ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M. Phil. MEDICAL PHYSICS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

- To motivate the students about pre-research activities.
- To impart knowledge on various topics like medical applications of laser, solid state physics, bioanalysis and imaging, dielectric and optical, magnetic and superconducting properties of various materials.
- Gain knowledge on recent developments in nanoscience and technology field.
- To learn about ultrasound imaging, diagnostic and therapeutic radiation physics in addition to non-ionizing radiation physics applied to various clinical diagnosis of various diseases.

PROGRAMME OUTCOME (POs):

- At the end of the course students will be able to apply the knowledge gained in various subjects effectively for carrying out research in manufacturing and medical sector. They can also carryout interdisciplinary research activities with confidence.

ANNA UNIVERSITY, CHENNAI
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M. Phil. MEDICAL PHYSICS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM
CURRICULA AND SYLLABI

SEMESTER I

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MY7101	Laser Medicine	PC	4	4	0	0	4
2.	MY7102	Numerical Methods and Statistics	FC	4	4	0	0	4
3.		Elective I	PE	4	4	0	0	4
4.		Elective II	PE	4	4	0	0	4
			TOTAL	**16**	**16**	**0**	**0**	**16**

SEMESTER II

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MY7211	Seminar	EEC	2	0	0	2	1
2.	MY7212	Project	EEC	32	0	0	32	16
			TOTAL	**34**	**0**	**0**	**34**	**17**

TOTAL NO. OF CREDITS: 33

PROFESSIONAL CORE (PC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Laser Medicine	PC	4	4	0	0	4

FOUNDATION COURSES (FC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Numerical Methods and Statistics	FC	4	4	0	0	4

PROFESSIONAL ELECTIVES (PE)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MY7001	Advanced Solid State Physics	PE	4	4	0	0	4
2.	MY7002	Biomedical Optical Spectroscopy	PE	4	4	0	0	4
3.	MY7003	Laser theory	PE	4	4	0	0	4
4.	MY7004	Medical Ultrasonics	PE	4	4	0	0	4
5.	MY7005	Molecular Imaging Techniques	PE	4	4	0	0	4
6.	MY7006	Nanotechnology and its applications	PE	4	4	0	0	4
7.	MY7007	Physics of Advanced Radiation Therapy	PE	4	4	0	0	4
8.	MY7008	Radiation Physics and Dosimetry	PE	4	4	0	0	4
9.	MY7009	Stereotactic Radiosurgery and Stereotactic Radiotherapy	PE	4	4	0	0	4
10.	MY7010	Three Dimensional Conformal Radiotherapy	PE	4	4	0	0	4

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Project	EEC	32	0	0	32	16
2.		Seminar	EEC	2	0	0	2	1

MY7101 **LASER MEDICINE** **L T P C**
4 0 0 4

OBJECTIVE:

- To provide the basics of laser tissue interaction applied to various treatments
- To give a detailed description of the interaction mechanisms of laser with biological tissues and providing an updated review of clinical applications of laser.

UNIT I LASER TISSUE INTERACTION 12

Laser tissue interaction – photophysical process - photobiological process - absorption by biological systems - different types of interactions - thermal - photochemical (one photon and multiphoton) -PhotoDynamic Therapy- Bio-stimulation- electro mechanical - photo ablative process.

UNIT II TISSUE OPTICS & MEDICAL LASERS 12

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 - Ruby, Nd-YAG, Ar ion, CO_2, Excimer, Gold vapour laser - beam delivery system and control.

UNIT III SURGICAL AND THERAPEUTIC APPLICATIONS OF LASERS 12

Evaporation and excitation techniques - sterilization - hemostasis - laryngeal surgery - cancer surgery - liver surgery - stomach surgery - gynecological surgery - urological surgery - cardiac surgery- Photo Dynamic Therapy - Dermatology – dentistry - Cosmetic Surgery- Ophthalmology- LPLT.

UNIT IV LASERS IN PHOTO DIAGNOSIS 12

Laser induced fluorescence studies - cancer diagnosis – OCT – IR Imaging – FRET - FLIM - lasers in genetic engineering - trace elements detection.

UNIT V LASER SAFETY REGULATIONS, STANDARDS, AND GUIDELINES FOR PRACTICE 12

Laser use Risk Management- knowledge of standards, regulations, and professional practice guidelines - identification of hazards and risks- implementation of control measures- Types of Hazards- Protection standards for lasers - safety regulations - specific precautions.

TOTAL: 60 PERIODS

OUTCOME:

- Can safely employ lasers appropriately with the knowledge of their wavelength and power for various biological applications.

REFERENCES:

1. Thyagarajan. K & Ajoy Ghatak, "Laser fundamentals and applications", Springer, 2010.
2. Hector J Rabal, Roberto A Braga Jr., "Dynamic Laser Speckle and applications", CRC Press ,2009.
3. helena jelínková, lasers for medical applications-diagnostics, therapy and surgery,woodhead publishing limited, 2013
4. Markolf Neimz, "Laser Tissue interactions", Springer science & Business media, 2004.
5. Fotakis. C, Papazoglou. T & Kalpouzos. C, "Optics and Lasers in Biomedicine and Culture", Springer, 2000.
6. Guy A Catone, Charles C Alling, "Laser Applications in Oral and Maxillofacial Surgery", W.B. Saunders, 1997.
7. Carruth. J. A. S. and McKenzie. A. L., "Medical Lasers", Adam Hilger Ltd., 1992.
8. Myron L Wolbarsht, "Laser applications in Medicine and Biology – Vol-5", Plenum press, 1991.
9. Martellucci. S. S. and Chester. A. N., "Laser Photobiology and Photomedicine", Plenum Press, 1985.
10. Pratesi. R.and Sacchi. C. A., "Lasers in Photomedicine and Photobiology", Springer, 1980.

MY7102 **NUMERICAL METHODS AND STATISTICS** **L T P C**
4 0 0 4

OBJECTIVE:

- To expose the student with various mathematical methods for numerical analysis and Statistical significance.
- To impart knowledge on systems of equation, probability statistics and error analysis.

UNIT I NUMERICAL INTERPOLATION, DIFFERENTIATION AND INTEGRATION 12

Newton's forward and backward interpolation formulae - Lagrange's interpolation formula for unequal intervals - Error in polynomial interpolation and Newton's interpolation formula - Numerical differentiation - Maximum and minimum of a tabulated function - Numerical integration - Trapezoidal rule - Romberg's method- Simpson's rule - Practical applications of Simpson's rule.

UNIT II NUMERICAL SOLUTION OF ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 12

Solution by Taylor's series - Euler's method - Runge-Kutta method - Predictor - Corrector method - Milne's method - Adam Baschforth method - Numerical solution of partial differential equations - Finite equations - Elliptic equations - Laplace equation - Poisson's equation - Parabolic equations - Hyperbolic equations.

UNIT III EMPIRICAL LAWS AND CURVE FITTING 12

Linear law and laws reducible to linear law – method of moments - method of group averages - principle of least squares - Fitting of straight line and parabola.

UNIT IV STATISTICS 12

Measures of central tendency, mean, median, mode, dispersion, standard deviation, root mean square deviation, moments, skewness and kurtosis - Application to radiation detection. Binomial distribution, Poisson's distribution, Gaussian distribution, exponential distribution, bi-variant distribution, correlation and regression -Chi-Square distribution, t - distribution- F – distribution – error propagation**.**

UNIT V RESEARCH METHODOLOGY 12

Introduction - Defining research problem - research design - Important concepts - different research design - basic principles of experimental design - sampling design - steps and types of sampling design. Purpose and problem statements - Literature review - Frameworks - Research questions and hypotheses - Multimethod research.

TOTAL: 60 PERIODS

OUTCOME

- Can fit the data points to an appropriate curve with better correlation.
- Analyze the given set of data points for better discrimination using the knowledge of statistics.
- Estimate the errors involved in the experimental measurements.

REFERENCES

1. Guest. P G, "Numerical Methods of Curve Fitting", Cambridge University Press, 2013.
2. John F Monahan, "Numerical Methods of Statistics", Cambridge University Press, Second Edition, 2011.
3. Kothari. C.R, "Research Methodology", New Age International publishers, New Delhi, 2008.
4. Shastry. S.S, "Introductory Methods of Numerical Analysis", Prentice Hall, New Delhi, 1984.
5. Gerald C.F. and Wheatley P.O, "Applied Numerical Analysis", Sixth Edition, Pearson Education Asia, New Delhi, 2002.
6. Burden R.L. and Faires T.D. "Numerical Analysis" Seventh Edition, Thomson Asia Pvt. Ltd. Singapore, 2002.

MY7001 **ADVANCED SOLID STATE PHYSICS** **L T P C**
4 0 0 4

OBJECTIVE:

- To expose the students with the theoretical concepts of Solid State Physics.
- To impart knowledge on crystal structure and binding, electronic properties, lattice dynamics, dielectric & optical properties and magnetic and superconducting properties of materials.

UNIT I CRYSTAL STRUCTURE AND BINDING 12

Symmetry - crystal lattice - unit cell (conventional and Wigner-seitz unit cell) - crystal structures - crystallographic point groups and space groups - reciprocal lattice - Brillouin zone - force between atoms - cohesive energy - bonding in solids - ionic, covalent, metallic and hydrogen bonded crystals.

UNIT II ELECTRONIC PROPERTIES 12

Free electron theory (classical and quantum) - electronic specific heat - electrical and thermal transport - failures of free electron model - periodic crystalline potential - Bloch theorem - formation of energy bands - Band structure of Nanomaterials - classification of solids - Fermi surface of metals.effective mass and concept of hole - intrinsic and extrinsic semiconductors - direct and indirect bandgap of semiconductors.

UNIT III LATTICE DYNAMICS 12

Vibrational modes of mono and diatomic lattices - quantization of lattice vibration - lattice specific heat theories (Einstein and Debye models) - phonon momentum - scattering of neutrons by phonons - neutron diffraction - lattice thermal conductivity - normal and Umklapp process – anharmonicity and thermal expansion

UNIT IV DIELECTRIC AND OPTICAL PROPERTIES 12

Polarization - theory of polarizability - Clausius-Mossotti relation - piezo - pyro and ferroelectric properties of crystals - antiferroelectricity and ferrielectricity - absorption process in semiconductors - photoconductivity - photoluminescence - Defects in crystals- color centers

UNIT V MAGNETIC PROPERTIES AND SUPERCONDUCTIVITY 12

Classification of magnetic materials - Hund's rule - ferromagnetic order - Curie point - exchange integral - saturation magnetization - origin of domains - magnons - Superconductivity - electron-phonon interaction - cooper pairs - BCS theory - energy gap and its temperature dependence - London equation - Josephson effect - high temperature superconductivity.

TOTAL: 60 PERIODS

OUTCOME:

- Can understand the structural, electric, magnetic, and optical properties of materials.
  - Can classify materials based on their different properties.

REFERENCES

1. Philip Phillips, "Advanced Solid State Physics", Cambridge University Press, 2012.
2. William D. Callister, David G. Rethwisch "Fundamentals of Material science and Engineering an Introduction", sixth edition, Wiley India, 2009.
3. S.O. Pillai "Solid State Physics", Sixth Edition, New Age International (P) Ltd Publishers, New Delhi, 2010.
4. Kittel. C, "Introduction to Solid State Physics", Wiley Eastern, 1996
5. Hummel. R.E, "Electronic properties of materials", Narosa, 1993.
6. Chandra. A.K, "Quantum Chemistry", Prentice Hall 1990
7. Ashcroft. N.W and Mermin. N. D, "Solid state Physics" Saunders 1976
8. R.J. Elliott and A.F. Gibson "An Introduction to Solid State Physics and its Applications", MacMillan, 1974.
9. Dekker. A.J, "Solid State Physics", Prentice Hall, 1957.

MY7002 BIOMEDICAL OPTICAL SPECTROSCOPY L T P C
4 0 0 4

OBJECTIVE:

- To provide the knowledge for use of various spectroscopic methods in bioanalysis and Imaging.
- To enrich them with knowledge about various Optical components and their importance.

UNIT I TISSUE OPTICS 12

Structure of cells and tissues – light-matter interactions - physical models and mechanism. Specific features of living tissues from the point of optics. Relations of scattering and absorption in tissues - interaction of lasers with tissues – Thickness and optical properties of appropriate skin layers - Skin pigments (melanin, bilirubin, carotene, hemoglobin) and their spectra - Blood composites and their spectral properties - difference between oxygenated and deoxygenated hemoglobin absorption spectra.

UNIT II LIGHT PROPOGATION IN TURBID MEDIA 12

Models of light propagation in tissues - absorption and scattering coefficients, anisotropy, penetration depth, transport parameters - Diffuse reflectance (remission) - Time-resolved remittance models. Modeling of isotropic, anisotropic and layered tissue structures. Experimental studies of light propagation in tissues – tissue phantoms.

UNIT III OPTO ELECTRONIC DEVICES 12

UV- Visible - IR sources - Laser diode - LED – Super luminescence diode – Optical detectors – characteristics – diode detectors – PMT – CCD – Streak camera - fibers – coupler – intensity and phase modulated fiber sensors.

UNIT IV PHOTONIC IMAGING TECHNIQUES 12

Lifetime based Imaging – Confocal Microscopy-Two Photon excitation Fluorescence Microscopy-Near field imaging- Biological and biomedical applications-OCT, elastography - Laser Doppler perfusion monitoring & imaging – Thermal imaging for medical diagnosis.

UNIT V BIOMEDICAL DIAGNOSTICS 12

Biosensors for Biomedical applications-Glucose diagnostics - *in vitro* clinical diagnostics-Atomic Spectroscopy in biological and Clinical analysis – Flow Cytometry – Capillary Electrophoresis techniques in biomedical analysis- Fluorescence and Raman Spectroscopy – NIR Fluorescence Imaging.

TOTAL: 60 PERIODS

OUTCOME:

- Can design block diagram for their specific applications
- Can employ their knowledge in determining the optical properties.
- Apply the knowledge about biomedical optics to improve the diagnostic efficiency of diseases.

REFERENCES:

1. Paras N. Prasad, "Introduction to biophotonics", John Wiley & Sons, 2004.
2. Tuan Vo-Dinh, "Biomedical photonics handbook", CRC press, 2003.
3. Markolf H Niemz, "Laser Tissue interactions fundamentals and applications", Springer, 2004.
4. Ashley j Welch, Martin J C Van Gemect, "Optical Thermal response of Laser irradiated tissue", Springer, 2011.
5. Gupta. S C, "Optoelectronic Devices and Systems", Prentice Hall of India Pvt Ltd., 2005.

MY7003 **LASER THEORY** **L T P C**
4 0 0 4

OBJECTIVE:

- To expose the students with theoretical aspects of laser theory and its applications.
- To provide knowledge on laser theory, resonators and switching theory, gas & liquid lasers, solid state & semiconductor lasers and their applications.

UNIT I LASER THEORY 12

Absorption - Spontaneous and stimulated emission - Einstein's coefficients - threshold conditions for laser action - Line broadening, Mechanism - Lorentzian and Doppler line shapes - Small signal gain - Gain coefficient - gain saturation - Rate equations for 3 and 4 level systems.

UNIT II RESONATORS AND SWITCHING THEORY 12

Resonant cavity - Fox and Li - Boyd and Gorden's theory on resonators - modes - Spot size - Types of resonators - Mode selection - Q switching theory and technique - Mode locking theory and technique.

UNIT III GAS AND LIQUID LASERS 12

He-Ne, Argon Ion, Carbon dioxide, Nitrogen - Metal vapour - Gas dynamics - Excimer - Free electron lasers - Dye lasers-organic dyes - Pulsed and CW dye lasers - Threshold conditions - Pumping configurations.

UNIT IV SOLID STATE AND SEMICONDUCTOR LASERS 12

Ruby, Nd : YAG, Nd : Glass, Ti-sapphire, Alexandrite, lasers - Semiconductor lasers - Homo junction - Hetro junction - Quantum well laser.

UNIT V APPLICATIONS 12

Speckle, speckle interferometry - Holography - Holographic interferometry - Material processing - Surface treatment – welding - drilling - Laser ranging - Laser Doppler Velocimetry - Pollution monitoring - Medical applications.

TOTAL: 60 PERIODS

OUTCOME

- Employ lasers with the basic knowledge about lasers for material characterization, interferometry, velocimetry and medical applications at their fundamental frequency and higher harmonic

REFERENCES

1. Dr. Avadhanulu. M N, Dr. Hemne. P S, "An Introduction to Laser theory and applications", S Chand and Company Ltd., 2012.
2. Paul R Berman Vladmir S Malinovsky, " Principles of Laser Spectroscopy and Quantum optics ", Princeton University Press, 2011.
3. Nambiar. K R, "Laser: Principles types and applications ", New Age International Publishers, 2005.
4. William T. Silfvast, " Laser Fundamentals ", Cambridge University Press, 1999.
5. Yariv. A, "Quantum Electronics", Third Edn., Addison-Wesley 1990.
6. Oshea, Callen and Rhcdes, "An Introduction to Lasers and their Applications", Addison Wesley, 1985.
7. Hariharan, "Optical Holography", Academic Press, New York, 1983.
8. Erf.R.K, "Speckle Metrology", Academic Press, New York, 1978.

MY7004 **MEDICAL ULTRASONICS** **L T P C**
4 0 0 4

OBJECTIVE:

- To learn the interaction mechanism and production methodology of ultrasound.
  To learn the tissue interaction mechanism and scanning methods

UNIT I ULTRASOUND PRODUCTION AND ITS CHARACTERISTICS 12

Basic ultrasound- frequency- speed- wavelength-power amplitude- acoustic impedance matching–beam width- reflection –refraction –scattering –attenuation- production and propagation- transducer- types – piezo electric –magnetostriction- ferro electric crystals- efficiency-transducer mounting – probe and its types

UNIT II SCANNING METHODS 12

A, B, M-mode, system design-real time scanning –dynamic focus, compound scanning- resolution-axial, lateral- factors affecting image quality. 3-D, 4-D Applications to Ophthal – Obstertrics & Gynaecology.

UNIT III DOPPLER METHODS 12

Double doppler shift-single beam doppler- continuous wave & pulsed wave doppler – high pulse repetition frequency doppler- directivity and spectral analysis- duplex scanning – color & power doppler – blood flow measurements –– cardiovascular applications- ultrasound guided biopsy – tissue doppler mapping.

UNIT IV APPLICATIONS OF ULTRASOUND 12

Cavitation – types of cavitation – commercial ultrasound contract agent – molecular imaging –cases of sonoporation-drug carriees – therapeutic gases – cell death – high intensity focus ultrasound

UNIT V DOSIMETRY, SAFETY AND BIO-EFFECTS 12

Intensity- exposure time – spatial power & pressure measurement – mechanism of possible ultrasound induced biological effects- dose reduction techniques.

TOTAL : 60 PERIODS

OUTCOME:

- Gain knowledge about ultrasound & its safety level and importance of optimum scanning methodology.

REFERENCES

1. Michel Postema, " Fundamentals of Medical Ultrasonic", Spon press, 2011.
2. Hill. C R, Bamber. J C, Ter Haar. G R, " Physical principles of Medical Ultrasonic", John Wiley & Sons, publishing, 2004.
3. David J Cheeke N, “Fundamental and Applications of Ultrasonic waves ", CRC Press, 2002.
4. Lerski R.A. (Ed), “Practical Ultrasound”, IRL Press, Oxford, 1988
5. Woodcock J.P., “Ultrasonics”, Adam Hilger Ltd., U.K., 1979
6. Hylton b.Meire, John, Basic Ultrasound , Wiley & Sons, 1995.
7. Robert T.Beyer and Stephen V. Letcher, “Physical Ultrasonics”, Academic Press London, 1969.

MY7005 **MOLECULAR IMAGING TECHNIQUES** **L T P C**
4 0 0 4

OBJECTIVES:

- To enrich the knowledge about microscopes
- To educate the types of microscopes, their resolution, image contrast and depth of investigation

UNIT I OPTICAL MICROSCOPY 12

Optical microscopy- Use of polarized light microscopy – Phase contrast microcopy – Interference Microscopy – hot stage microscopy - surface morphology – confocal microscopy – florescence microscopy.

UNIT II SCANNING ELECTRON MICROSCOPY 12

Basic design of the scanning electron microscopy – types of electron source - Modes of operation– Backscattered electrons – secondary electrons- typical forms of contrast– Resolution and contrast – enhancement – Specimen Preparation - applications of SEM.

UNIT III TRANSMISSION ELECTRON MICROSCOPY 12

Basic principles - Modes of operation – Specimen preparation – Diffraction in imperfect crystals – Dislocations – precipitates – Structure of Grain boundaries and interfaces- HRTEM use in nanostructures – SAED – FFT pattens.

UNIT IV ATOMIC FORCE MICROSCOPY 12

Basic concepts-Interaction force - AFM tip on nanometer scale structures- force curves, measurements and manipulations-feed back control-different modes of operation –contact, non contact and tapping mode-Imaging and manipulation of samples in air or liquid environments-Imaging soft samples. Scanning Force Microscopy-Shear force Microscopy-Lateral Force Microscopy-Magnetic Force microscopy.

UNIT V SCANNING TUNNELING MICROSCOPY 12

Principle- Instrumentation- importance of STM for nanostructures – surface and molecular manipulation using STM -3D map of electronic structure.

TOTAL: 60 PERIODS

OUTCOME:

- Can use various microscopes to characterize the materials to study the surface properties

REFERENCES

1. Goldstein. J, Newbury. D. E, Joy. D.C, and Lym. C.E., “Scanning Electron Microscopy and X-ray Microanalysis”, 2003.
2. Flegler. S.L, Heckman. J.W and Klomparens. K.L, “Scanning and Transmission Electron Microscopy: A Introduction”, WH Freeman & Co, 1993.
3. Goodhew. P.J, Humphreys. J, Beanland. R, “Electron Microscopy and Analysis”, 2001.
4. Haynes. R, Woodruff. D.P and Talchar. T.A, “Optical Microscopy of Materials”, Cambridge University press, 1986.
5. Brain Herman and John J Lemasters – “Optical Microscopy”. Emerging methods and Applications -1993, Academic Press.
6. Grey Haustad, "Atomic force Microscopy understanding Basic Modes & Advanced Applications", Wiley, 2012.

MY7006 NANOTECHNOLOGY AND ITS APPLICATIONS L T P C
4 0 0 4

OBJECTIVE:

- To provide basic knowledge on Nanomaterials their synthesis and characterization
- To make the students understand the importance of Nanotechnology
- To make the students understand the fundamental aspects of Nanotechnology and its importance in emerging biomedical applications.

UNIT I NANO SYSTEMS 12

Size effect and properties of nanoparticles - melting point, surface tension, wettability - specific surface area–change in optical properties, electrical properties, and mechanical properties. Quantum confinement in 3D, 2D, 1D and zero dimensional nano structures .

UNIT II SYNTHESIS OF NANOMATERIALS 12

Top down and Bottom up approach - Gas phase condensation – Vacuum deposition -Physical vapor deposition (PVD) - chemical vapor deposition (CVD) – Atomic Layer Deposition (ALD) - laser ablation- Sol-Gel- Ball milling – Electrodeposition- wet chemical methods - spray pyrolysis – plasma based synthesis process (PSP) - hydrothermal synthesis – biosynthesis.

UNIT III NANOMATERIALS FOR MEDICAL APPLICATIONS 12

Nobel nano metals - quantum dots – magnetic nano particles – carbon nano tubes and one dimensional nano structures - Graphene – dendrimers – cytosine nano particles.

UNIT IV CHARACTERIZATION 12

X-ray diffraction – crystallite size- Surface area - florescence microscopy – surface charges and particles size by zeta potential analyzer - UV – visible spectroscopy for absorption, transmission and band gap determination – electrochemical characterization for nano materials.

UNIT V MEDICAL APPLICATIONS 12

Applications of nanoparticles, quantum dots, Nanotubes and nanowires - tissue engineering – nano medicines – drug delivery – quantum dot protein sensors – Molecular machines - OCT – nano robots – PDT – PTT.

TOTAL: 60 PERIODS

OUTCOME:

- Can synthesize medically important nanoparticles and characterize them and apply them for various diagnostic and therapeutic applications.

REFERENCES

1. Timp. G., “Nanotechnology”, Editor, AIP press, Springer, 1999.
2. Hari Singh Nalwa, “Nanostructured materials and Nanotechnology’’, Academic Press, USA, 2002.
3. “Hand book of Nanoscience, Engineering and Technology (The Electrical Engineering handbook series)", Kluwer Publishers, 2002.
4. Mark Ratner, Daniel Ratner, " Nanotechnology", Pearson Publication, 2003.
5. John Dinardo. N, Weinheim Cambridge, " Nanoscale characterization of surfaces & interfaces ", Wiley, 2000.
6. Charles P Poole Jr, " Introducation to Nanotechnology ", Frank J Owens,Wiley Publication, 2003.

MY7007

PHYSICS OF ADVANCED RADIATION THERAPY

L T P C
4 0 0 4

OBJECTIVE:

- To provide knowledge based and practical skills training to support the implementation of advanced Radiotherapy techniques in India.

UNIT I CONFORMAL RADIOTHERAPY WITH MULTI LEAF COLLIMATOR 12

MLC - different categories –commercial MLC systems –– MLC acceptance testing, commissioning and safety assessment - Quality Assurance of MLCs - Leaf position detection – recent developments in MLC.

UNIT II INTENSITY MODULATION RADIATION THERAPY 12

IMRT –Different methods – physical optimization –– 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 delivery system quality assurance.

UNIT III IMAGE GUIDED RADIATION THERAPY 12

Imaging techniques for guidance in Radiation therapy – clinical procedures in employing imaging technologies – Methods to manage respiratory gating - Effect of motion on the total dose distribution – 4D computed tomography imaging and treatment planning - Gated Radiation Delivery- IGRT QA protocol.

UNIT IV VOLUMETRIC MODULATED ARC THERAPY 12

Introduction to VMAT - 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.

UNIT V PARTICLE BEAM THERAPY 12

Proton beam therapy- Physics of proton beams- Equipment for proton beam therapy- configurations of proton delivery systems- treatment planning in particle therapy- Heavy ion therapy-Carbon ion therapy-Neutron therapy-Boron Neutron Capture Therapy.

TOTAL: 60 PERIODS

OUTCOME:

- To practice, all aspects of clinical medical physics with safe, accurate and effective delivery of Radiotherapy treatment

REFERENCES

1. Steve Webb, “The Physics of Three–Dimensional Radiotherapy”, Institute of Physics Publishing, 2002.
2. Faiz M Khan and Roger A Potish, “Treatment Planning in Radiation Oncology”, Lippincott Williams and Wilkins, 2011.
3. Faiz M Khan, “The Physics of Radiation Therapy”, Lippincott Williams & Wilkins, 2014.
4. Jatinder R Palta and T. Rockwell Mackie, “Intensity Modulation Radiation Therapy”, Medical Physics publishing, 2003.
5. Arthur Boyer, Ph.D.,Peter Biggs, Ph.D., James Galvin, D.Sc., Eric Klein, M.Sc., Thomas LoSasso, Ph.D., Daniel Low, Ph.D., Katherine Mah, M.Sc., Cedric Yu, D.Sc., “ AAPM Report No. 72, Basic Applications of Multileaf collimators”, AAPM, USA,2001.

6. Paul J. Keall Virginia ,Gig S. Mageras , James M. Balter, Richard S. Emery , Kenneth M. Forster , Steve B. Jiang, Jeffrey M. Kapatoes , Hideo D. Kubo , Daniel A. Low , Martin J. Murphy ,Brad R. Murray , Chester R. Ramsey , Marcel B. van Herk, S. Sastry Vedam , John W. Wong , Ellen Yorke, "AAPM Report No:91, Management of Respiratory motion in radiation oncology", AAPM, USA, 2006.
7. Thomas F. DeLaney, Hanne M. Kooy, "Proton and charged particle radiotherapy", Lippincott Williams & Wilkins, 2008.
8. Soren M. Bentzen, Minesh P. Mehta, Paul M. Harari, Wolfgang Tomé, "Radition Oncology Advances", Springer, 2008.

MY7008 RADIATION PHYSICS AND RADIATION DOSIMETERS L T P C
4 0 0 4

OBJECTIVES

- Designed to teach the students about the basic radiation physics and instruments used to detect and measure radiation.

Unit I ATOMIC STRUCTURE

Structure of matter - Atomic structure- Building up the models- schematic description of the atomic structure - nucleus - peripheral electrons/shells- Binding energies in atoms and molecules - energy and matter - binding energies in atoms and molecules - perturbation of binding energies - excitation - ionization- nuclear forces and nuclear energy levels -Abundance of stable nuclei as a function of the number of protons and neutrons - influence of N/Z on stablility.

Unit II NUCLEAR TRANSFORMATION

Quantification of Radioactivity - activity: quantity and unit - General properties of alpha, beta and gamma rays- Radioactive transformations associated with strong interactions- associated with the electrostatic force and associated with the weak interaction and artificial radioactivity - radioactive disintegration and decay - Laws of radioactivity - half life of a radioactive nuclide - specific activity - equilibrium with radioactive daughter products- laws of successive transformations - natural radioactive series.

Unit III INTERACTION OF RADIATION WITH MATTER

Interaction of electromagnetic radiation with matter-thomson scattering - photoelectric and compton process and energy absorption - pair production - attenuation and mass energy absorption coefficients - relative importance of various processes. - HVL - TVL - Interction of charged particle with matter- collision losses - cerenkow radiation - radiative losses - - Bremmstrahlung - interaction of neutron with matter.

Unit IV RADIATION QUANTITIES AND UNITS

Measurement of Activity - cuire - Becquerel - decay constant - half life - relationship beteween half life and decay constant - exposure and absorbed dose - Roentgen - Gray - electron volt (eV) - Half value layer as an index of penetration of radiation - linear and mass attenuation coefficients - KERMA - CEMA - Radiation Protection and its units - linear energy transfer (LET) - stomping power.

Unit V PRINCIPLES OF RADIATION DETECTION AND DOSIMETERS

Introduction - Properties of dosimeters - theory of gas filled detector - Ionization chamber - proportional counter -GM counter - dead time and recovery time - quenching - scintillation detector- semiconductior detector - Radiogrphic and radiochromic - Thermoluminescent dosimeters (TLD) - optically stimulated dosimeters (OSLD)- Gel dosimetry.

TOTAL: 60 PERIODS

OUTCOME:

students willbe able to understand about radiation and their interaction with matter, different types of radiation quantities with their units and radiation detectors.

REFERENCES:

1. Radiation oncology Physics: Hand book for teachers and students, E.B.Podgorsak , IAEA Publicationss, 2005.
2. Hand book of Radiotherapy Physics - Theory and practice, P.Mayles, A.Nahum and JC Rosenwald , CRC Press, Taylor and Francis Group, LLC - 2007.
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MY7009 STEREOTACTIC RADIOSURGERY AND STEREOTATIC RADIOTHERAPY L T P C
4 0 0 4

OBJECTIVE:

- To provide the knowledge on principle of gamma knife and linac based Radiosurgery and Radiotherapy

UNIT I STEREOTACTIC RADIOSURGERY AND STEREOTACTIC RADIOTHERAPY 12

Radiosurgery and Stereotactic Radiotherapy-Gamma Knife and Linac based Radiosurgery-Methods of immobilization, localization devices and potential for frameless stereotaxy - Treatment Planning Imaging and Evaluation - Treatment Delivery.

UNIT II CLINICAL INDICATIONS 12

Structure and Functioning of the brain. Clinical implications and malformations - AV AOVM, glioma, meningioma, acoustic schwanoma, pituitary adenoma and others.

UNIT III LINAC BASED RADIOSURGERY 12

Physical principles involved in the design of current linear Accelerators-Design and Characteristics - Modifications to the normal acclearators for Radiosurgery- MLC - Dosimetry of various collimators-3D calculation algorithms for non-coplanar fields-Quality assurance checks for radiosurgery-Image fusion in treatment planning and treatment evaluation.

UNIT IV QUALITY ASSURANCE 12

Scope of Computers in Radiation Treatment planning-Factors to be incorporated in computational algorithms- Cost effectiveness of Treatment Planning System -Hardware and Software requirements Periodic software and hardware Q.A checks - Installation and Quality Acceptance of TPS and Linac accessories for Radiosurgery.

UNIT V RADIOBIOLOGY OF SRS AND SRT

Physical and Biological factors affecting cell survival-tumor re-growth and normal tissue response-Non conventional fractionation scheme and their effect of re-oxygenation, repair redistribution in the cell cycle - High LET radiation therapy - TDF- LQ Model-Radiobiology of Radiosurgery - Radiobiology of fractionated Stereotactic Radiotherapy.

TOTAL: 60 PERIODS

OUTCOME:

- Can perform quality assurance in Linac and Gamma-knife and treat patient with respect of Radiobiological effect

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MY7010 THREE DIMENSIONAL CONFORMAL RADIOTHERAPY L T P C
4 0 0 4

OBJECTIVES:

- To expose the students with basic concepts of conformal radiotherapy.
- To impart knowledge on three dimensional radiation therapy treatment planning, treatment optimization, conformal therapy with multileaf collimators, treatment machine features for conformal therapy, imaging for conformal radiotherapy planning.

UNIT I 3D RADIATION THERAPY TREATMENT PLANNING 12

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 12

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 12

Brahme’s theory of orientation – Optimization of Beam Profiles, Dynamic Wedge of Linac Wedges with MLC’s. Linac’s with Independent Collimators – Instrumentation – Radiation Detectors-ion chamber, Diode, Film, TLD - Electronic Portal Imaging Devices.

UNIT IV MACHINE FEATURES FOR CONFORMAL THERAPY 12

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 12

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: 60 PERIODS

OUTCOME:

- Prepare 3D and IMRT treatment plans
- Analyze and discuss treatment plans for special cases

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