance tests and calibration of various radiotherapy equipments and familiarize about treatment planning techniques in the treatment of cancer.

MP7001 ADVANCED CLINICAL RADIATION THERAPY PHYSICS L T P C
3 0 0 3

OBJECTIVE

- Designed to provide knowledge on advanced radiation therapy modalities to improve the quality of radiotherapy.

UNIT I CONFORMAL RADIOTHERAPY WITH MULTI LEAF COLLIMATOR 9

Introduction to CRT with MLC-Modern developments in MLC – Different categories of MLC – Leaf position detection – commercially available MLC systems — MLC acceptance testing, commissioning and safety assessment – clinical application – 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, compensator based IMRT –potential problems with IMRT – Commissioning and QA for IMRT treatment planning –patient specific quality assurance– IMRT delivery system quality assurance.

UNIT III SPECIAL TECHNIQUES IN RADIATION THERAPY 9

Total Body Irradiation, Total Skin Electron Therapy, electron arc treatment and dosimetry-intraoperative radiotherapy. Stereotactic radiotherapy-cone and mMLC based X knife-gamma knife dosimetry and planning procedures. QA protocols- Physical, clinical and planning aspects of stereotactic body radiotherapy, tomotherapy and cyberknife based therapy.

UNIT IV IMAGE GUIDED RADIATION THERAPY 9

Concept,imaging modality,kVCBCT and MVCBCT. Mechanics of breathing – Methods to manage respiratory motion in radiation treatment – x-ray imaging techniques for guidance in the Radiation therapy setting – clinical procedures in employing x-ray imaging technologies. – Effect of motion on the total dose distribution – 4D computed tomography imaging and treatment planning. delivery- QA protocol and procedures.

UNIT V VOLUMETRIC MODULATED ARC THERAPY 9

Introduction-Machine Commissioning and Quality Assurance-Dosimetric Aspects- Treatment Planning- Comparison of VMAT treatment plans with conventional IMRT planning-Patient Specific Quality Assurance.-Electronic Portal Imaging device -its clinical applications including QA tool in machine and patient specific quality assurance and gamma index analysis.

TOTAL: 45 PERIODS

OUTCOME

- Students will be able to handle state of the art radiotherapy techniques like IMRT, SRS, SRTetc.

TEXTBOOKS

1. Steve Webb, The Physics of Three–Dimensional Radiotherapy, Institute of Physics Publishing, Bristol and Philadelphia, 2002.
2. Faiz M Khan and Roger A Potish, Treatment Planning in Radiation Oncology, Williams and Wilkins, USA, 2003.

REFERENCES

1. Faiz M Khan , The Physics of Radiation Therapy, 5th edition, Lippincott Williams & Wilkins, USA, 2003.
2. Jatinder R Palta and T. Rockwell Mackie, Intensity Modulation Radiation Therapy, Medical Physics publishing, Madison , Wisconsin, 2003.
3. AAPM Report No. 72 , Basic Applications of Multileaf collimators, AAPM, USA, 2001.
4. AAPM Report No:91,Management of Respiratory motion in radiation oncology, 2006.3

MP7002 BIOLOGICAL EFFECTS OF IONIZING RADIATION L T P C
3 0 0 3

OBJECTIVE

- Designed to provide knowledge on the interaction of radiation at cellular and tissue level and their relevance in Radiotherapy.

UNIT I ACTION OF RADIATION ON LIVING CELLS 9

Target theory - single hit and multi hit target theory - 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 RESPONS TO IRRADIATION AND ITS RADIOSENSITIVITY 9

Cell survival parameters – in vitro and in vivo experiments on mammalian cell systems - 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.

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.

TOTAL: 45 PERIODS

OUTCOME

- Students will be able to decide the type of radiation, dose, fractionation with respect to different type of cancer and stage.

TEXTBOOKS

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.

REFERENCES

1. 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
2. H. Smith, J. W. Stather, Biological effects of ionising radiation, Landolt-Börnstein - Group VIII Advanced Materials and Technologies Volume 4, 2005, pp 5-40
3. Dr. Claus Grupen Biological Effects of Ionizing Radiation Graduate Texts in Physics 2010, pp 212-228
4. B. Kanyár, G. J. Köteles, Dosimetry and Biological Effects of Ionizing Radiation, Handbook of Nuclear Chemistry 2011, pp 2211-2257

MP7003 **BIOMEDICAL OPTICAL SPECTROSCOPY** **L T P C**
3 0 0 3

OBJECTIVE

- Designed to provide the knowledge for use of different laser spectroscopic methods in bioanalysis.

UNIT I TISSUE OPTICS **9**

Structure of cells and tissues – light-matter interaction: absorption, scattering, reflection, refraction, luminescence, interference, polarization; their physical models and mechanisms. Specific features of living tissues from the point of optics. Relations of scattering and absorption in tissues -different interaction of lasers with tissues – Thickness and optical properties of appropriate skin layers - Skin pigments (melanin, bilirubin, carotene, hemoglobin) and their spectra - Composition of blood. Spectral properties of erythrocytes, thrombocytes and blood plasma - Differences between oxygenated and deoxygenated hemoglobin absorption spectra.

UNIT II LIGHT PROPOGATION IN TURBID MEDIA **9**

Models of light propagation in tissues and the parameters used absorption and scattering coefficients, anisotropy, penetration depth, transport parameters; their connection with diffuse reflectance (remission). Time-resolved remittance models. Modeling of anisotropy, isotropic and layered tissue structures. Experimental studies of light propagation in tissues; tissue phantoms in experiments

UNIT III OPTO ELECTRONIC DEVICES **9**

Conventional UV- Visible - IR sources - LED – principles of Lasers – super luminescence diode – Optical detectors – characteristics – diodes – PMT – CCD – Streak camera - fibers – coupler – intensity and phase modulated fiber sensors.

UNIT IV OPTICAL SPECTROSCOPY IN MEDICINE **9**

Optical characteristics of biomolecules from the point of spectroscopy – principles of UV – Visible absorption – IR and FTIR absorption – Raman and Fluorescence spectroscopy – application with regard to characterization of biomolecules – blood oxygen, glucose measurements, monitoring drug concentration, cancer diagnosis.

UNIT V OPTICAL IMAGING OF CELLS AND TISSUES **9**

Transillumination – fluorescence and Raman microscopy – fluorescence life time imaging – FRET imaging - principles of OCT – confocal lasers scanning microscopy – application of multiphoton techniques – Optical tweezers - laser safety procedures.

TOTAL: 45 PERIODS

OUTCOME

- The student can able to design different laser spectrometers and devices for spectroscopic analysis and imaging of cells and tissues.

TEXTBOOKS

1. Markolf H Niemz, Laser-Tissue Interactions Fundamentals and Applications, Springer- Verlag Berlin Heidelberg New York, 1996.
2. A.J.Welch, M. Van Germet, Optical Thermal Response of Laser-Irradiated Tissue, Plenum press, NY, 1995.

REFERENCES

1. Joseph R Lakowitz, Principles of Fluorescence spectroscopy, Plenum press, NY, 2002.
2. William W. Parson, Modern Optical Spectroscopy: With Exercises and Examples from Biophysics and Biochemistry, Springer, 2009.
3. Nikolai V. Tkachenko, Optical Spectroscopy: Methods and Instrumentations, Elsevier, 2006
4. Paras N Prasad, Introduction to Biophotonics: John Wiley and Sons Inc. 2003.

MP7004 **BIOSENSORS** **L T P C**
3 0 0 3

OBJECTIVE

- The objective of this course is to link engineering principles to understanding of biosystems in sensors and bioelectronics. This course covers the principles, technologies, methods and applications of biosensors and bioinstrumentation.

UNIT I BIOSENSOR TRANSDUCERS 9

Electrochemical transducers (amperometric- potentiometric, conductimetric) - 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 II 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 III TYPES OF BIOSENSORS 9

Catalytic biosensors- mono-enzyme electrodes-bi-enzyme electrodes-enzyme sequence electrodes and enzyme competition electrodes-Affinity-based biosensors- Inhibition- based biosensors-Cell-based biosensors-Biochips and biosensor arrays- Problems and limitations.

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-Tissue and organelles (animal and plant tissue)-Cell culture; Immunoreceptors-Chemoreceptors-Limitations.

UNIT V BIOSENSORS FOR MEDICAL APPLICATIONS 9

Biorecognition elements and transduction technology - 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

OUTCOME

- Upon successful completion of this course, students will be able to explain biosensing and transducing techniques, design and construct biosensors instrumentation

TEXTBOOKS

1. Tatsuo Togawa,Toshiyo Tamura, P. Ake Oberg, Biomedical Transducers and Instruments, CRC Press, New York, 1997.
2. Jacob Kline, Handbook of Bio Medical Engineering, Academic press Inc., Sandiego, Oxford University Press, 2004.
3. Smart Biosensor Technology, G. K. Knoff, A. S. Bassi, CRC Press, 2006

REFERENCES

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

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MP7005 **INDUSTRIAL RADIOGRAPHY** **L T P C**
3 0 0 3

OBJECTIVE

- Designed to provide the knowledge of interaction of x and gamma ray with matter and the principle behind the NDT of metals.

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

OUTCOME

- Can able to use ionizing radiation and ultrasound in industrial and non-destructive applications efficiently without any radiation hazards.

TEXTBOOKS

1. Mc Gonnagle," Non destructive testing", Mc Graw 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.

Attested

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MP7006 MEDICAL APPLICATIONS OF LASER L T P C
3 0 0 3

OBJECTIVE

- Designed to teach the photobiological effect and its applications in diagnosis and therapy.

UNIT I LASER CHARACTERISTIC AS APPLIED TO MEDICINE AND BIOLOGY 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.

UNIT II STUDIES OF CELL BIOLOGICAL FUNCTIONS AND STRUCTURE USING LASERS 9

Optical properties of tissues (normal and tumor) - experimental methods to determine the reflectance, transmittance, absorption and emission properties of tissues. Laser systems in medicine and biology - Nd-YAG, Ar ion, CO2, Excimer - Gold vapour laser - beam delivery system and control.

UNIT III SURGICAL APPLICATIONS OF LASERS 9

Evaporation and excitation techniques - sterilization - hemostasis - laryngeal surgery - cancer surgery - liver surgery - stomach surgery - gynecological surgery - urological surgery - cardiac surgery- lasers in Opthalmology – Dermatology and Dentistry – cosmetic surgery.

UNIT IV LASERS IN DIAGNOSIS AND THERAPY 9

Trace elements detection - laser induced fluorescence studies - cancer diagnosis - photo radiation therapy of tumors - lasers in endoscopy – lasers in laproscopy – lasers in trapping of cells and genetic engineering - biosimulation.

UNIT V LASER SAFETY REGULATIONS 9

Basic laser safety – eye hazards – skin hazards – electrical hazards – fire and flood hazards – laser safety classess – technical precautions – nontechnical measures – laser safety regulations – common obstacles – laser medical surveillance.

TOTAL: 45 PERIODS

OUTCOMES

- On completion, students will be able to use different lasers of optoelectronic devices for different diagnostic and therapeutic applications.

TEXTBOOKS

1. S. S. Martellucci and A. N. Chester, Laser Photobiology and Photomedicine, Plenum Press, New York, 1985.
2. R. Pratesi and C. A. Sacchi, Lasers in Photomedicine and Photobiology, Springer Verlag, West Germany, 1980.

REFERENCES

1. Markolf H. Neimz, Laser-Tissue Interactions, Springer Verlag, Germany, 1996.
2. Ronald W. Waynant, Lasers in Medicine, CRC Press, 2010.
3. J. A. S. Carruth and A. L. McKenzie, Medical Lasers, Adam Hilger Ltd., Bristol,1992.
4. D.R. Vij, K. Mahesh, Medical applications of lasers, Springer, 2002.

MP7007 **MEDICAL IMAGING TECHNIQUES** **L T P C**
3 0 0 3

OBJECTIVE

- To illustrate, how physics is applied to the problems of clinical measurement, diagnosis, patient management and biomedical research using various Medical Imaging Technique.

UNIT I ADVANCED X-RAY IMAGING SYSTEMS 9

Bremsstralung-characteristic line spectrum- factors affecting the x-ray spectrum- Attenuation of heterogeneous and homogenous x-rays – Attenuation coefficients- Attenuation mechanisms- Radiographic image quality-factors affecting image quality- Focal spot-Heel Effect –Filters – Grids -Intensifying Screens – X-ray film- Diagnostic applications of X-rays-Skeletal system-soft tissues-the Chest –– mobile and dental x- ray machine-mammography- CT**:** Basic principle – Generation of CT – Helical CT – Single slice and Multi slice CT scan System– Image reconstruction – CT artifacts.

UNIT II MAGNETIC RESONANCE IMAGING: 9

Basic principles – Spin – Processing – Relaxation time – Free induction decay – T1, T2 proton density weighted image – Pulse sequences - Basic and advance Pulse sequences – MR instrumentation –– Image formation–Localisation of the signal - Factors influencing signal intensity- contrast and resolution - Types of magnets –super conductors– RF Transmitters – RF receivers – Gradiant coils – RF shielding - MR Spectroscopy-FMRI – MR Artifacts – safety aspects in MRI.

UNIT III DIAGNOSTIC ULTRASOUND 9

Ultrasonic waves - Beam characteristics –- 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.

UNIT IV RADIOISOTOPES IN DIAGNOSIS 9

Production of artificial radio nuclides- Radio pharmaceuticals- -Radio nuclides imaging- Selection of Radioisotopes-Image quality-radionuclides – Specific Activity and effective halflife- -Scintillators-gamma camera.-radioactive tracers-Static and Dynamic Imaging- uptake for Cardiac, Renal, Respiratory disorders - dilution analysis and its Applications- positron emission computed tomography(PET) – SPECT(elementary ideas) – density measurements, image reconstruction.

UNIT V THERMOGRAPHY AND OTHER IMAGING TECHNIQUES 9

Physics of thermography - infrared detectors -thermographic equipments - quantitative medical thermography - pyroelectric video camera - applications of thermography - Fluorescence Imaging –Fluorescence Life-time Imaging – Electrical impedance tomography (EIT) – Electrical Source Imaging (ESI) – Magnetic Source Imaging (MSI).

TOTAL: 45 PERIODS

OUTCOMES

On completion, students will be able to:

1. Identify the major medical imaging methods for clinical and biomedical research
2. The student can able to discuss the principle and working of State of the Art imaging techniques Viz., MRI,PET ,SPECT and describe methods for generating 2D and 3D medical Images.

TEXTBOOKS

1. Christensen',s Physics of Diagnostic Radiology by Thomas S Curry, IV Edition, Lippincott Williams & Wilkins, 1990.
2. The Essential Physics for Medical Imaging – 2nd Edition –Jerrold T Bushberg, Lippincott Williams & Wilkins 2002.
3. Medical Physics: Imaging, Jean A. Pope, Heinemann Publishers, 2012
4. MRI – Perry Sprawls – Medical Physics Publishing, Madison, Wisconsin-2000.

REFERENCES

1. Advances in Diagnositc Medical Physics – Himalaya Publishing House-2006.
2. Diagnositc Ultrasound applied to OBG – Sabbahaga – Maryland -1980.
3. Essentials of Nuclear Medicine Imaging. F A Mettler,MJ Guibertau,Saunders, 2005.
4. Molecular Imaging FRET Microscopy and Spectroscopy Edited by Ammasi Periasamy and Richard N Day, Oxford Press 2005.

MP7008 MONTE CARLO TECHNIQUES IN DOSIMETRY L T P C
3 0 0 3

OBJECTIVE

- To provide knowledge for the evaluation of dosimetry using statistical approach

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 PHOTON AND 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 LIGHT TRANSPORT 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.

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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

OUTCOME

- The student will be able to use Monte Carlo code to design the source and evaluate the dosimetric parameters and doses.

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

MP7009 NANO TECHNOLOGY FOR BIOMEDICAL APPLICATIONS L T P C
3 0 0 3

OBJECTIVE

- Design to provide knowledge on properties, systhensis and characterization of nanoparticles for biomedical applications.

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 BioMEMS Neuro 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

OUTCOME

- Students can able to synthesis and characterize nano particles for bio technological applications.

TEXTBOOKS

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. Freitas Jr , Nanomedicine , Freitas Jr.Kluwer publications, 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.

MP7010 NUCLEAR MEDICINE L T P C
3 0 0 3

OBJECTIVE

- Designed to provide knowledge on the use of unsealed radioactive isotopes in diagnosis and radiation medicine.

UNIT I PHYSICS OF NUCLEAR MEDICINE AND RADIO PHARMACEUTICALS 9

Radio isotopes in medical diagnosis in vitro and in vivo procedures - scintillation counters - specific activity - effective half-life - Radio isotope generators - method of preparation, purity, quality, stability and quality control of radio pharmaceuticals.

UNIT II RECTILINEAR SCANNERS AND GAMMA CAMERAS 9

Single head- dual head scanners - cameras - Auger camera: Design criteria, resolution, sensitivity measurements, choice of collimators - comparison between them, quality control in instrumentation.

UNIT III CLINICAL SCANNING OF DIFFERENT ORGANS 9

Bone scanning - Principal agents for bone scanning, 99m Tc, indications for bone scanning, various agents for bone scanning - interpretation - Pitfalls in bone scanning - limitations - radio pharmaceuticals used for brain scanning - technique with Technetium pertechnetate - scan clinical applications - radio pharmaceuticals in liver scanning comparison - technique with 99m Tc - sulfur scans - pitfalls - clinical applications - energy spectrum of Ga-67, optimization of parameters for 67Ga scanning - clinical applications.

UNIT IV DISPLAY SYSTEMS 9

Criteria for evaluation of radioisotope imaging systems in terms of concentration ratios - radioisotope systems - comparison between black and white and color displays - observer's visual response curves and determination of detection contrasts - ROC curves.

UNIT V DYNAMIC STUDIES USING RADIOISOTOPES AND ADVANCED IMAGING SYSTEMS 9

Saturation, analysis, dynamic methods, activation analysis - Models of body compartments - Deconvolution techniques - Occupancy principle - SPECT, PET, Nuclear cardiology - Monoclonal studies and RIA.

TOTAL: 45 PERIODS

OUTCOME

- Students will be able to, prepare radiopharmaceuticals for diagnosis and therapy in nuclear medicine department

TEXTBOOKS

1. W. H. Blahd, Nuclear Medicine, McGraw Hill Co., New Delhi, 2002.
2. W. N. Wagner, Principles of Nuclear Medicine, W. B. Saunders Co., London, 1990.
3. Nuclear Medicine Physics, A Hand Book for Teachers and Students, D.L.Bailey, J.L.Humm., A.Todd-Pokropek, A.Van Aswegen, IAEA, 2014
4. Essential Nuclear Medicine Physics, Rachel A Powsner and Edward R Powsner, 2nd Edition, Blackwell publishing, 2006.
5. Physics and Radibiology of Nuclear Medicine, Gobal B Saha, 3rd Edition, Springer, 2006.

REFERENCES

1. J. Herbert and D. A. Rocha, Text Book of Nuclear Medicine, Vol. 2 and 6, Lea and Febiger Co., Philadelphia, 2002.
2. S. Webb, The Physics of Medical Imaging Medical Science Series Adam Hilger Publications, Bristol, 1990.
3. Magdy M. Khalil, Basic Sciences of Nuclear Medicine, Springer, 2011
4. Marie Claire. Cantone, Christoph.Hoeschen, Radiation Physics for Nuclear Medicine, Springer, 2010.

MP7011 RADIATION HAZARDS EVALUATION AND CONTROL L T P C
3 0 0 3

OBJECTIVE

- The overall objective of radiation protection is to protect human health against deleterious effects of **ionising radiation**, during medical practices (diagnosis and therapy).

UNIT I RADIATION PROTECTION STANDARDS 9

Radiation dose to individuals from natural radioactivity in the environment and man- made sources – philosophy behind radiation protection and Basic concepts of radiation protection standards- Historical background _ ICRP and its recommendations – the system of radiological protection – Justification of practices, Optimization of protection and individual dose limits – Radiation and tissue weighting factors, equivalent dose, effective doe, committed equivalent dose, committed effective dose – concepts of collective dose – potential exposures, dose and dose constrains- system of protection for intervention – categories of exposures – occupational, public and medical exposures – permissible levels for neutron flux – factors governing internal exposure – radionuclide concentrations in air and water – ALI, DAC and contamination levels.

UNIT II EVALUATION OF EXTERNAL AND INTERNAL HAZARDS 9

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

UNIT III PLANNING AND SHIELDING CALCULATIONS 9

Planning of medical radiation installations – design of diagnostic, deep therapy, telegamma and accelerator installations, brachytherapy facilities and medical radioisotope laboratories - Classification of radio nuclide labs - bioassay and air monitoring - Particle accelerators Protective equipment - protective equipment - waste disposal rules and facilities - Radiation safety during source transfer operations Special safety features in accelerators, reactors. Planning of medical radiation installations – General considerations and evaluation of work load.

UNIT IV ADIOACTIVE WASTE DISPOSAL AND TRANSPORT 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 - Sampling techniques for air, water and solids – Geological, hydrological and meteorological parameters – Ecological considerations.

Disposal of radioactive wastes - General methods of disposal - Management of radioactive waste in medical.Transportation of radioactive substances - Historical background - General packing requirements - Transport documents - Labeling and marking of packages - Regulations applicable for different modes of transport - Transport by post - Transport emergencies - Special requirements for transport of large radioactive sources and fissile materials - Exemptions from regulations – Shipment approval – Shipment under exclusive use – Transport under special arrangement – Consignor's and carrier's responsibilities

UNIT V RADIATION EMERGENCIES, MEDICAL MANAGEMENT & LEGISLATION 9

Radiation accidents and emergencies in the use of radiation sources in medicine - Loading and unloading of sources - Loss of radiation sources and their tracing - Typical accident cases. Radiation injuries, their treatment and medical management - Case histories. National legislation – Regulatory framework – Atomic Energy Act – Atomic Energy (Radiation Protection) Rules – Applicable Safety Codes, Standards, Guides and Manuals – Regulatory Control – Licensing, Inspection and Enforcement – Responsibilities of Employers, Licensees, Radiological Safety Officers and Radiation Workers – National inventories of radiation sources – Import, Export procedures.

TOTAL: 45 PERIODS

Attested

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OUTCOME

Students will be able to effectively act as medical radiation safety officer in diagnostic and therapy departments.

TEXTBOOKS

1. R. F. Mold, Radiation Protection in Hospitals, Adam Hilger Ltd., Bristol, 1985.
2. A. Martin and S. A. Harbisor, An introduction to Radiation Protection, John Wiley & sons Inc., New York, 1981.
3. ICRP Publications, 1990.
4. Atoms, Radiation and Radiation Protection, James E. Turner, Wiley-VCH Verlag, 2007.
5. Physics for Radiation Protection- A Hand book, James E.Martin, Wiley-VCH, 2nd Edtion, 2006

REFERENCES

1. Khan, Faiz M. Treatment Planning in Radiation Oncology, 5th Edition Lippincott Williams & Wilkins, 2014
2. Glenn F.Knoll. Radiation Detection and Measurement,3rd edition John Wiley &Sons,Inc,2000
3. Subramania Jayaraman,Lawrence H.Lanzl.,Clinical Radiotherapy physics,CRC Press,Inc,1996
4. E.B.Podgorsak, Radiation Oncology Physics IAEA Publication .
5. K.N.Govindarajan Advanced Medical Radiation dosimetry, Prentice-Hall of India Pvt.Ltd,2004

MP7012 ULTRASONICS IN MEDICINE L T P C
3 0 0 3

OBJECTIVE

- To impart knowledge to the students in the field of ultrasonics which has been used in numerous fields of medicine especially gynecology, ophthalmology and cardiology.

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.

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 GYNAECOLOGY VASCULAR 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 AND ECHOCARDIOGRAPHY **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

OUTCOME

- students can able to understand propagation of ultrasonic waves through tissues, the ultrasonic transducers , ultrasound imaging and Doppler instrumentation also make them aware of safety issues relevant to ultrasound.

TEXTBOOKS

1. M. Hussey, Basic Physics and Technology of Medical Diagnostic Ultrasound, McMikkan, London 1990.
2. W. M. McDicken, Diagnostic Ultrasonic principles and use of Instrument, 2nd edition, John Wiley 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. ter Haar, Physical Principles of Medical Ultrasonics, John Wiley & Sons, 2005.
2. George L. Gooberman, Ultrasonics: Theory and Application, Hart Publishing Company, 1969.
3. Michiel Postema, Fundamentals of Medical Ultrasonics, Taylor & Francis, 2011
4. Francis A. Duck, A.C Baker, H.C Starritt, Ultrasound in Medicine, CRC Press, 2002