Dr. N.G.P.ARTS AND SCIENCE COLLEGE (Autonomous)

REGULATIONS 2019-20 for Post Graduate Programme
(Outcome Based Education model with Choice Based Credit System)
M.Sc. Degree
(For the students admitted during the academic year 2020-21 and onwards)

Programme

M.Sc. Medical Physics – Two year (2 Years of academic + 1 Year Internship)

Eligibility

The candidates who have passed B.Sc. Physics with 60% and above aggregate marks with Mathematics as one of the ancillary subjects in regular mode from a recognized university.

Admission Criteria

The admission is based on the marks secured in the entrance examination conducted by Dr.N.G.P.ASC and the marks secured in UG degree by the candidate. The entrance examination will be conducted for 100 marks in the pattern of multiple choice questions from B. Sc. Physics. (Major Subjects - 75 marks and Ancillary Subjects – 25 marks).

Programme Educational Objectives

1. The Curriculum is designed to attain the following learning goals which students shall accomplish by the time of their Post Graduation:
2. The aim of this programme is designed to enable a student to optimize their learning and their knowledge by implementing in medicine and biology in order to improve health care.
3. To develop new methods & techniques for the radiology and imaging and radiotherapy related science.
4. To plan radiotherapy treatment methods, delivery, verification and execution.
5. To develop radiation dosimetry and ensure radiological safety of healthcare workers, patients and public.
6. At the end of the programme the student will have an in depth knowledge in the field of Medical Physics and related sciences.

PROGRAMME OUTCOMES:

On the successful completion of the program, the following are the expected outcomes.

PO Number	PO Statement
PO1	To impart the quality of Medical Physics program focuses on the clinical application of radiation sciences in medicine. Students are trained to play a central role in developing, planning and implementing patient treatment programs.
PO2	To Apply medical physics theories, methods and tools related to measurement of radiation dose (relative and absolute), verification of output from radiation producing machines, patient-specific treatment plans development, approval, and verification.
PO3	To provide hands-on clinical education and to prepare the graduate for the AERB board certification examination and a professional career in radiation therapy.
PO4	To develop treatment plans that provides adequate target coverage while sparing normal and critical tissues.
PO5	To demonstrate an awareness of the complexity of knowledge in medical physics as well as receptiveness to alternative interpretations, new knowledge, and alternative approaches to problem solving.

TOTAL CREDIT DISTRIBUTION

Courses	Credits	Total Marks		Credits	Cumulative Total
Core- Theory	4	13x100	1300	52	52
Core- Practical	3	4x 100	400	12	12
Elective	4	4x100	400	16	16
Medical Physics Summer Training	2	1x100	100	2	2
Project work	8	1x200	200	8	8
Total			**2400**	**90**	**90**

CURRICULUM

M.Sc. MEDICAL PHYSICS PROGRAMME

Course Code	Course Category	Course Name	L	T	P	Exam (hours)	Max Marks			Credits
							CIA	ESE	Total	
First Semester										
192MP2A1CA	Core-I	Nuclear Physics	4	1	-	3	25	75	100	4
192MP2A1CB	Core-II	Radiation Physics	4	1	-	3	25	75	100	4
192MP2A1CC	Core-III	Biomedical Electronics and Instrumentation	4	1	-	3	25	75	100	4
192MP2A1CD	Core-IV	Radiological Anatomy, Physiology and Pathology	4	1	-	3	25	75	100	4
192MP2A1CP	Core Practical-I	Biomedical Electronics and Instrumentation Lab	-	-	6	3	40	60	100	3
192MP2A1DA	DSE-I	Solid State Physics	4	-	-	3	25	75	100	4
202MP2A1DB		Advanced Materials In Medicine And								
202MP2A1DC		Artificial Intelligence In Health Care								
		Total	**20**	4	**6**	**-**	**-**	**-**	**600**	**23**

Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Second Semester										
192MP2A2CA	Core-V	Radiation Detectors and Instrumentation	4	1	-	3	25	75	100	4
192MP2A2CB	Core-VI	Physics of Radiation Therapy	4	1	-	3	25	75	100	4
192MP2A2CC	Core-VII	Physics of Radiology Imaging	4	1	-	3	25	75	100	4
202MP2A2CP	Core Practical-II	Radiation Measuring and Monitoring Instrumentation	-	-	6	6	40	60	100	3
192MT2A2IC	EDC	Mathematical Physics	4	-	-	3	25	75	100	4
192MP2A2DA	DSE-II	Radiation Dosimetry and Standardization	4	1	-	3	25	75	100	4
192MP2A2DB		Biomedical Optical Spectroscopy								
192MP2A2DC		Programming in C++								
TOTAL			**20**	**4**	**6**	**-**	**-**	**-**	**600**	**23**

Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Third Semester										
192MP2A3CA	Core-VIII	Advanced Radiotherapy Physics	4	1	-	3	25	75	100	4
192MP2A3CB	Core-IX	Physics of Nuclear Medicine	4	1	-	3	25	75	100	4
192MP2A3CC	Core-X	Radiation Biology	4	1	-	3	25	75	100	4
192MP2A3CD	Core-XI	Brachytherapy Physics	4	1	-	3	25	75	100	4
192MP2A3CP	Core Practical-III	Treatment Planning, Radiation Dosimetry and Survey	-	-	6	6	40	60	100	3
192MP2A3DA	DSE-III	Materials for Radiation Dosimeters	4	-	-	3	25	75	100	4
192MP2A3DB		Nanotechnology for Biomedical Applications								
192MP2A3DC		Monte Carlo Techniques in Dosimetry								
192MP2A3CT	Summer Training	Medical Physics Summer Training					40	60	100	2
		Total	**20**	**4**	**6**	**-**	**-**	**-**	**700**	**25**

Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Fourth Semester										
192MP2A4CA	Core-XII	Radiation Hazards Evaluation and control	4	-	-	3	25	75	100	4
192MP2A4CP	Core Practical-IV	Machine Acceptance and Quality Assurance (QA)	-	-	6	6	40	60	100	3
192MP2A4DA	DSE-IV	Quality Control, Acceptance Testing And Calibration of Radiation System	**4**	-	-	**3**	**25**	**75**	**100**	**4**
192MP2A4DB		Applications of Radiation and Radioisotopes in Health and Agriculture								
192MP2A4DC		Biosensors								
192MP2A4CV	Project	Project and Viva Voce	-	-	16		80	120	200	8
Total			**8**	**-**	**22**	**-**	**-**	**-**	**500**	**19**
GRAND TOTAL									**2400**	**90**

Note:

- As per the Atomic Energy Regulatory Board safety code: AERB/RF-SC/MED, the candidate should undergo minimum 12 Months of internship at AERB recognized well-equipped radiation therapy department after successful completion of M.Sc. Medical Physics Programme to work as a qualified Medical Physicist in a Radiotherapy facility in India.
- The Candidates are eligible for appearing RSO examination after completion of minimum 12 Months of internship at AERB recognized well-equipped radiation therapy department.

29/12/21
BoS Chairman/HoD
Department of Medical Physics
Dr. N. G. P. Arts and Science College
Coimbatore – 641 048

DISCIPLINE SPECIFIC ELECTIVE

Students shall select the desired course of their choice in the listed elective course during Semesters

Semester I (Elective I)

List of Elective Courses

S. No.	Course Code	Name of the Course
1.	192MP2A1DA	Solid State Physics
2.	202MP2A1DB	Advanced Materials In Medicine And Healthcare
3.	202MP2A1DC	Artificial Intelligence In Health Care

Semester II (Elective II)

List of Elective Courses

S. No	Course Code	Name of the Course
1.	192MP2A2DA	Radiation Dosimetry and Standardization
2.	192MP2A2DB	Biomedical Optical Spectroscopy
3	192MP2A2DC	Programming in C++

Semester III (Elective III)

List of Elective Courses

S. No.	Course Code	Name of the Course
1.	192MP2A3DA	Materials For Radiation Dosimeters
2.	192MP2A3DB	Nanotechnology For Biomedical Applications
3.	192MP2A3DC	Monte Carlo Techniques In Dosimetry

Semester IV (Elective IV)

List of Elective Courses

S. No	Course Code	Name of the Course
1.	192MP2A4DA	Quality Control, Acceptance Testing And Calibration of Radiation System
2.	192MP2A4DB	Applications of Radiation and Radioisotopes in Health and Agriculture
3.	192MP2A4DC	Biosensors

EXTRA CREDIT COURSES

The following are the courses offered under self study to earn extra credits:

S. No.	Course Code	Course Name
1	192MP2ASSA	Research Methodology
2	192MP2ASSB	Ultrasonics In Medicine

MOOC (NPTEL/SWAYAM/ SPOKEN TUTORIAL)

The following are the online courses offered:

Please refer the following link to select the courses

www.swayam.org

www.nptel.ac.in

www.spokentutorial.org

Regulation
(2019-2020)

PG Programme

Effective from the academic year 2019-20 and applicable to the students admitted to the Degree of Master of Arts/Commerce/Management/Science.

1. NOMENCLATURE

1.1 Faculty: Refers to a group of programmes concerned with a major division of knowledge. Eg. Faculty of Computer Science consists of Programmes like Computer Science, Information Technology, Computer Technology, Computer Applications etc.

1.2 Programme: Refers to the Master of Arts/Management/Commerce/Science Stream that a student has chosen for study.

1.3 Batch: Refers to the starting and completion year of a programme of study. Eg. Batch of 2015–2017 refers to students belonging to a 2-year Degree programme admitted in 2015 and completing in 2017.

1.4 Course: Refers to a component (a paper) of a programme. A course may be designed to involve lectures / tutorials / laboratory work / seminar / project work/ practical training / report writing / Viva voce, etc or a combination of these, to effectively meet the teaching and learning needs and the credits may be assigned suitably.

a) **Core Courses**

A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

b) **Extra Departmental Course (EDC)**

A course chosen generally from a related discipline/subject, with an intention to seek exposure in the discipline relating to the core domain of the student.

c) **Discipline Specific Elective Course (DSE)**: DSE courses are the courses offered by the respective disciplinary/ interdisciplinary programme.

d) Project Work:

It is considered as a special course involving application of knowledge in problem solving/analyzing/exploring a real-life situation. The Project work will be given in lieu of a Core paper.

e) Extra credits

Extra credits will be awarded to a student for achievements in co-curricular activities carried out outside the regular class hours. The guidelines for the award of extra credits are given in section two, these credits are not mandatory for completing the programme.

e) Advanced Learner Course (ALC):

ALC is doing work of a higher standard than usual for students at that stage in their education. Research work carried out in University/ Research Institutions/ Industries of repute in India or abroad for a period of 15 to 30 days.

2. EXTRA CREDITS

- Earning extra credit is mandatory. However, it is not essential for programme completion.
- Extra Credits will be awarded to a student for achievement in co-curricular/ extracurricular activities carried other than the regular class-hours.
- A student is permitted to earn a maximum of 10 extra Credits during the programme duration of PG from I to IV Semester.
- Candidate can claim a maximum of 1 credit under each category listed.

The following are the guidelines for the award of Extra credits:

2.1 Proficiency in Foreign Language

Qualification	Credit
A pass in any foreign language in the examination conducted by an authorized agency	1

2.2 Proficiency in Hindi

Qualification	Credit
A pass in the Hindi examination conducted by Dakshin Bharat Hindi Prachar Sabha	1

Examination passed during the programme period only will be considered for extra credit

2.3 Self-study Course

Qualification	Credit
A pass in the self-study courses offered by the department	1

The candidate should register in the self-study course offered by the department only in the III semester

2.4 Typewriting/Short hand

A Pass in shorthand /typewriting examination conducted by Tamil Nadu Department of Technical Education (TNDTE) and the credit will be awarded.

Qualification	Credit
A pass in the type writing /short hand examination offered by TNDTE	1

2.5 Diploma / Certificate

Courses offered by any recognized University / NCVRT

Qualification	Credit
A pass in any Certificate /Diploma/PG Diploma Course	1

2.6 CA /ICSI/ CMA

Qualification	Credit
Qualifying foundation/Inter level/Final in CA/ICSI/CMA etc.	1

2.7 Sports and Games

The Student can earn extra credit based on their achievement in sports as given below:

Qualification	Credits
Achievement in University/State /National/ International	1

2.8 Online Courses

Pass in any one of the online courses

Qualification	Credit
SWAYAM/NPTEL/Spoken Tutorial etc.,	1

2.9 Publications / Conference Presentations (Oral/ Poster) /Awards

Qualification	Credit
Research Publications in Journals/oral/poster presentation in Conference	1

2.10 Innovation / Incubation / Patent / Sponsored Projects / Consultancy

Qualification	Credit
Development of model/ Products/ Prototype/ Process/App/Registration of Patents/ Copyrights/ Trademarks/Sponsored Projects/Consultancy	1

2.11 Representation

Qualification	Credit
Participation in State / National level celebrations such as Independence day, Republic day Parade, National Integration camp etc.,	1

3. EXAMINATIONS

The following are the distribution of marks for External and Internal i.e., Comprehensive examination and Continuous Internal Assessment and passing minimum marks for theory papers of PG programmes.

TOTAL MARKS	EXTERNAL		Internal Max. marks	Overall Passing Minimum for total marks (Internal + External)
	Max. marks	Passing Minimum for External alone		
100	75	38	25	50
50	50	25	----	25

The following are the Distribution of marks for the Continuous Internal Assessment in the theory papers of PG programmes.

S. No.	For Theory– PG courses	Distribution of Marks
1	TESTS I (2 hours)	5
2	TESTS II / End semester Model test (3 hours)	10
3	OBE- Rubrics	10
	TOTAL MARKS	**25**

The following are the distribution of marks for the External Assessment in PG Theory courses

S. No.	For Theory– PG courses	Distribution of Marks	
1	Comprehensive (Written) Examination	65	50
2	Online MCQ Examination	10	--
	TOTAL MARKS	**75**	**50**

The following are the distribution of marks for External examinations (CE) and Continuous Internal Assessment (CIA) and passing minimum marks for the practical courses of PG programmes.

TOTAL MARKS	EXTERNAL		Internal Max. marks	Overall Passing Minimum for total marks (Internal + External)
	Max. marks	Passing Minimum for External alone		
100	60	30	40	50
200	120	60	80	100

The following are the distribution of marks for the Continuous Internal Assessment (CIA) in PG practical courses

S. No.	For Theory – PG Practical courses	Distribution of Marks	
1	Tests: Two tests out of which one shall be during the mid semester and the other to be conducted as model test at the end of the semester.)	24	48
2	OBE- Rubrics	16	32
	TOTAL MARKS	**40**	**80**

The following are the distribution of marks for the External Assessment in PG practical courses

S. No.	For Theory – PG Practical courses	Distribution of Marks	
1	Experiment-I	25	50
2	Experiment-II	25	50
3	Record & Viva-Voce	10	20
	TOTAL MARKS	**60**	**120**

The following are the distribution of marks for Project and Viva voce examinations/Industrial Training and Continuous Internal Assessments and passing minimum marks for the project courses/Industrial Training of PG programmes

TOTAL MARKS	EXTERNAL		Internal Max. marks	Overall Passing Minimum for total marks (Internal + External)
	Max. marks	Passing Minimum for External alone		
100	60	30	40	50
200	120	60	80	100

The following are the distribution of marks for the Continuous Internal Assessment in PG Project/ Industrial Training courses.

S. No.	For- PG Project courses/ Industrial Training	Distribution of Marks	
1	Review-I	10	20
2	Review-II	10	20
3	Review-III	10	20
4	Documentation	10	20
	TOTAL MARKS	**40**	**80**

The following are the distribution of marks for the External Examination (CE) in PG Project /Industrial Training courses

S. No.	For- PG Project courses/ Industrial Training Courses	Distribution of Marks	
1	Record Work and Presentation	40	80
2	Viva-Voce	20	40
	TOTAL MARKS	**60**	**120**

- The end semester examinations shall normally be conducted after completing 90 working days for each semester.

- The maximum marks for each theory and practical course (including the project work and Viva-Voce examination in the final Semester) shall be 100 with the following breakup.

(i) **Theory Courses**

Continuous Internal Assessment (CIA) : 25 Marks

End Semester Exams (ESE) : 75 Marks

(Online Exam: 10 Marks &Written Exam: 65 Marks)

(ii) **For Practical Courses**

Continuous Internal Assessment (CIA) : 40 Marks

End Semester Exams (ESE) : 60 Marks

Continuous Assessment OBE Rubrics Score Sheet

Degree: _____ Branch: _____ Semester: _____

Course Code: _____ Course: _____

Max. Marks: Internal:_____ External: _____ Total: _____

S. No.	REG. NO.	THEORY / PRACTICAL & LIBRARY CLASS PARTICIPATION (15) (Compulsory)				RUBRICS ASSESSMENT (SELECT ANY ONE)									Total Marks out of : 30	Total Marks out of : 16 / 10 / 08 / 04
						PAPERS / REPORTS (15)			ASSIGNMENTS (15)			CLASS PRESENTATION (15)				
		Library	Integration of Knowledge	Interaction & Participation	Demonstration of Knowledge	Organization & Knowledge	Format & Spelling	Reference / Experiments	Demonstration of Knowledge	Format & Spelling	Reference	Content & Coherence	Creativity and Speaking Skills	Duration of Presentation		
		6	3	3	3	5	5	5	5	5	5	5	5	5		
1																

a) Utilization of Library

Marks will be awarded to the student based on the hours spent in the library after the working hours and submission of report by the student.

Hours spent in Library	Marks	Type of Document submitted
2	1	Report/ Assignment/ Class presentation
4	2	
6	3	
8	4	
10	5	
12	6	

- During the Library hour, the student must spend time in reading the articles, books, journals of their subject of interest
- Each student should borrow minimum three books during the semester

b) Class Participation

Active participation in classroom discussion by the student will be evaluated based on Integration of knowledge, Interaction and Participation and demonstration of knowledge.

c) Papers / Reports/ Assignments/ Class Presentation

The student will be evaluated based on his ability to do analysis of application of theory to real world problems or creative extension of class room learning and his/her ability to communicate the given topic effectively and clearly. The following are the distribution of marks for the continuous internal assessment in PG practical courses

4. FOR PROGRAMME COMPLETION

Programme Completion (for students admitted during the A.Y.2019-20 and Onwards)

Student has to complete the following:

i) Core, EDC, DSE, Project as mentioned in the scheme
ii) Internship / Industrial/ Institutional training as mentioned in the scheme

Students must undertake industrial / institutional training for a minimum of 15 days and not exceeding 30 days during the II semester summer vacation. The students will submit the report for evaluation during III semester.

Based on the performance Grade will be awarded as follows:

Marks Scored	**Grade to be awarded**
75 and above	A
60-74	B
50-59	C
< 50	Re-Appearance

Course Code	Course Name	Category	L	T	P	Credit
192MP2A1CA	NUCLEAR PHYSICS	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The basic principles, theory and concepts of Nuclear Physics
- The concepts of particle accelerators
- The various types of natural/particle induced nuclear reactions.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain about Nucleus, its energy states and radioactivity principles.	K3
CO2	Write the Applications of decay types and Nuclear reactions.	K3
CO3	Outline the concepts of accelerators and their medical applications.	K4
CO4	Evaluate various nuclear models and nuclear reactions.	K4
CO5	Analyze different types of spectroscopy with varied detectors.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	M	S
CO2	M	S	S	S	S
CO3	S	S	S	S	M
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A1CA	NUCLEAR PHYSICS	SEMESTER I

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Nucleus 8 h

General Properties of Nuclei – Constituents of Nuclei, Nuclear Size, Nuclear Radii, Nuclear Mass – Nuclear Units - Atomic Mass Unit, Electron Volt- Binding Energy - Systematic of Binding Energy - Mass Defect, Mass Excess, Packing and Binding Fraction - Discovery of Radioactivity – Radioactive Decay- Activity, Half Life, Mean Life - Decay Constant - Radioactive Series – Radioactive Equilibrium - Secular, Transient, Non Equilibrium.

Unit II Radioactive Decay Types 10 h

Alpha Decay – Energetics and Spectrum- Beta Decay and its Energies – Origin of Continuous Beta Spectrum - Neutrino Hypothesis – Properties of Neutrino - Nuclear Isomerism- Gamma Decay – Nature of Gamma Rays- Internal Conversion

– Positron Emission - Electron Capture- Nuclear Fission and it's Discovery - Energy Release in Fission - Nature of the Fission Fragments - Energy Distribution Between the Fission Fragments - Fissile and Fertile Materials - Spontaneous Fission - Source of Energy in Stars - Nuclear Reactions and its Types - Conservation Laws - Q Values - Cross Section.

Unit III Particle Accelerators 12 h

Introduction - Classification and Performance Characteristics of Accelerators - Industrial, Medical and Research Applications – Resonant Transformer – Cascade Generator - Van De Graff Generator - Cyclotron - Betatron - Syncro Cyclotron- Linear Accelerator - Microtron– Electron Syncrotron – Proton Syncrotron.

Unit IV Nuclear Models, Fission And Fusion Reactors 15 h

Shell Model, Liquid Drop Model - Fission - Energetics of Fission Process, Controlled Fission Reactions - Chain Reaction – Basics of Reactor - Gas Cooled Reactors - Advanced Gas Cooled Reactors- Pressurized Water Reactor - Boiling Water Reactor - Heavy Water Reactor - Breeder Reactor - Fusion Process - Characteristics of Fusion - Solar Fusion -Controlled Fusion Reactors - Critical Conditions - Four Factor Formula.

Unit V Nuclear Electronics And Techniques 15 h

Preamplifiers – Amplifiers - Single Channel Analyzers - Counting Statistics - Energy Measurements - Spectrometer - Introduction to Spectroscopy - Definition of Energy Spectra - Measurement of an Integral Spectrum and Differential Spectrum - Energy Resolution of a Detection System - Multichannel Analyzer - Calibration of MCA - Charged Particle Spectroscopy - Energy Straggling- Time of Flight Spectrometer – Detector Telescopes.

Text Books

1 Enge. H. 1983. Introduction to Nuclear Physics, 1st Edition, Addison Wesley publisher.

2 Ghoshal. S. N. 1997. Nuclear Physics, 4th Edition, S. Chand Ltd publisher

References

1 Kenneth Krane. S. 1987. Introductory Nuclear Physics, 3rd Edition, John Wiley and Springer publisher.

2 MuraleedharaVarier. M. 2009. Nuclear Radiation Detection, Measurements and Analysis, 2nd edition, Narosa publisher.

3 Stefaan Tavernier. 2010. Experimental Techniques in Nuclear and Particle Physics, 4th Edition, Springer publisher.

4 D. C. Tayal. 2009. Nuclear Physics, 2nd edition, Himalaya Publishing House.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A1CB	RADIATION PHYSICS	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The knowledge in Non Ionizing Radiation and their use in medicine.
- The broad knowledge on the Ionizing Radiation, X-ray production, and properties of X-rays
- The Interaction of Directly and indirectly ionizing radiation with matter and its effects.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain about Non Ionizing Radiation and the concept of classification of LASER and its uses in medicine.	K4
CO2	Outline the X-ray tube construction and safe operation of the X-ray tube and its function.	K4
CO3	Evaluate the theories of atomic physics nuclear reactions uncertainty and exclusion principles to radiation physics.	K4
CO4	Infer the Physics aspects of Interaction of indirectly ionizing radiation with matter.	K4
CO5	Distinguish the Interaction of directly ionizing radiation with matter and its effects inside a living object.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	M	M	M	S
CO3	M	S	S	M	S
CO4	S	S	S	M	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A1CB	RADIATION PHYSICS	SEMESTER I

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Non Ionizing Radiation 10 h

Different Sources of Non Ionizing Radiation - Radio Frequency, Microwaves, Infrared, Visible and Ultra Violet Radiation Production, Physical Properties and their Interaction with Tissues - Electrical Impedance and Biological Impedance – Thermography - Radio Frequency Ablation.

Lasers: Theory and Mechanism- Interaction of Laser Radiation with Tissues - Phototherapy - Photothermal -Photochemical - Photoablation - Electromechanical Effect - Lasers in Medicine.

Unit II X-RAY Generators 12 h

Discovery - Production - Properties of X-Rays - Characteristics and Bremstralung - Design of Hot Cathode X-Ray Tube - Basic Requirements of Medical Diagnostic, Therapeutic and Industrial Radiographic Tubes - Rotating Anode Tubes - Hooded Anode Tubes - X-Ray Tubes for Crystallography - Rating of Tubes - Safety Devices in X-Ray Tubes : Ray Proof and Shockproof Tubes - Insulation and Cooling of X-Ray Tubes - Mobile Unit - C- Arm and Dental Unit – Maintenance of X-Ray Tube Unit.

Filament and High Voltage Transformers – High Voltage Circuits - Half-Wave and Full Wave Rectifiers - Condenser Discharge Apparatus - High Frequency Genetrators - Voltage Doubling Circuits - Current and Voltage Stabilizers - Control Panels - X-Ray Circuits - Image Intensifiers and Closed Circuit TV Systems – Flat Panel Technology.

Unit III Interaction Of Photons With Matter 12 h

Ionization and Excitation - Attenuation - Linear Attenuation Coefficient - Mass Attenuation Coefficient - Energy Transfer and Mass Energy Absorption Coefficients - HVL – Rayleigh Scattering – Thomson Scattering - Photoelectric Effect – Compton Effect – Pair Production – Positron Annihilation - Relative Importance of Various Types of Interactions - Importance of Interaction in Tissue.

Unit IV Interaction Of Charged Particles With Matter 14 h

Classical Theory of Inelastic Collisions with Atomic Electrons – Energy Loss Per Ion Pair by Primary and Secondary Ionization – Dependence of Collision Energy Losses

on the Physical and Chemical State of the Absorber – Cerenkov Radiation – Electron Absorption Process – Radiative Collision – Range Energy Relation –

Continuous Slowing Down Approximation (CSDA) – Straight ahead Approximation and Detour Factors – Transmission and Depth Dependence Methods for Determination of Particle Penetration - Empirical Relations Between Range and Energy – Back Scattering.

Interaction of Heavy Charged Particles - Energy Loss by Collision – Range Energy Relation – Bragg Curve – Specific Ionization – Stopping Power – Bethe Bloch Formula.

Unit V Interaction Of Neutrons With Matter 12 h

Neutron Sources – Properties – Energy Classifications – Elastic and Inelastic Scattering Coefficients and Cross Sections – Energy Transfer and Logarithmic Energy Decrement - Nuclear Reactions – Dependence on E and Z – (n,p), (n,2n), (n,γ) and other Reactions – Neutron Activation - Radio Isotope Production.

Text Books

1 Johns. H. E and Cunningham. 1984. The Physics of radiology, 4th Edition, Charles C Thomas Publishers.

2 E.B.Podgarsak. 1996. Radiation Physics for Medical Physicists, 2nd Edition, Springer Verlag Publishers.

References

1 MarkolfNeimz. H. 1996. Laser-Tissue Interactions, 3rd Edition, Springer Verlag publisher

2 Curry, T.S. Dowdey and J.E. Murry, R.C. 1984. Christensen's introduction to the Physics of diagnostic radiology, 3rd Edition, Philadelphia, Lea & Febiger publisher.

3 Podgarsak. E.B. 2005. Radiation Oncology Physics: Handbook for Teachers and Students, IAEA, Vienna publisher.

4 Attix. F. H. 2004. Introduction to Radiological Physics and Radiation Dosimetry, 4th Edition, Viley VCH, Verlog publisher.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A1CC	BIOMEDICAL ELECTRONICS AND INSTRUMENTATION	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The knowledge in digital principles and its applications.
- The application of op-amps for various mathematical applications
- The bio electric signal recording, physiological assist devices, operation theater equipments.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Manipulate the component types and connections used to build functioning electronic circuits.	K3
CO2	Explain about solving problems related to number systems and Boolean algebra	K4
CO3	Construct the basic architecture of different Microprocessors.	K4
CO4	Estimate the concept of various bioelectric potentials generated in human body and related equipments.	K4
CO5	Evaluate human physiology and anatomy with signal processing paradigms.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	M	S
CO2	S	S	S	M	S
CO3	M	S	S	S	S
CO4	S	M	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A1CC	BIOMEDICAL ELECTRONICS AND INSTRUMENTATION	SEMESTER I

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Basic Electronics 8 h

Diode - Triode - Semi Conductor Diode - Characteristics - Voltage Regulator Circuits - LED - Bipolar Junction Transistors - CB and CE Configuration Characteristics. FET - MOSFET- Principle of Operation – Characteristics - JFET Amplifier.

Op-Amp - Circuit Symbol-Ideal Op-Amp Characteristics-CMRR-Applications: Adder, Subtractor, Analog Integrator, Analog Differentiator, Voltage-to-Current Converter, Current-to-Voltage Converter and Logarithmic Amplifier.

Unit II Digital Electronics 10 h

Logic Gates - Boolean Algebra - Boolean Laws – De-Morgan's Theorem - Implementation of Logic Circuits From Truth Table – Sum-of-Products Method – Products-of-Sum Method - Combinational Circuits: Multiplexer and De-Multiplexer Circuits - BCD to Decimal Decoders Seven Segment Decoders - Decimal to BCD Encoder.

Arithmetic Building Blocks: Half-Adder and Full-Adder - Digital Comparator. Flip Flops: RS, Clocked RS, D-Flip Flop, Edge-Triggered D Flip Flop – J K Flip Flop-Sequential Logic Circuits: Registers - Shift Registers – Applications. Counters: Ripple Counters Up, Down and Up-Down Ripple Counters - Asynchronous and Synchronous Counters- ADC And DCA.

Unit III Microprocessor 12 h

Architecture of 8-Bit Microprocessor: Intel 8085A Microprocessor, Pin Description and Internal Architecture - Operation and Control of Microprocessor: Timing and Control Unit, Op-Code Fetch Machine Cycle, Memory Read/Write Machine Cycles, I/O Read/Write Machine Cycles, Interrupt Acknowledge Machine Cycle, State Transition Diagram- Instruction Set - Assembly Language Programming - Interfacing - Interrupts - Programmable Peripheral Interface - Programmable Interval Timer.

Unit IV Physiological Assist Devices 15 h

Cardiac Output Measuring Techniques – Dye Dilution Method, Thermo Dilution Method, BP Method - Blood Flow Measuring Techniques: Electromagnetic Type - Ultrasound Blood Flow Meter, Automatic Counting Of RBC, WBC And Platelets.

Measurement of Blood Pressure – Direct Methods And Indirect Methods - Temperature - Respiration Rate - Heart Rate Measurement - O2 , CO2

Measurements, Respiratory Volume Measurement, BMR Measurement, Plethysmography Technique, Detection of Various Physiological Parameters Using Impedance Technique. Kidney Machine – Hemodialysis Units – Peritoneal Dialysis - Lithotripsy - Various Types of Endoscopy.

Unit V Bioelectric Signal Recording And Clinical Equipment 15 h

Bio-Electrodes: Surface - Micro - Needle Electrodes - Equivalent Circuits of Electrodes – Biochemical and Transcutaneous - Electrodes: PH, PO2, PCO2 Bio amplifiers – Bio potential Signals and their Recording: Bio amplifiers- Carrier Amplifier, - Isolation Amplifier - Differential Amplifier - Chopper Amplifier - Instrumentation Amplifier - Bioelectric Signals (ECG, EMG, EEG, EOG & ERG) and their Characteristics - Electrodes For ECG, EEG And EMG - ECG Machine - EMG Machine – 10-20 Electrodes Placement System for EEG - EEG Machine - Heart Sound and Characteristics, PCG - Biochemical Measurement Techniques: Chemical Fibro Sensors, Fluorescence Sensors - Glucose Sensor - Colorimeter, Spectro Photometer, Flame Photometer – Chromatography - Mass Spectrometer , Auto Analyzer.

Text Books

1 Santanue Chattopadhyay, 2006. A text book of Electronics, 1st Edition, New Central Book Agency publisher. Kolkata.

2 Malvino. A. P and Leach. D. P. 1994. Digital Principles and Applications, 5th Edition, Tata McGraw-Hill Publishing Co publisher, New Delhi.

References

1 Bhattacharya. A. B. 2007, Electronic Principles and Applications, 2nd Edition, New Central Book Agency, Kolkata.

2 Geddes LA and Baker L.E. 1989, Principals of Applied Biomedical Instrumentation, 3rd Edition, John Wiley and sons, New york.

3 Mathur. A. P. 2005, Introduction to Microprocessors, 3rd Edition, Tata McGraw-Hill Publishing Co, New Delhi.

4 R. S. Khandpur. 1990, Handbook of Biomedical Instrumentation, Tata McGraw Hill, NewDelhi.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A1CD	RADIOLOGICAL ANATOMY, PHYSIOLOGY AND PATHOLOGY	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The structure and function of Organs, systems.
- The cancer prevention and public education and early detection and screening.
- The professional aspects and role of Medical Physicists.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Demonstrate the normal organization of the organ systematic levels	K3
CO2	Experiment the anatomy of human body, nomenclature, and radiographic anatomy.	K4
CO3	Categorize the indications for and complications of various treatments procedure.	K4
CO4	Assess the site specific signs, symptoms, diagnosis and management for all types of cancer.	K5
CO5	Summarize the outcomes of various treatment methods, including the interpretation of clinical trials.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	M	S	S
CO2	S	S	S	S	S
CO3	M	M	M	S	S
CO4	M	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A1CD	RADIOLOGICAL ANATOMY, PHYSIOLOGY AND PATHOLOGY	SEMESTER I

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Human Anatomy and Physiology 20 h

Introduction to Human Body - The Cells, Tissues and Organization of Body - Blood Skin - Lymphatic System - Skeletal System - Nervous System - Endocrine System - Cardiovascular - Respiratory System - Digestive System (Gastro-Intestinal) - Excretory System - Reproductive System - Special Senses.

Unit II Radiographic Anatomy 9 h

Anatomy of Human Body Nomenclature - Surface Anatomy - Radiographic Anatomy - Cross Sectional Anatomy – Identify the Different Organs/Structures on Plain X-rays, CT scans and other available Imaging Modalities. Normal Anatomy & Deviation for Abnormalities.

Unit III Tumor Pathology, Cancer Screening And Treatment Modalities 15 h

Tumor Pathology and Carcinogenesis - Basic Pathological Features of Cancers and Interpretation of Clinico-Pathological Data - Benign and Malignant Disease - Methods of Spread of Malignant Disease - Staging and Grading Systems - Treatment Intent – Curative & Palliative - Cancer Prevention and Public Education- Patient Management on Treatment – Monitoring and Common Management of Side Effects – Information and Communication. Screening - Definition, Principles, Evaluating Screening Tests, Developing and Evaluating a Cancer Screening Programme - Different Kind of Screening Tests - Screening for Specific Types of Cancer - Genetic Counseling. Treatment – Essential Terms, Surgery, Radiation, Chemotherapy, Biological Therapy, Hormone Therapy, Transplantation, Targeted Therapies, Radiolabelled Immunotherapy, Gene Therapy, other Treatment Methods (Cryosurgery, Laser Therapy, Photodynamic Therapy, Hyperthermia), Cancer Clinical Trials.

Unit IV Site Specific Signs, Symptoms, Diagnosis and Management 8 h

Head and Neck, Breast, Gynecological, Gastro-Intestinal Tract, Genito - Urinary, Lung & Thorax, Lymphomas & Leukemias & other Cancers including AIDS Related Cancers.

Unit V Professional Aspects and Role of Medical Physicists 8 h

General Patient Care - Principles of Professional Practice – Medical Terminology – Research & Professional Writing – Patient Privacy – Ethical & Cultural Issues. Legal Aspects – Confidentiality, Informed Consent, Health and Safety.

Text Books

1. Ross and Wilson. 2014. Anatomy and Physiology in Health and Illness by Anne Waugh, Allison Grant, 12th Edition, published by Churchill Livingstone.
2. Henry Gray. 2009. Anatomy and physiology, 30th Edition, Philadelphia: Lea & Febiger

References

1. Rod R. Seely. 1999. Anatomy and Physiology, 5th edition, Mcgraw-Hill College.
2. Meschan. 1969. Normal Radiation Anatomy, 8th edition, WB Sunders Company.
3. C. K. Warrick. 2001. Anatomy and Physiology for Radiographers, Oxford University Press
4. C. H. Best and N. B. Taylor. 1999. A Test in Applied Physiology, Williams and Wilkins Company, Baltimore.

192MP2A1CP	CORE PRACTICAL: BIOMEDICAL ELECTRONICS AND INSTRUMENTATION LAB	SEMESTER I

Total Credits: 3
Total Instructions Hours: 72 h

S.No	List of Experiments
1	Zener regulated power supply and percentage of regulation.
2	Transistor characteristics- CB and CE configuration.
3	Transistor characteristics- CB and CE configuration.
4	Single stage FET amplifier- CS configuration.
5	FET characteristics.
6	OP-Amp applications- Adder, Subtractor, Differentiator and Integrator
7	Logic gates OR, AND, NOT, NOR and NAND Gates.
8	NAND gate as a universal gate
9	Half adder and Full adder.
10	A/D and D/A converters.
11	Microprocessor programming.
12	Photosensitive diodes.

Note: Out of 12 - 10 Experiments

References

1 J. Hughes. 2015. Practical Electronics: Components and Techniques, 1st edition, O'Reilly Media Publisher.

2 Ian Sinclair. 1980. Practical Electronics Handbook, 6th Edition, Elsevier Publisher.

3 N.D.Bhatt. 1990. Elementary Engineering Drawing, Charater Publishing Co.

4 S.K.Hajra Choudry. 1992. Elements of Workshop Teaching, Vol.I and II. Tata McGraw Hill Publishing Co., New Delhi.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A1DA	SOLID STATE PHYSICS	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The basic principles, theory and concepts of Solid State Physics.
- The Crystalline state and structure.
- The Superconductivity and Semiconducting properties of solids.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Illustrate the various crystal structures and forces associated with it.	K3
CO2	Explain the application of lattice structures heat processes associated with it.	K4
CO3	Outline the theories of various metals and semiconductors and their mobility phenomena.	K4
CO4	Classify different types of magnetic materials.	K4
CO5	Categorize different types of superconductivity and their applications.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	M	M	M	S	M
CO2	M	S	S	S	M
CO3	S	S	S	S	M
CO4	S	S	S	S	S
CO5	M	S	S	S	M

S Strong M Medium L Low

192MP2A1DA	SOLID STATE PHYSICS	SEMESTER I

Total Credits: 4
Total Instruction Hours: 48 h

Syllabus

Unit I CRYSTAL PHYSICS 8 h

Types of Lattices - Miller Indices - Simple Crystal Structures - Crystal Diffraction - Bragg's Law - Reciprocal Lattice (Sc, Bcc, Fcc) - Laue Equations - Structure Factor - Atomic Form Factor - Types of Crystal Binding - Cohesive Energy of Ionic Crystals- Madelung Constant - Inert Gas Crystals - Vander Waal - Landon Equation - Metal Crystals - Hydrogen Bonded Crystals.

Unit II LATTICE DYNAMIC 10 h

Mono atomic Lattices - Lattice with two Atoms Per Primitive Cell - First Brillouin Zone - Group and Phase Velocities - Quantization of Lattice Vibrations - Phonon Momentum – Inelastic Scattering by Phonons - Debye's Theory of Lattice Heat Capacity - Einstein's Model and Debye's Model of Specific Heat - Thermal Expansion - Thermal Conductivity - Umklapp Processes.

Unit III THEORY OF METALS AND SEMICONDUCTORS 10 h

Free Electrons Gas in Three Dimensions - Electronic Heat Capacity - Wiedmann-Franz Law - Hall Effect - Band Theory of Metals and Semiconductors - Bloch Theorem - Kronig-Penny Model -Semiconductors - Intrinsic Carrier Concentration - Mobility - Impurity Conductivity - Fermi Surfaces and Construction - Experimental Methods in Fermi Surface Studies - De Haas Van Alphen Effect - Application of Semiconductor in Medicine.

Unit IV MAGNETIC PROPERTIES OF MATERIALS 10 h

Elementary Ideas of Dia, Para and Ferro Magnetism - Quantum Theory of Paramagnetism - Rare Earth Ion - Hund's Rule - Quenching of Orbital Angular Momentum - Adiabatic Demagnetization - Quantum Theory of Ferromagnetism - Curie Point - Exchange Integral - Heisenberg's Interpretation of Weiss Field - Ferromagnetic Domains - Bloch Wall - Spin Waves - Quantization - Magnons - Thermal Excitation of Magnons - Curie Temperature and Susceptibility of Ferrimagnets - Theory of Antiferromagnetism - Neel Temperature - Application of Magnet in Medicine.

Unit V SUPER CONDUCTIVITY 10 h

Experimental Facts-Occurrence - Effect of Magnetic Fields - Meissner Effect - Entropy and Heat Capacity - Energy Gap - Microwave and Infrared Properties - Type I and II Superconductors - Theoretical Explanation - Thermodynamics of Super Conducting Transition - London Equation - Coherence Length - BCS Theory - Single Particle Tunneling - Josephson Tunneling - DC And AC Josephson Effects - High Temperature Super Conductors - SQUIDS.

Text Books

1 Kittel. C. 2005. Introduction to Solid State Physics, 7th Edition, Wiley, New York

2 Pillai. S. O. 2002. Solid State Physics, 6th Edition, New Age International, New Delhi.

References

1 Blakemore. J. S. 1985. Solid State Physics, 2nd Edition, Publisher Cambridge University

2 Dekker. A. J. 1986. Solid State Physics, 2nd Edition, Macmillan India, New Delhi.

3 Pillai. S. O. 2007. Problems and Solutions in Solid State Physics, 4thEdition, New Age International, New Delhi.

4 A.M.Wahab. 2007. Structure and Properties of Materials, 2nd edition, Narosa Publishing house, New Delhi, India

Course Code	Course Name	Category	L	T	P	Credit
202MP2A1DB	ADVANCED MATERIALS IN MEDICINE AND HEALTHCARE	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The classification of solids and its various structure.
- The material properties and their applications in medicine.
- The concept of Thermography and its applications.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the different structure of crystals.	K4
CO2	Determine the crystal structure and the properties of crystals.	K5
CO3	Explain the various method of Nanoparticles synthesis.	K4
CO4	Understand the Biomechanism of biomaterial and its classification also used in various application.	K5
CO5	Explain the concept of Thermography and its medical application.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	M	S	S	S	S
CO2	M	M	M	M	S
CO3	S	S	M	S	S
CO4	S	M	M	M	S
CO5	S	S	S	S	S

S Strong M Medium L Low

202MP2A1DB	ADVANCED MATERIALS IN MEDICINE AND HEALTHCARE	SEMESTER I

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Material Structures 10 h

Classification of Solid, Types of Solids, Space Lattice, Crystal Structure of Materials, Unit Cell, Symmetries in Crystals, bravais lattice, Miller and Miller-Bravais indices, simple cubic structure (SC), Body Centered Cubic, (BCC), Face Centered (FCC) Structure, Hexa gonal closed Paced Structure (HCP), Special Cubic Crystal Structure: Diamond, Zinc Blende Structure, Nacl Structure.

Unit II Material Properties 10 h

Diffraction of X-rays, Bragg's Law, Braggs's X-ray Spectrometer, Determination of Crystal Structure: Laue's Method, powder Crystal method & Rotating Crystal Method. Braggs's Law & Crystal Structures.

Properties: Mechanical Properties, Electric Properties, Magnetic Properties, Optical properties and Chemical properties. Optical Properties and Applications: Introduction, Classification of optic Materials, Absorption in Metals, Insulators, and Semi conductors, Traps, Excitons and Color Centres.

Unit III Nanomaterials & Applications 12 h

Nanoscale, Nanotechnology, Production Techniques, Sol-gel method, Co-precipitation Method and Radiofrequency sputtering method, Characterization Techniques: X-ray diffraction, spectroscopic techniques like UV-Visible, Infrared Spectroscopy, Raman Spectroscopy. Optical and Electron microscopy. Applications in Medicine: Targeted Drug Delivery, Hyperthermia, Bioimaging & Therapy Biosensors photoablation Therapy Carbon Nanotubes, Nanowires, Quantum dots and its properties and applications.

Unit IV Biomaterial & Applications 8 h

Introduction, Biomechanism, Classifications of Biomaterials: Metals and Alloys and Glass and Glass Ceramics, Polymers and Composites. Applications: Uses of Biomaterial, Biomaterials in organ. Biomaterials in body System.

Unit V Thermography 8 h

Introduction, Basic Principles, Detectors & Equipment, Medical Thermography, Thermographic Camera, Advantages of Thermography. Applications In Medicine: Detection of tumors, Mapping of Blood Vessels, Investigation of Bone Fracture, placental localization, burns and frostbite.

Text Books

1 S. O. Pillai, 2005. Solid State Physics, 6th Edition, New age International Pvt Ltd.

2 Charles Kittel, 2013. Introduction to Solid State Physics, 8th Edition, John Wiley.

References

1 C.M. Srivastava and C.Srivasan, 1997, Science of engineering materials: 2nd Edition, New age International.

2 V. RAGHAVAN, 2019, Material Science and Engineering : A first course, Edition 6.

3 Dr. V Rajendran 2017, MATERIALS SCIENCE, McGraw Hill Education.

4 Hossein Hosseinkhani, 2019, Nanomaterials in Advanced Medicine 1st Edition, Wiley-VCH.

Course Code	Course Name	Category	L	T	P	Credit
202MP2A1DC	ARTIFICIAL INTELLIGENCE IN HEALTH CARE	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The artificial intelligence, specifically computational models of intelligence.
- The machine learning models and their applications in medicine and healthcare.
- The performance of specific models as applied to biomedical problems, and justify their use and limitations.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the concept of artificial intelligence, specifically computational models of intelligence	K3
CO2	Analyze about machine learning and expert systems.	K4
CO3	Explain about the application of artificial intelligence in healthcare.	K5
CO4	Summarize the application of artificial intelligence in diagnostic radiology and radiation oncology.	K3
CO5	Analyze the tools and technologies and its implementation in healthcare sector and social issues.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	M	M	M	S	M
CO2	M	S	S	S	M
CO3	M	M	S	S	M
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

202MP2A1DC	ARTIFICIAL INTELLIGENCE IN HEALTH CARE	SEMESTER I

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Artificial Intelligence 10 h

Concept of Artificial Intelligence - Artificial Intelligence Problems – Topics of Artificial Intelligence – Timelines of Artificial Intelligence – Production Systems – State space representation – Branches of Artificial Intelligence – Applications of Artificial Intelligence. Learning: Types of Learning – Machine Learning – Intelligent Agents

Unit II Supervised and Unsupervised Learning and Expert Systems 10 h

Supervised Learning: Support Vector Machines – Inductive Logic Programming – Case based reasoning – ensemble Classifiers – Nearest Neighborhood – Fuzzy Network. Unsupervised Learning: Expectation Maximization – Self Organization Maps – Adaptive Resonance Theory. Expert Systems: Characteristics – Development – Applications of Expert Systems

Unit III Applications of Artificial Intelligence in Healthcare 10 h

Artificial Intelligence and Human Intelligence, Artificial Intelligence in Healthcare Sector - Artificial Intelligence in Preventive Healthcare - Artificial Intelligence in Radiology - Artificial Intelligence in Pathology - Artificial Intelligence in Surgery - Artificial Intelligence in Anesthesiology - Artificial Intelligence in Psychiatry - Artificial Intelligence in Cardiology - Artificial Intelligence in Pharmacy - Artificial Intelligence in Dermatology - Artificial Intelligence in Dentistry - Artificial Intelligence in Orthopedics - Artificial Intelligence in Ophthalmology.

Unit IV Artificial Intelligence in Oncology and Radiation Oncology 10 h

Role in screening - Role in diagnosing; emphasis on radiology - Role in prognostication - AI in radiation oncology: Image acquisition - Tumor and organs at risk segmentation - Image registration – AI in Radiation Treatment planning - Radiation delivery methods.

Unit V Implementation and Evaluation 8 h

Tools and Technologies for implementing AI methods - Model evaluation and performance metrics, cross-validation, model interpretability. Ethical, Legal, and Social Issues of AI in medicine and healthcare Challenges of Artificial Intelligence - Advantages and Disadvantages.

Text Books

1 Arvin Agah, 2013. Medical Applications of Artificial Intelligence, 1st Edition, CRC Press.

2 Adam Bohr, Kaveh Memarzadeh, 2020. Artificial Intelligence in Healthcare, 1st Edition, Academic Press.

References

1 Bernard Nordlinger, Cédric Villani , Daniela Rus, 2020. Healthcare and Artificial Intelligence, 1st Edition, Springer.

2 Vinod Chandra S S, Anand Hareendran S (2014), Artificial Intelligence and Machine Learning, PHI.

3 Rajit Rattan, Tejinder Kataria, 2019. Artificial intelligence in oncology, its scope and future prospects with specific reference to radiation oncology, Review Published by the British Institute of Radiology.

4 Arjun Panesar, 2019. Machine Learning and AI for Healthcare: Big Data for Improved Health Outcomes, 1st Edition, Apress.

Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Second Semester										
192MP2A2CA	Core	Radiation Detectors and Instrumentation	4	1	-	3	25	75	100	4
192MT2A2IC	EDC	Mathematical Physics	4	-	-	3	25	75	100	4
192MP2A2CC	Core	Physics of Radiation Therapy	4	1	-	3	25	75	100	4
192MP2A2CD	Core	Physics of Radiological Imaging	4	1	-	3	25	75	100	4
202MP2A2CP	Core Practical	Radiation Measuring and Monitoring Instrumentation	-	-	6	6	40	60	100	3
192MP2A2DA 192MP2A2DB 192MP2A2DC	Elective	Radiation Dosimetry and Standardization / Biomedical optical Spectroscopy/Programming in C++	4	1	-	3	25	75	100	4
		Total	**20**	**4**	**6**				**600**	**23**

D. Skumar 14/12/2020

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Course Code	Course Name	Category	L	T	P	Credit
192MP2A2CA	RADIATION DETECTORS AND INSTRUMENTATION	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The various types of detectors used to measure high-energy (ionizing) radiations
- The electronic systems used to count and measure high-energy radiations
- The general properties of radiation detection systems.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Analyze the various types of radiation detectors to measure radioactive materials or produced.	K4
CO2	Function of scintillation detectors and methods of its detection.	K4
CO3	Analyze the concept the Dosimetric instruments.	K4
CO4	Simplify about the protection instruments for X-ray, Photon, Electron, neutron and contamination instruments.	K4
CO5	Explain about the nuclear medicine instruments.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	M	M	M	S
CO3	M	S	S	M	S
CO4	S	S	S	M	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A2CA	RADIATION DETECTORS AND INSTRUMENTATION	SEMESTER II

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Introduction To Radiation Measurements And Gas Filled Detectors 12 h

Statistical nature of radiation emission - Types of errors - Random error and systematical errors.

Principle of gas filled detectors- Relationship between high voltage and charge collected - Ionization chambers - Construction and working of condenser type chamber, thimble chambers- Gas multiplication- Proportional Counters, Geiger Muller Counters - Dead time and recovery time – Quenching -Voltage and current characteristic of gas filled chambers- Characteristics of organic and inorganic counters - Calorimetry - Principle and application for absolute dosimetry.

Unit II Principles of Radiation Detection Using Scintillation and Other Detectors 14 h

Principle of Scintillation, Luminescence- Relationship between pulse height and energy- Type of Radiation incident particle - Photomultiplier tube - Assembly of a scintillation counter and role of light pipes - Dead time of scintillation counters - Sources of background in a scintillation counter - Resolving time – Resolving power

Principle of detection Process - Diode, MOSFET Semi conductor detectors - Voltage current characterization - Thermoluminescence dosimeters (TLD) – Detection process - Glow curve and dose response - Common TLD materials and their characteristics – Fading - Residual TL - Annealing Process - Reuse.

Radiographic and Radio chromic films - Film characteristic and calibration - Optically stimulated luminescence dosimeters (OSLD) - Radio photo luminescent dosimeters - Neutron detectors – Nuclear track emulsions for fast neutrons – Solid state nuclear track detectors (SSNTD).

Unit III Dosimetry Instruments 12 h

Secondary standard therapy level dosimeters: Farmer type, Parallel Plate, RFA, Well type chambers (Re entrant, Sealed chamber) – Pocket C dosimeters – Different types of electrometers – MOSFET, Vibrating condenser and Varactor bridge types – Radioisotope calibrator – Phantoms (Water, Solid, Water Equivalent, Anthropomorphic phantom) – Brachytherapy dosimeters – Thermo luminescent

dosimeter readers for medical applications – Calibration and maintenance of dosimeters.

Unit IV Protection Instruments 12 h

TLD badge readers – PM film densitometers – Glass dosimeters readers - Digital pocket dosimeters using solid state devices and GM counters – Teletector – Industrial gamma radiography survey meter – Gamma area (Zone) alarm monitors - Contamination monitors for alpha, beta and gamma radiation – Hand and foot monitors - Laundry and portal monitors - Scintillation monitors for X and gamma radiations – Neutron monitors, tissue equivalent survey meters – Flux meter and dose equivalent monitors – Pocket neutron monitors -Teledose systems.

Unit V Nuclear Medicine Instruments 10 h

Instruments for counting and spectrometry – Portable counting systems for alpha and beta radiation – Gamma ray spectrometers – Multichannel analyzer – Liquid scintillation counting system – RIA counters – Whole body counters – Air monitors for radioactive particulates and gases - Details of commercially available instruments and systems.

Text Books

1 Knoll. G. F, 2000. Radiation detection and measurement, 3rd Edition, John Wiley publisher.

2 Nicholas Tsoulfanidis, 1995. Measurement and Detection of Radiation, 2nd Edition, Taylor & Francis.

References

1 Podgarsak. E.B. 2005. Radiation Oncology Physics: Handbook for Teachers and Students, IAEA, Vienna publisher.

2 Meredith. W. J and Massey. J.B, 1972. Fundamental Physics of Radiology, 2nd Edition, John Wright and sons, UK

3 Price W.J, 1964. Nucleus Radiation detection, 2nd Edition, McGraw-Hill, New York.

4 Kapoor. S.S. and. Ramamurthy.V, 1986. Nuclear Radiation Detectors,1st Edition, New Age International (P)Ltd.

Course Code	Course Name	Category	L	T	P	Credit
192MT2A2IC	MATHEMATICAL PHYSICS	EDC	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The repertoire of mathematical methods that are essential to the solution of advanced problems encountered in the fields of applied Medical Physics.
- The Programming skills in C++, MATLAB/MATHEMATICA, and STATISTICA
- The concept of test of randomness and random number generation.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Build the concepts of probability theory, statistical distributions and frequency distributions.	K3
CO2	Analyze the application of Poisson's Statistics, Goodness-of-fit tests, Sampling distributions.	K4
CO3	Inference the Simultaneous linear equations concept to solve problems.	K4
CO4	Simplify the concept of test of randomness and random number generation.	K4
CO5	Take part in Programming Skills in C++, MATLAB/ MATHEMATICA, and STATISTICA.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	M	S	S	S
CO2	S	M	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	M	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MT2A2IC	MATHEMATICAL PHYSICS	SEMESTER II

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Probability, Statistics and Errors 10 h

Probability - Addition and multiplication laws of probability, conditional probability, population, variates, collection, tabulation and graphical representation of data.

Basic ideas of statistical distributions frequency distributions, averages or measures of central tendency, arithmetic mean, properties of arithmetic mean, median, mode, geometric mean, harmonic mean, dispersion, standard deviation, root mean square deviation, standard error and variance, moments, skewness and kurtosis.

Application to radiation detection - Uncertainty calculations, error propagation, time distribution between background and sample, minimum detectable limit.

Binomial distribution, Poisson distribution, Gaussian distribution, exponential distribution - Additive property of normal variates, confidence limits, Bivariate distribution, Correlation and Regression, Chi-Square distribution, t-distribution, F-distribution

Unit II Counting and Medical Statistics 10 h

Statistics of nuclear counting - Application of Poisson's statistics - Goodness-of-fit tests - Lexie's divergence coefficients Pearson's chi-square test and its extension - Random fluctuations Evaluation of equipment performance - Signal-to-noise ratio - Selection of operating voltage - Preset of rate meters and recorders - Efficiency and sensitivity of radiation detectors - Statistical aspects of gamma ray and beta ray counting - Special considerations in gas counting and counting with proportional counters - Statistical accuracy in double isotope technique.

Sampling and sampling distributions - Confidence intervals. Clinical study designs and clinical trials. Hypothesis testing and errors. Regression analysis.

Unit III Numerical Methods 10 h

Why numerical methods, accuracy and errors on calculations - Round-off error, evaluation of formulae. Iteration for Solving x = g(x), Initial Approximation and Convergence Criteria. Interpolations: 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 - Curve fitting - Principle of least squares - Discrete Fourier Transform - Fast Fourier Transform - Applications – Random waveforms and noise.

Simultaneous linear equations: Gauss elimination method - Jordan's modification. - Inverse of a matrix by Gauss - Jordan Method - Roots of nonlinear equations: Newton- Raphson method - Iterative rule -Termination criteria -Taylor series - approximating the derivation - Numerical differentiation formulas - Introduction to numerical quadrature - Trapezoidal rule - Simpson's 2/3 rule - Simpson's Three-Eighth rule - Picard's method - Taylor's method -Euler's method - the modified Euler's method - Runge-Kutta method.

Unit IV Monte Carlo Method 10 h

Random variables - Discrete random variables - Continuous random variables - probability density function - Discrete probability density function - Continuous probability distributions - Cumulative distribution function - Accuracy and precision - Law of large number - Central limit theorem - Random numbers and their generation - Tests for randomness - Inversion random sampling technique including worked examples - Integration of simple 1-D integrals including worked examples.

Unit V Computational Tools & Techniques 8 h

Computational packages: Overview of programming in C++, MATLAB/ MATHEMATICA, and STATISTICA in data analysis and graphics and cloud computations.

Text Books

1 F. E. Croxton, Elementary statistics with applications in medicine and the biological sciences, Dover, New York, 1st Edition, 1959.

2 S.P. Gupta, Statistical methods, Sultan Chand & Sons Educational publishers, New Delhi 44th Edition, 2014.

References

1 S. S. Sastry, Introductory Methods of Numerical Analysis, Prentice Hall of India, New Delhi, 5th Edition, 2012.

2 Dahlberg G, 2007. Statistical Method of Medical & Biology students, 4th Edition, G. Allen & Unwin ltd.

3 E. Balagurusamy , 2013. Object Oriented Programming with C++ by, 6th Edition, TMH Publisher

4 W. Band, Introduction to Mathematical Physics, Van Nostrand Reinhold Inc.U.S., 1stEdition, 1959.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A2CB	PHYSICS OF RADIATION THERAPY	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The physics of various therapy machines.
- The dosimetric characteristics of the radiation beam and dose distributions.
- The treatment techniques, treatment planning and dose computation for external beam therapy.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the principle and function of various therapy facilities.	K4
CO2	Discuss various central axis dosimetric parameters..	K4
CO3	Classify the beam modifying devices and its construction.	K4
CO4	Explain the treatment planning process, planning techniques in teletherapy.	K4
CO5	Explain the Characteristics of electron beam, treatment techniques and MU calculation.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	M	M	M	S
CO3	M	S	S	M	S
CO4	S	S	S	M	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A2CB	PHYSICS OF RADIATION THERAPY	SEMESTER II

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Therapy Beam Generators 12 h

Kilo voltage therapy X-ray Units, Superficial therapy, deep therapy - Spectral distribution of kV x-rays and effect of filtration - Thoraeus filter - Output calibration procedure - Telecobalt units: Construction and working, Source design, Beam shutter mechanisms - Beam collimation, Penumbra and its types, Trimmers and Breast cones - Beam directing device - Front, Back Pointers, Pin & arc ODI, Laser- Isocentric gantry.

Linear accelerator - Design - Principle and function of klystron and magnetron, traveling and standing waveguide, pulse modulators and auxiliary systems, bending magnet systems, treatment beam production - X-rays - Electron beam, Beam collimation, Asymmetric collimator, Multileaf collimator, Dose monitoring and Beam stabilization - Interlocks - Electron contamination- Relative merits and demerits of kV x-rays, gamma rays, MV x-rays and electron beams.

Unit II Central Axis Dosimetry Parameters 13 h

Collimator Scatter factor, Phantom scatter factor and total scatter factors - Percentage depth doses (PDD), tissue air ratio(TAR), back scatter factor/Peak scatter factor (BSF/PSF) - Tissue phantom ratio (TPR) - Tissue maximum ratio (TMR) - Relationship between TAR and PDD and its applications - Relationship between TMR and PDD and its applications –Scatter air ratio(SAR) – Scatter maximum ratio(SMR) - Off axis ratio field factors - Surface dose and buildup region -Isodose chart - Measurements of Isodose curves – Characteristic of isodose curves– Dosimetric data resources for treatment Calculation - Concept of equivalent square relative dose calculation

Unit III Beam Modification And Shaping Devices 10 h

Trimmers - Wedge filters – Universal, motorized and dynamic wedges – Shielding blocks - Field shaping, custom blocking - Styrofoam cutting machine - Tissue compensation – Design of compensators, 2D compensators, 3D compensators - MLC.

Unit IV Treatment Planning In Teletherapy 13 h

Electron contamination, Dmax, Dmax, Buildup Dose, incident dose, exit dose, skin. DVHs –Differential, Integral - Treatment planning in Teletherapy – Target volume definition and dose prescription criteria – ICRU29, ICRU 50, ICRU 62 and ICRU 83 -SSD and SAD set ups – Two and three dimensional localization techniques, Dose specification and normalization Positioning/Immobilization - 2D and 3D simulation techniques - Conventional simulator - CT simulator - Use of contrast, markers - Patient data acquisition - Contours, Image registration and segmentation from CR, CT, MRI, US, PET, fusion techniques - Virtual simulation – Digitally reconstructed radiographs(DRR).

Field arrangements – Single, Parallel opposed and multiple fields – Corrections for tissue inhomogeneity, Contour shapes and beam obliquity – Integral dose. Arc/rotation therapy and Clarkson technique for irregular fields–Mantle and inverted Y Fields. Conventional and Conformal radiotherapy. Gradient Index, Treatment time and Monitor unit calculations using Co-60 and Linear accelerator calculations, SSD and SAD/Isocentric technique.

Unit V Electron Beam Therapy 12 h

Energy specification - Depth dose characteristics of electron beam (Ds, Dx, R100, R90,Rp, etc.) – Determination of absorbed dose - Characteristic of clinical electron beams – Monitor unit calculations – Output factor formalisms - Planning and dose calculation effects of patient and beam geometry - Internal heterogeneities - Treatment planning techniques – Collimation - Field abutment techniques -Photon electron mixed beams – Electron arc therapy. ICRU71. Electron cutouts and dose calculation, Electron applicator.

Text Books

1 Faiz Khan. M, 2014. The Physics of Radiation Therapy, 5th Edition, Wolterskluwer.

2 Podgarsak. E.B. 2005. Radiation Oncology Physics: Handbook for Teachers and Students, IAEA, Vienna publisher.

References

1 G.C.Bentel, 1992. Radiation Therapy Planning, 1st Edition, Macmillan Publishing Co., New York.

2 Faiz M. Khan, Roger A. Potish, 1998. Treatment Planning in Radiation Oncology, Williams & Wilkins, Baltimore.

3 Hendee. W. R, 2004. Medical Radiation Physics, preface of 3rd Edition, Medical Publishers Inc London.

4 Bomford. C. K, kunkler. I. H, Walter and Miller's, 2002. Textbook of Radiotherapy, 6th revised edition, Churchill Livingstone.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A2CC	PHYSICS OF RADIOLOGY IMAGING	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The principle of various medical imaging equipments such as X-ray, CT, MRI, Ultra Sound, Mammogram and Fluoroscopy.
- The physics principles underlying imaging reconstruction techniques.
- The factors affecting image quality and QA test for of various image modality.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Inference the concept of the prime factors that are associated with x-ray imaging	K4
CO2	Explain the concept of mammography and fluoroscopy. Imaging procedures.	K5
CO3	Interpret the principle of CT, image reconstruction methods and factors influencing the image quality.	K5
CO4	Discuss the physics concept of MR Imaging and its QA	K5
CO5	Explain the basic principle of ultrasound and different image display modes..	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	M	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	M	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A2CC	PHYSICS OF RADIOLOGY IMAGING	SEMESTER II

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Principles Of X-Ray Diagnosis & Conventional Imaging 14 h

Interactions of X-rays with human body - Differential transmission of x-ray beam - Spatial image formation - Visualization of spatial image - Limitations of projection imaging technique viz. superimposition of overlying structures and scatter - Application of contrast media and projections at different angles to overcome superimposition of overlying structures - Prime factors kVp, mAs and SID/SFD- Filters - Scatter reduction - Beam restrictors – Grids (Types of Grids) – Air gap technique - Cassettes - Intensifying screen - Absorption efficiency and conversion efficiency - Structure of x-ray film, types of films, manual processing - Film handling and storage, characteristics of x-ray film, film processing, influence of temperature and time, replenisher, dark room, Automatic film processor - Image quality, contrast resolution, noise, geometric factors, optimal quality image, artifact, beam limiting devices - QA of Diagnostic X-ray.

Different Radiography Techniques: Xero - radiography, Digital Subtraction Techniques, Orthopantomography (OPG), Computed radiography (CR) and Digital radiography (DR).

Unit II Mammography and Fluoroscopy 14 h

Mammography: Mammographic X-ray tube design, x-ray generator and AEC. Compression paddle, grid, collimation, filtration and HVL - Magnification - Screen film cassettes and film processing - Digital Mammography - QA.

Fluoroscopy: Conventional fluoroscopy, dark room adaptation, image intensifiers, closed circuit TV systems, flat panel detectors - Modern trends in interventional Radiology - Bi-plane imaging, rotational angiography, cardiac imaging, real time imaging characteristics – Filtration, continuous and pulsed fluoroscopy, high dose rate fluoroscopy, spot imaging, Digital Subtraction acquisition technique, road mapping, image magnification, last image hold, automatic exposure control, automatic brightness control, brightness gain - Image quality - Radiation dose management: dose area product (DAP) meters, peak skin dose, cumulative dose and dosimetric techniques in interventional radiology - Dose management for paediatric and pregnant patients in interventional imaging, Diagnostic Reference levels and guidelines - QA.

Unit III Computed Tomography 12 h

Computed tomography scanning principle, CT number, Image display - CT Equipment, System design, Gantry geometry, x ray tubes, filters and collimation, Detector array – Generation of CT- Modes of CT acquisition, Axial acquisition, Helical acquisition, Cone beam acquisition, Cardiac CT, CT angiography, CT perfusion - CT image reconstruction, back projection, Filtered back projection, Fourier reconstruction, cone beam reconstruction, Iterative reconstruction, post processing tools, volume rendering, MPR, MIP - Image quality, Spatial resolution, Noise and factors influencing them, Quality assurance - Image artifacts, Radiation dose management: factors affecting patient dose CTDI, CTDIvol, dose length product (DLP), multiple scan average dose (MSAD)- QA of CT.

Unit IV Magnetic Resonance Imaging 10 h

Basics physics of MRI, magnetism, nuclear characteristics, hydrogen characteristics, magnetization vector, precession, radiofrequency and resonance, MRI signal, flip angle - Relaxation time, T1 relation time, T2 relaxation time, Comparison of T1 and T2- MR signal localization, gradient field, slice selection, phase encoding gradient, frequency encoding gradient, composite signal, K-space- MR imaging sequences, spin echo sequence, T1 weighted image, T2 weighted image, spin density weighted image, inversion recovery, gradient recalled echo – Specialized MR sequences, MR angiography, perfusion imaging, diffusion imaging, functional imaging, MR spectroscopic imaging – MR instrument and bio safety, Image quality and artifacts - QA of MRI.

Unit V Ultrasound 10 h

Basics of ultrasound, propagation of sound, interaction of ultrasound with matter - Ultrasound transducer, piezoelectric material, transducer design, transducer array - Beam properties - Near field - Far field - Side lobes - Spatial resolution - Image data acquisition - Data acquisition systems, ADC - Receiver, echo display modes, scan converter - Image data acquisition, pulse echo acquisition - Ultrasound image display, amplitude mode, motion mode, brightness mode - Doppler ultrasound - ultrasound image quality - Image artifacts - Bio-effects of ultrasound - QA of ultrasound

Text Books

1 Curry, T.S. Dowdey and J.E. Murry, R.C, 1990. Christensen's introduction to the Physics of diagnostic radiology, 4th Edition, Philadelphia, Lea & Febiger publisher.

2 Bushberg,S.T; Seibert, J.A; Leidholt, E.M & Boone, J.M, 2011. The essential Physics of Medical imaging, 3rd Edition, Baltimore, Williams & Wilkins publisher.

References

1 Johns. H.E. & Cunningham. J.R, 1983. The Physics of Radiology, 4th Edition, Springfield, III.

2 Thayalan. K, 2014. The Physics of Radiology and Imaging, 1st Edition, Jaypee Brothers Medical Publishers Private Limited.

3 David J. Dowsett; Patrick A. Kenny; Eugene Johnston R, 2006. The Physics of Diagnostic imaging, 2nd Edition, CRC Press.

4 Farr. R. F and PJ Allisy-Roberts, 2006. Physics for Medical Imaging, 2nd Edition Saunders.

202MP2A2CP	CORE PRACTICAL-II: RADIATION MEASURING AND MONITORING INSTRUMENTATION	SEMESTER II

Total Credits: 3
Total Instructions Hours: 72 h

S.No	Contents
1	Statistics of Radioactive Counting.
2	Determination of plateau and resolving time of a G.M counter and its application in estimating the shelf ratio and activity of a beta source
3	Production and attenuation of Bremmstralung.
4	Determine the range of beta particles
5	Backscattering of beta particles.
6	Quality Assurance of a diagnostic X-ray machine
7	Absorption and backscattering of Gamma rays- Determination of HVT
8	Radiation protection survey of Diagnostic Radiology installation
9	Manual Treatment Planning of Two and Three fields
10	Study of Voltage-Current Characteristics of an Ion Chamber
11	Cross Calibration of Ion Chambers
12	Dose output measurement of photon (low and high energy X-ray) beams used in radiotherapy department.

Note Any 10 Experiments

References

1. IAEA TRS-398,1st Edition 2006 Absorbed Dose Determination in External Beam Radiotherapy An International Code of Practice for Dosimetry Based on Standards of Absorbed Dose to Water.
2. FaizM. Khan, 5th Edition, 2015, The Physics of Radiation Therapy Lippincott Williams and Wilkins, U.S.A.
3. Monograph on Radiation Physics Practical's for Medical Physics Students by Dr.S. Sathiyan, 2014.
4. M.R. Deokar, 2007. Laboratory Manual, Radiological Physics and Advisory Division, Bhabha Atomic Research Centre, Mumbai.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A3DA	MATERIALS FOR RADIATION DOSIMETERS	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- To provide fundamental concepts of radiation dosimeters based on the electronic band structure concepts.
- To make students understand different types of dosimeters and their respective applications.
- To provide an overview on various synthesis techniques and to give detailed understanding in working principles of current dosimeter materials

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Develop the fundamental knowledge on the working principle of dosimeters	K5
CO2	Distinguish the different types of dosimeters and their applications	K4
CO3	Formulate the different synthesis techniques and their influence on the properties of dosimeters	K6
CO4	Determine the structure-property relationships of dosimeter materials	K5
CO5	Perceive the properties required for various materials used in medical applications.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	M	S	S	S
CO4	S	S	M	M	S
CO5	S	S	S	S	S

S Strong **M Medium** **L Low**

Course Code	Course Name	Category	L	T	P	Credit
192MP2A2DA	RADIATION DOSIMETRY AND STANDARDIZATION	DSE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The dosimetric quantities and units and its relations.
- The dosimetric standardization of X-ray, gamma, neutron beams and radionuclides.
- The Concept of chemical dosimetry and various chemical dosimeters..

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Discuss the relationship between kerma, absorbed dose and exposure under CPE.	K4
CO2	Explain the Dosimetric standardization of high-energy photons and electrons.	K6
CO3	Discuss about neutron standard dosimetry and to optimize the inter comparison and standardization.	K6
CO4	Interpret methods of measurement of radioactivity	K5
CO5	Describe mechanism of radiolysis of aqueous solutions of biologically relevant compounds and radiation chemistry.	K6

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	M
CO2	S	M	S	S	M
CO3	M	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A2DA	RADIATION DOSIMETRY AND STANDARDIZATION	SEMESTER II

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Radiation Quantities and Units 12 h

Radiation quantities and units - Radiometry - Particle flux and fluence - Energy flux and fluence - Cross section - Linear and mass attenuation coefficients - Mass energy transfer and mass energy absorption coefficients - Stopping power - LET - Radiation chemical yield - W value - Dosimetry - Energy imparted - Absorbed dose - Radiation and tissue weighting factors, equivalent dose, effective dose, committed equivalent dose, committed effective dose - Concepts of collective dose - KERMA- CEMA - Exposure - Air kerma rate constant - Charged particle equilibrium (CPE) - Relationship between kerma, absorbed dose and exposure under CPE - Dose equivalent - Ambient and directional dose equivalents [(H*(d) and H'(d)] - Individual dose equivalent penetrating Hp(d) - Individual dose equivalent superficial Hs(d).

Unit II Dosimetry & Standardization Of X and Gamma Rays Beams 12 h

Dosimetry Standards: Primary and Secondary standards, traceability, uncertainties in measurements.

Two stage energy transfer process - Electronic equilibrium: Charged Particle Equilibrium (CPE), Transient Charged Particle Equilibrium (TCPE). Brag Gray, Burlin and Spencer Attix cavity theories. Free Air Ionization chamber (FAIC) – design measurement of exposure and limitations. Cavity ion chambers - Dose in free space (Dgas) , Dose in Medium (Dmed), expression for sensitivity, - General definition of calibration factors – Nx, Nk, ND, air, ND, w. Different types of Ion chambers- Cylindrical, parallel plate, spherical. Temperature pressure correction: Thermometers, pressure gauges. Saturation correction: Charge collection efficiency based on Mie theory.

Polarity correction: Two voltage method for continuous and pulsed beam. Beam quality, beam quality index, expression for beam quality correction coefficient.

IAEA TRS277: Reference conditions, various steps to arrive at the expression for Dw starting from Nx. TRS398: Reference conditions, Various steps involved in Dw calculations, AAPM TG 51 and other dosimetric protocols. Calorimetric standards – Inter comparison of standards.

Unit III Neutron Standards & Dosimetry 12 h

Neutron standards – Primary standards, secondary standards - Neutron yield and fluence rate measurements - Manganese sulphate bath system - Precision long counter - Activation method - Neutron spectrometry - Threshold detectors - Scintillation detectors - Multispheres - Neutron dosimetry - Neutron survey meters- Calibration - Neutron field around medical accelerators

Unit IV Standardization Of Radionuclide 12 h

Methods of Measurement of radioactivity – Defined solid angle and 4Л counting – Beta gamma coincidence counting – Standardization of beta emitters and electron capture nuclides with proportional, GM and scintillation counters – Standardization of gamma emitters with scintillation spectrometers – Ionization chamber methods – Extrapolation chamber – Routine sample measurements – Liquid counter – Windowless counting of liquid samples – Scintillation counting methods for alpha, beta and gamma emitter – Reentrant ionization chamber methods – Methods using (n, ŕ) and (n, p) reactions – Determination of yields of neutron sources – Space integration methods – Solids state detectors.

Unit V Radiation Chemistry and Chemical Dosimetry 12 h

Definitions of free radicals and G-Values - Kinetics of radiation chemical transformations – LET and dose-rate effects – Radiation chemistry of water and aqueous solutions, peroxy radicals, pH effects – Radiation chemistry of gases and reactions of dosimetry interest – Radiation polymerization - Effects of radiation on polymers and their applications in dosimetry – Description of irradiators from dosimetric view point – Dosimetry principles.

Definitions of optical density - Molar absorption coefficient - Beer – Lamberts law-spectrophotometry – Dose calculations – Laboratory techniques – Reagents and procedures - Requirements for an ideal chemical dosimeter – Fricke dosimeter – FBX dosimeter – Free radical dosimeter – Ceric sulphate dosimeter – Other high and low level dosimeters – Applications of chemical dosimeters in radiotherapy and industrial irradiators. Biological Dosimetry - Chromosome aberration analysis.

Text Books

1 Attix. F. M, 1991. Introduction to Radiological Physics and Radiation Dosimetry, 1st Edition, Viley– VCH, Verlog.

2 IAEA TRS 398, 2006. Absorbed dose determination in Photon and Electron beams, updated version of TRS 277.

References

1 GovindaRajan, 1992. Advanced Medical Radiation Dosimetry, 1st Edition, Prentice hall of India Pvt.Ltd., New Delhi.

2 AAPM TG 51, 2014. Absorbed dose determination for photon beams, revised version.

3 Greening J R, Green S, Charles M W, Fundamentals of Radiation Dosimetry, 3rd Edition,London: Taylor & Francis, 2010.

4 Shaheen Dewji and Nolan E Hertel, Advanced Radiation Protection Dosimetry, CRC Press (Taylor & Francis Group), 1st Edition, 2019.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A2DB	BIOMEDICAL OPTICAL SPECTROSCOPY	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The fundamental understanding of optical spectroscopy and imaging of biological tissue
- The concepts of tissue absorption, scattering and fluorescence, and build on these principles to rigorous analytical and computational models of light diffusion.
- The concept of optical medical device instrumentation, and clinical applications.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Build the concept of light matter interaction, Specific features of living tissues from the point of optics.	K3
CO2	Examine the studies of light propagation in tissues.	K4
CO3	Inspect the IR sources, optical detectors and fibres.	K4
CO4	Function of optical spectroscopy in medicine.	K4
CO5	Analyze optical imaging of cells and tissues.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	M	S	S
CO2	S	M	M	M	S
CO3	M	S	S	M	S
CO4	S	S	S	M	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A2DB	BIOMEDICAL OPTICAL SPECTROSCOPY	SEMESTER II

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Tissue Optics 10 h

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 Propagation In Turbid Media 10 h

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 Optoelectronic Devices 10 h

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 10 h

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 8 h

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

Text Books

1 Markolf H Niemz, 1996. Laser-Tissue Interactions Fundamentals and Applications, Springer- Verlag Berlin Heidelberg New York.

2 A.J.Welch, M. Van Germet, 1995. Optical Thermal Response of Laser-Irradiated Tissue, Plenum press, NY.

References

1 Joseph R Lakowitz, 2002. Principles of Fluorescence spectroscopy, Plenum press, NY.

2 William W. Parson, 2009. Modern Optical Spectroscopy: With Exercises and Examples from Biophysics and Biochemistry, Springer.

3 Nikolai V. Tkachenko, 2006. Optical Spectroscopy: Methods and Instrumentations, Elsevier.

4 Paras N Prasad, Introduction to Biophotonics, 2003. John Wiley and Sons Inc

Course Code	Course Name	Category	L	T	P	Credit
192MP2A2DC	PROGRAMING IN C++	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The fundamental programming concepts and methodologies which are essential to building good C++ programs.
- The fundamental programming methodologies in the C++ programming language via laboratory experiences.
- The fundamental Microsoft Visual Studio programming use.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the basic concepts of C++ programs.	K4
CO2	Discuss the methods of classes and objects.	K5
CO3	Interpret the binary operators and Types of Inheritance	K5
CO4	Explain about Pointers and Arrays.	K5
CO5	Explain about File stream classes	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	M	S	S	S
CO3	M	S	M	S	S
CO4	S	S	S	M	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A2DC	PROGRAMING IN C++	SEMESTER II

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Introduction To C++ 10 h

Key concepts of Object-Oriented Programming –Advantages – Object Oriented Languages – I/O in C++ - C++ Declarations. Control Structures: - Decision Making and Statements: If, Else, jump, goto, break, continue, Switch case statements - Loops in C++: For, While, Do - Functions in C++ - Inline functions – Function Overloading.

Unit II Classes and Objects 14 h

Declaring Objects – Defining Member Functions – Static Member variables and functions – array of objects –friend functions – Overloading member functions – Bit fields and classes – Constructor and destructor with static members.

Unit III Operator Overloading 10 h

Overloading unary, binary operators – Overloading Friend functions – type conversion – Inheritance: Types of Inheritance – Single, Multilevel, Multiple, Hierarchal, Hybrid, Multi path inheritance – Virtual base Classes – Abstract Classes.

Unit IV Pointers 10 h

Pointers – Declaration – Pointer to Class , Object – this pointer – Pointers to derived classes and Base classes – Arrays – Characteristics – array of classes – Memory models – new and delete operators – dynamic object – Binding , Polymorphism and Virtual Functions

Unit V Files 8 h

Operations – Binary and ASCII Files – Random Access Operation – Templates – Exception Handling - String – Declaring and Initializing string objects – String Attributes – Miscellaneous functions.

Text Books

1 Ashok N Kamthane, 2006. Object-Oriented Programming with ANSI andTurbo C++, 1 st Edition, published by Pearson Education.

2 E. Balagurusamy, 2013. Object-Oriented Programming With C++, 6 th Edition, published by Tata Mc-Grawhill.

References

1 Maria Litvin & Gray Litvin, 1997. C++ for you, 1 st Edition published Skylight.

2 Brian W. Kernighan and Dennis M. Ritchie, 2006. "The C programming Language" Prentice-Hall.

3 Bjarne Stroustrup, "The C++ Programming language", Third edition, Pearson Education.

4 HM Deitel and PJ Deitel "C++ How to Program", Seventh Edition, 2010, Prentice Hall.

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CHAIRMAN
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M.Sc. (Medical Physics)(Students admitted during the AY 2020-21)

Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Third Semester										
192MP2A3CA	**Core**	Advanced Radiotherapy Physics	4	1	-	3	25	75	100	4
192MP2A3CB	**Core**	Physics of Nuclear Medicine	4	1	-	3	25	75	100	4
192MP2A3CC	**Core**	Radiation Biology	4	1	-	3	25	75	100	4
192MP2A3CD	**Core**	Brachytherapy Physics	4	1	-	3	25	75	100	4
192MP2A3CP	**Core Practical - I**	Treatment Planning, Radiation Dosimetry and Survey	-	-	6	6	40	60	100	3
192MP2A3DA	**DSE-III**	Materials for Radiation Dosimeters	4	-	-	3	25	75	100	4
192MP2A3DB		Nanotechnology for Biomedical Applications								
192MP2A3DC		Monte Carlo Techniques in Dosimetry								
192MP2A3CT	**Summer Training**	Medical Physics Summer Training	-	-	-	-	40	60	100	2
Total			24		6				700	25

EXTRA CREDIT COURSES

The following are the courses offered under self study to earn extra credits:

S. No.	Course Code	Course Name
1	192MP2ASSA	Research Methodology
2	192MP2ASSB	Ultrasonics In Medicine

Course Code	Course Name	Category	L	T	P	Credit
192MP2A3CA	ADVANCED RADIOTHERAPY PHYSICS	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- To be familiar with clinical indications for conformal radiotherapy
- A general understanding of the treatment planning process
- To understand the advanced radiation therapy techniques

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the conformal radiotherapy techniques such as 3DCRT, IMRT and IMAT.	K5
CO2	To understand the use of imaging KVCT and MVCT during radiation therapy to improve the precision and accuracy of treatment delivery.	K5
CO3	Observe the difference of dose delivery of SRS/SRT.	K5
CO4	Describe particulate beam therapy, Carbon ion therapy – Proton therapy – Hadron therapy.	K5
CO5	Understand the concepts of treatment planning systems and review dosimetry methods for Photons and electrons.	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A3CA	ADVANCED RADIOTHERAPY PHYSICS	SEMESTER III

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Conformal & Intensity Modulated Radiationtherapy 12 h

3D Conformal Radiotherapy Techniques - IMRT Principles –MLC based IMRT – step and shoot and sliding window techniques – Compensator based IMRT – Planning process – Inverse treatment planning – Immobilization for IMRT – dose verification phantoms, dosimeters, protocols and procedures – machine and patient specific QA- Intensity modulated arc therapy (IMAT e.g. Rapid Arc)

Unit II Image Guided Radiotherapy And Tomotherapy 12 h

Image Guided Radiotherapy (IGRT)- concept - imaging modality - kV cone beam computed tomography (KVCT)- MV cone beam computed tomography (MVCT)- image registration- plan adaptation- QA protocol and procedures - special phantom- 4DCT. Tomotherapy - Principle - Commissioning - Imaging - Planning and Dosimetry - Delivery - Plan adaptation.

Unit III Stereotactic Radiosurgery & Radiotherapy (SRS/SRT) 12 h

Cone and mMLC based X-knife – Gamma Knife – immobilization devices for SRS/SRT – dosimetry and planning procedures – evaluation of SRS/SRT treatment plans – QA protocols and procedures for X and Gamma knife units – patient specific QA- physical, planning, clinical aspects and quality assurance of stereotactic body radiotherapy (SBRT) and Cyber knife based therapy.

Unit IV Special Techniques In Radiation Therapy 12 h

Total Body Irradiation (TBI) – large Field Dosimetry – Total Skin Electron Therapy (TSET) – Electron arc treatment and dosimetry – Intraoperative Radiotherapy. Particulate beam therapy: Neutron captures therapy– Carbon ion therapy –Proton Therapy – Hadron Therapy.

Unit V Introduction To Treatment Planning System And Dose Calculation Algorithm 12 h

Scope of computers in radiation treatment planning – review of algorithms used for treatment planning computations – pencil beam, double pencil beam, Clarkson method, convolution superposition, lung interface algorithm, fast Fourier transform, Inverse planning algorithm, Monte Carlo based algorithms. Treatment planning calculations for photon beam and electron beam – factors to be incorporated in computational algorithms-plan optimization – direct aperture optimization – beamlet optimization –simulated annealing – dose volume histograms – indices used for plan comparisons – hardware and software requirements – beam & source library generation-networking, DICOM and PACS.

Text Books

1. FaizKhan. M, 2014. The Physics of Radiation Therapy, 5th Edition, Wolterskluwer.
2. Van Dyk. J, 1999. The Modern Technology of Radiation Oncology, Volume -1, Medical Physics Pub Corp.

References

1. Webb. S, 2001. Intensity Modulated radiation therapy, 1st Edition, CRC Press
2. Webb. S,1993. The Physics of Three Dimensional Radiation Therapy, 1st Edition, CRC Press
3. Levit. S. H, Purdy. J. A, Perez. C. A and Vijayakumar. S, 2006. Technical Basis of Radiation therapy Practical Applications, 1st, Edition, Springer.
4. Thomas Bortfeld, Rupert Schmidt- Ullrich, Wilfried De Neve, David E Wazer, 1993. Image Guided Radiotherapy, 3rd Edition, Springer Berlin Heidelberg.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A3CB	PHYSICS OF NUCLEAR MEDICINE	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The properties and production of radionuclides used in nuclear medicine.
- The use of unsealed radioactive isotopes in diagnostic radiology and radiation therapy.
- The Principles of internal dosimetry and calculation of the radiation dose from internally administered radionuclide.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the applications of radioisotopes to diagnostic/ therapeutic in Nuclear Medicine	K5
CO2	Understand the properties of radiopharmaceuticals used in Nuclear Medicine.	K5
CO3	Discuss about Data acquisition and processing with various equipments, quality control of instruments and labeled agents	K5
CO4	Understand the treatment for thyroid disorders and palliative treatment using radioisotope.	K5
CO5	Describe Internal Dosimetry and calculation of the radiation dose from internally administered radionuclide	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A3CB	PHYSICS OF NUCLEAR MEDICINE	SEMESTER III

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Radionuclide and Its production 12 h

Introduction to nuclear medicine- unsealed Sources- production of radionuclide used in nuclear medicine- reactor based radionuclide, accelerators based radionuclide, photonuclear activation, equations for radionuclide production, radionuclide generators and their operation principles- various usages of radiopharmaceuticals.

Unit II In -vivo and In-vitro Techniques 10 h

Thyroid uptake measurements- reno gram- life span of RBC, blood volume studies etc-general concept of radionuclide- imaging and historical developments-In-vitro techniques- RIA/IRMA techniques and its principles.

Unit III Emission Tomography Techniques 12 h

Radionuclide imaging: other techniques and instruments- the rectilinear scanner and its operational principles- basic principles and design of the anger Camera / scintillation camera- system components, detector system and electronics- different types of collimators- design and performance characteristic of the parallel hole, converging, diverging and pin hole collimator- image display and recording systems- digital image processing systems- scanning camera- limitation of the detector system and electronics.

Different imaging techniques: basic principles- two dimensional imaging techniques-Three dimensional imaging techniques – basic principles and problems-focal plane tomography- emission computed tomography- single photon emission computed tomography- positron emission tomography-various image reconstruction techniques during image formation such as back projection and Fourier based techniques- iterative reconstruction method and their drawbacks-attenuation correction, scatter correction, resolution correction, other requirements or sources of error- image quality parameters: spatial resolution, factor affecting spatial resolution, methods of evaluation of spatial resolution, contrast, noise-NEMA protocols followed for quality assurance / quality control of imaging instruments.

Unit IV Applied Positron Emission Tomography Imaging 12 h

Principles of PET, PET instrumentations- annihilation coincidence detection- PET detector scanner design- data acquisition for PET- data corrections and quantitative aspect of PET- working of medical cyclotron- radioisotopes produced and their

characteristic- treatment of thyrotoxicosis - thyroid cancer with I-131, use of P-32 and Y-90 for palliative treatment- radiation synovectomy and the isotopes used.

Unit V Internal Radiation Dosimetry 14 h

Different compartmental model- single compartmental model- two compartmental model with back transference- two compartmental model without back transference-classical methods of dose evaluation: beta particle dosimetry-equilibrium dose rate equation, beta dose calculation specific gamma ray constant-gamma ray dosimetry-geometrical factor calculation- dosimetry of low energy electromagnetic radiation- MIRD technique for dose calculations- basic producer and some practical problems- cumulative activity, equilibrium dose constant, absorbed fraction, specific absorbed fraction, dose reciprocity theorem, mean dose per unit cumulative activity and problems related to the dose calculations-limitation of MIRD technique.

Text Books

1. J.Herbert and D.A.Rocha, 1984. "Text Book of Nuclear Medicine, Vol. 2 and 6, Lea and Febiger Co., Philadelphia.
2. Webb. S, 1990. The Physics of Medical Imaging, 2nd Edition, Medical Science Series, Adam Hilgers Publications, Bristol.

References

1. Blahd. W. H, 1980. Nuclear medicine, 1stedition, McGraw Hill Co., New Delhi.
2. Wagner. W. N, 1995. Principles of Nuclear Medicine, 2nd Edition, W. B. Saunders Co., London
3. Pant. G. S, 2003. Advances in diagnostic Medical Physics, 3rdEdition, Mumbai : Himalaya Pub. House
4. Ramesh Chandra, 2011, " Nuclear Medicine Physics: The Basics, 7th Edition, Lippincott Williams and Wilkins, Newyork.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A3CC	RADIATION BIOLOGY	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The Structure, Composition and function of the cells, tissue and organism.
- The interaction of radiation with cells and effects of radiation.
- The physical and biological factors influencing the biological effects of radiation with cells.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the structures and biological functions of cells, tissues, and organisms.	K5
CO2	Describe different interactions of radiation on living cells and its biological damage.	K5
CO3	Explain the biological basis 5Rs of fractionated radiotherapy	K5
CO4	Describe the relationship between LET, RBE and OER.	K5
CO5	Explain the effects of radiation and factors influencing radiation effect.	K6

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A3CC	RADIATION BIOLOGY	SEMESTER III

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Cell Biology 12 h

Cell physiology and biochemistry – structures of the cell - types of cells and tissue, their structures and functions - organic constituents of cells – carbohydrates, fats, proteins and nucleic acids – enzymes and their functions – functions of mitochondria, ribosomes, golgi bodies and lysosomes – cell metabolism – DNA as concepts of gene and gene action – mitotic and meiotic cell division – semi conservative DNA synthesis, genetic variation crossing over, mutation, chromosome segregation – heredity and its mechanisms.

Unit II Interaction of Radiation With Cells 12 h

Action of radiation on living cells – radiolytic products of water and their interaction with biomolecule – nucleic acids, proteins, enzymes, fats – influence of oxygen, temperature – cellular effects of radiation – mitotic delay, chromosome aberrations, mutations and recombinations – giant cell formation, cell death recovery from radiation damage – potentially lethal damage and sublethal damage recovery - pathways for repair of radiation damage- Law of Bergonie and Tribondeau.

Repair misrepair hypothesis – dual action hypothesis – modification of radiation damage – LET, RBE, dose rate, dose fractionation – oxygen and other chemical sensitizers – anoxic, hypoxic, base analogs, folic acid, and energy metabolism inhibitors – hyperthermic sensitization – radio-protective agents.

Unit III Biological Basis of Radiotherapy 10 h

Physical and biological factors affecting cell survival, tumor regrowth and normal tissue response – non-conventional fractionation scheme and 5R's of fractionated radiotherapy repair, repopulation, redistribution, reoxygenation and radiosensitivity in the cell cycle – high LET radiation therapy.

Unit IV Radiobiological Models 12 h

Cell population kinetic models- survival curve parameters – model for radiation action – target theory – multihit, multitarget –time dose fractionation – basis for dose fractionation in beam therapy – concepts for nominal standard dose (NSD)- Roentgen equivalent therapy (RET) – time dose fractionation (TDF) factors and cumulative radiation effects (CRE) – gap correction, linear and linear Quadratic models- TCP and NTCP evaluation.

Unit V Biological Effects of Radiation 14 h

Somatic effects of radiation – physical factors influencing somatic effects – dependence on dose, dose rate, type and energy of radiation, temperature, anoxia - acute radiation syndrome– LD50 dose, LD50,30 LD50,60 – effects of radiation on skin and blood forming organs- digestive track – sterility and cataract formation – effects of chronic exposure to radiation – induction of leukemia – radiation carcinogenesis – risk of carcinogenesis – animal and human data – shortening of life span – in-utero exposure – genetic effects of radiation-Radiation effects on Embryo and fetus – factors affecting frequency of radiation induced mutations – dose-effects relationship – first generation effects – effects due to mutation of recessive characteristics – genetic burden – prevalence of hereditary diseases and defects – spontaneous mutation rate – concept of doubling dose and genetic risk estimate.

Text Books

1. Hall. E. J, 1987. Radiobiology for Radiologists, 2ndEdition, J.B. Lippincott Co., Philadelphia.
2. Godden Steel, 2002. Principles of radiobiology, 3rdEdition, CRC Press.

References

1. Perez & Bradys, 2008. Principles and practice of radiation oncology, 5th Edition, Lippincott Williams and Willins.
2. Tubiana M, Dutreix. J,1990. Introduction of Radiobiology, 1st Edition, Taylor & Francis.
3. IAEA TRS 42, 2010. Radiation Biology: A Handbook for Teachers and Students, Vienna, Austria.
4. Kuppusamy Thayalan, 2017. Handbook of Radiobiology, Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi, India.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A3CD	BRACHYTHERAPY PHYSICS	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The Basics of Brachytherapy and its classification and various techniques based on dose rate, treatment time and placement of radioactive source.
- The production and construction of radionuclides and its physical properties.
- Brachytherapy dosimetry, treatment planning, advanced brachytherapy techniques and quality assurance procedures.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the physical properties and construction of brachytherapy sealed sources used in brachytherapy treatment.	K5
CO2	Describe the dosimetry procedures and various quality assurance tests in brachytherapy.	K5
CO3	Explain the basics of brachytherapy and its classification.	K5
CO4	Compare the treatment planning for various techniques. To understand the ICRU recommendations.	K4
CO5	Explain about the advanced brachytherapy techniques.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	M	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A3CD	BRACHYTHERAPY PHYSICS	SEMESTER III

Total Credits: 4
Total Instruction Hours: 60 h

Syllabus

Unit I Basics of Brachytherapy 12 h

Definition and classification of brachytherapy based on Dose rate considerations - low dose rate (LDR), high dose rate (HDR) and pulsed dose rate (PDR) and classification of brachytherapy techniques, Surface mould, Intracavitary, Interstitial and Intraluminal techniques. Applicators used in Brachytherapy - temporary and permanent implants. AAPM and IEC requirements for remote afterloading HDR Brachytherapy equipment.

Unit II Radionuclides and Their Properties 12 h

Introduction- Requirement for brachytherapy sources – Production and construction of sealed sources 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 and other commonly used brachytherapy sources.

Unit III Dosimetry and Quality assurance 14 h

Source specification – Concept of exposure rate constant, reference air kermarate(RAKR), apparent activity, air kerma strength(AKS), primary standard, water calorimetry, NK factor for Iridium-192 HDR calibration, room scatter correction-Stochholm system, Manchester system-,Paris system-point and line source dosimetry formalisms, Sievert integrals-TG43/TG43U1 formalisms, IAEA TECDOC 1274 and ICRU 72 recommendations. -AAPM TG 60 protocol for intravascular Brachytherapy -Image Guided adaptive Brachytherapy, commissioning, imaging, planning and dosimetry, delivery, plan adaptation, QA protocol and procedures.

Unit IV Treatment Planning 12 h

Brachytherapy treatment planning, CT/MR based brachytherapy planning - forward and inverse planning - DICOM image import / export from OT - record & verification.
Scope of computers in radiation treatment planning –Applicator reconstruction, montecarlo based algorithms - Optimization techniques -geometric optimization (GO) and volume optimization (VO) -Intracavitary & Interstitial HDR brachytherapy- ICRU 38 & ICRU 89 -ICRU 58 Recommendations.

Unit V Advanced Techniques In Brachytherapy 10 h

Accelerated partial breast irradiation using balloon catheter –Intraoperative Brachytherapy (IORT)- Ocular brachytherapy using photon and beta sources. Intravascular brachytherapy - classification - sources - Integrated Brachytherapy Unit (IBU) -Electronic Brachytherapy–Intensity Modulated Brachytherapy(IMBT).

Text Books

1. D. Baltas, 2007, The Physics of Modern Brachytherapy for oncology, Taylor and Francis, London,Uk.
2. FaizM. Khan, 5th Edition, 2015, The Physics of Radiation Therapy Lippincott Williams and Wilkins, U.S.A.

References

1. E.B.Podgorsak, 3rd Edition 2016, Radiation Physics for Medical Physicists, Springer.
2. E.B.Podgorsak, 2005, Radiation Oncology Physics: A Handbook for Teachers and Students, IAEA.
3. Phillip. Devlin, Ist Edition 2010, Brachytherapy: Applications and Techniques Lippincott Williams and Wilkins U.S.A.
4. Faiz M. Khan, Roger A. Potish, 1998, Treatment Planning in Radiation Oncology, Williams & Wilkins, Baltimore.

192MP2A3CP	CORE PRACTICAL : TREATEMENT PLANNING, RADIATION DOSIMETRY AND SURVEY	SEMESTER III

Total Credits: 3
Total Instructions Hours: 72 h

S.No	Contents
1	Dose output measurement of electron beams used in radiotherapy department using TRS 398 protocol.
2	Determination of Percentage Depth Dose(PDD) for Photon and electron Beams.
3	Determination of radiation field flatness, symmetry, beam quality index and penumbra of external photon beam.
4	Verification of mechanical and radiation alignment of a linear accelerator machine.
5	Periodic quality assurance of High Dose Rate (HDR) remote after loader brachytherapy unit.
6	AKS/RAKR measurement of HDR Brachytherapy sources using well type and cylindrical ionization chamber.
7	Familiarization with treatment planning procedure.
8	3DCRT Planning techniques in cancer of uterine cervix, Head and Neck, Oesophagus.
9	Pre-treatment Patient specific QA for IMRT.
10	Radiation protection survey of Medical Linear Accelerator unit.
11	Radiation protection survey of Brachytherapy unit.
12	Head Leakage and Collimator leakage level Measurement of linear accelerator machine (IEC).

Note: Out of 12 - 10 Experiments

References

1. IAEA TRS-398,1st Edition 2006 Absorbed Dose Determination in External Beam Radiotherapy An International Code of Practice for Dosimetry Based on Standards of Absorbed Dose to Water.
2. FaizM. Khan, 5th Edition, 2015, The Physics of Radiation Therapy Lippincott Williams and Wilkins, U.S.A.
3. Monograph on Radiation Physics Practical's for Medical Physics Students by Dr.S. Sathiyan, 2014.
4. M.R. Deokar, 2007. Laboratory Manual, Radiological Physics and Advisory Division, Bhabha Atomic Research Centre, Mumbai.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A3DA	MATERIALS FOR RADIATION DOSIMETERS	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- To provide fundamental concepts of radiation dosimeters based on the electronic band structure concepts.
- To make students understand different types of dosimeters and their respective applications.
- To provide an overview on various synthesis techniques and to give detailed understanding in working principles of current dosimeter materials

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Develop the fundamental knowledge on the working principle of dosimeters	K5
CO2	Distinguish the different types of dosimeters and their applications	K4
CO3	Formulate the different synthesis techniques and their influence on the properties of dosimeters	K6
CO4	Determine the structure-property relationships of dosimeter materials	K5
CO5	Perceive the properties required for various materials used in medical applications.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	M	S	S	S
CO4	S	S	M	M	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A3DA	MATERIALS FOR RADIATION DOSIMETERS	SEMESTER III

Total Credits: 4
Total Instruction Hours: 48 h

Syllabus

Unit I Energy Band Structure in Solids 10 h

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

Unit II Fundamentals of Dosimetry Defects in Solids 10 h

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

Unit III Types of Dosimeters 10 h

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

Unit IV Material Synthesis Techniques 10 h

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

Unit V Medical Applications of Dosimeters 8 h

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

Text Books

1. Neil W Ashcroft and N. David Mermin, 2014. Solid State Physics, India edition IE, Thomsom books, Reprint.
2. Khalil Arshak and Olga Korostynska, 2017. Advanced Materials and Techniques for Radiation Dosimetry, Artech House Publishers.

References

1. S.W.S. McKeever, 1995. Thermoluminescence Dosimetry Materials: Properties and Uses, Ramtrans Publishing.
2. S. O. Pillai, 2005. Solid State Physics, 6th Edition, New age International Pvt Ltd.
3. Frank Herbert Attix, 2007. Introduction to Radiological Physics and Radiation Dosimetry, John Wiley & Sons.
4. Charles Kittel, 2013. Introduction to Solid State Physics, 8th Edition, John Wiley.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A3DB	NANOTECHNOLOGY FOR BIOMEDICAL APPLICATIONS	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The various synthesis techniques for preparing Nanomaterials and application of Nanomaterials to targeted biological applications.
- The concepts of Nanomaterials and biomedical interaction.
- The basic of device fabrication for Nanomaterials -based biosensors.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the fabrication techniques used for developing Nanostructured materials.	K5
CO2	Develop the knowledge on micro fluidic patterning on extracellular surfaces.	K6
CO3	Justify the knowledge on the application of nanotechnologies in biological fields.	K5
CO4	Organize applications of Nanomaterials in the field of research, industrial and fulfilling therapeutic needs.	K4
CO5	Perceive knowledge of fabrication of sensors for biomedical applications.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A3DB	NANOTECHNOLOGY FOR BIOMEDICAL APPLICATIONS	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Fundamentals of Micro Fabrication 10 h

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 10 h

Micro fluidic Processes: Fundamentals of Laminar Fluids.The Role of Micro- Scale Fluid Dynamics in Bio Microelectromechanical systems (MEMS) and Neuro Microelectromechanical systems (MEMS) - Microelectrodes and Neuronal Interfaces, Microstereolithography.

Unit III Nano-Fabrication 8 h

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

Unit IV Nano -Biotechnology 10 h

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

Unit V Nano-Biosensors 10 h

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.

Text Books

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

References

1. Robert A. FreitasJr, 1998. Nanomedicine, Freitas Jr.Kluwer publications, USA.
2. Richard Coombs, Dennis W. Robinson, 1996. Nanotechnology in medicine and the biosciences, Gordon and Breach Publishers.
3. Eugene J.Koprowski, GeneKoprowski, 2011. Nanotechnology in medicine: Emerging applications, Mcgraw-Hill Education.
4. Tuan Vo-Dinh, 2007. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications, CRC Press.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A3DC	MONTE CARLO TECHNIQUES IN DOSIMETRY	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The modeling of ionizing and non-ionizing radiation transport.
- The role of Monte Carlo in dosimetry more accurately.
- The evaluation of dosimetry using statistical approach and different computer codes used for dosimetry.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Analyze various Monte Carlo techniques in solving various mathematical and physical problems.	K4
CO2	Perceive the knowledge to use Monte Carlo code to design the source and evaluate the dosimetric parameters.	K5
CO3	Interpret and evaluate the results of statistical nature using Monte Carlo technique for electron transport.	K5
CO4	Formulate the theory of the Monte Carlo simulation for ionizing and non-ionizing radiation.	K6
CO5	Create a mathematical model of tumor in tissue by understanding the Fick's law.	K6

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A3DC	MONTE CARLO TECHNIQUES IN DOSIMETRY	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Elements of Monte-Carlo Technique 12 h

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 8 h

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 8 h

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 10 h

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

Unit V Diffusion Theory of Light Transport in Tissue 10 h

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 proximation in three dimensions - finite beam profiles - green's function - diffuse liant fluence rates for finite beams.

Text Books

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. Frank Verhaegen, 2013. Monte Carlo Techniques in Radiation Therapy, CRC Press.

192MP2ASSA	SELF STUDY : RESEARCH METHODOLOGY	SEMESTER III

Total Credits: 1

Syllabus

Unit I Introduction to Research Methodology

Introduction- Meaning of Research - objectives of Research –Motivation of Research–Types of Research – Research approaches – Significance of Research - Research and scientific methods – Research Process– Criteria of good Research – Problems encountered by Researchers – Literature review.

Unit II Research Formulation

Defining a research problem -Selecting the Research problem–Necessity of defining the problem–Technique involved in designing problem-Research Design Formulation of Research design – Need for Research design – Features of a good design – Important concepts related to Research design. Different research designs– Basic principles of experimental designs.

Unit III Sampling Design

Census and sample survey –Implication of sample design- Steps involved sampling design – Criteria of selecting a sampling procedure- Characteristics of good sample design- different types of sample design-random sample from an infinite universe-complex random sampling designs.

Unit IV Statistical Techniques and Tools

Introduction of statistics – Functions – Limitations – Measures of central tendency - Arithmetic mean – Median – Mode – Standard deviation – Co-efficient of variation (Discrete serious and continuous serious) – Correlation - Regression – Multiple Regression. Sampling distribution – Standard error – Concept of point and interval estimation – Level of significance – Degree of freedom – Analysis of variance – One way and two way classified data – 'F'-test.

Unit V Interpretation and Report Writing

Meaning and Technique of interpretation – Techniques of interpretation-Precautions in interpretation – Significance of report writing – Different steps in writing a report – Layout of a Research report. Types of report – Mechanics of writing a research report – Precautions for writing a research report. Steps involvedin writing a a good report- concept of bibliography and reference

Text Books

1 C.R. Kothari, 2004. Research Methodology (Methods and Techniques), 2nd Edition, New Age International Publishers.

2 Gupta, S., 2001. Research Methodology and Statistical Techniques, Deep and Deep, New Delhi.

References

1 Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.

2 Mukul Gupta, Deepa Gupta, 2011. Research Methodology, PHI Learning Private Ltd., New Delhi.

3 S.C. Gupta and V.K. Kapoor, 2014. Fundamentals of Mathematical statistics, 10th Revised Edition, Sultan Chand & Sons, Delhi.

4 S.P. Gupta, 2014. Statistical methods, 44th Edition, Sultan Chand & Sons Educational publishers, New Delhi.

192MP2ASSB	SELF STUDY: ULTRASONICS IN MEDICINE	SEMESTER III

Total Credits: 1

Syllabus

Unit I Generation and Detection of Ultrasound

Basic principle of ultrasonagraphy - Generation of Ultrasound - Ultrasound tranducer- 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

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

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

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

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.

Text Books

1 M. Hussey, 1990. Basic Physics and Technology of Medical Diagnostic Ultrasound, 2nd Edition, McMikkan, London.

2 W. M. McDicken, 1992. Diagnostic Ultrasonic principles and use of Instrument, 2ndedition, JohnWiley and Sons, New York.

References

1 D. H. Evans and J. P. Wood Cock, 1998. Doppler ultrasound Physics Instrumentation and Clinical applications, John Wiley, Chichester.

2 C. R. Hill, J. C. Bamber, G. R. terHaar, 2005. Physical Principles of Medical Ultrasonics, John Wiley & Sons.

3 Sidney K Edelman, 2012. Understanding Ultrasound Physics, 4th Edition Edition, E.S.P. Ultrasound.

4 Wayne R. Hedrick, David L. Hykes , Dale E. Starchman, 2004. Ultrasound Physics and Instrumentation, 4th Edition, Mosby, USA.

192MP2A3CT	MEDICAL PHYSICS SUMMER TRAINING	SEMESTER III

Total Credits: 2

PREAMBLE

This course has been designed for students to learn and understand

- The clinical work carried out in Radiation Oncology, Radiology and Nuclear Medicine Departments.
- The duties and responsibilities of a Medical Physicist and Radiological Safety Officer (RSO).
- The Radiation safety instruments used to ensure safety of Patient, Radiation worker and Public.

Content

Students must undertake field training for 30 days during their II semester summer vacation to observe the clinical works carried out in Radiation Oncology, Radiology and Nuclear Medicine Department of AERB recognized Hospitals/ Research Institutes under the guidance and supervision of Medical Physicist and class advisor. The students will submit the report for evaluation during III semester.

The stages in Field Training Report Work are given below:

- A guide will be allotted by the Department to each student.
- The Student has to maintain the work diary.
- The training should be pursued in the department allotted by the hospital.
- Student should prepare a Training Report at the end of field training and it has to be certified and approved by the guide. (The Report should be in the Standard Format).
- The training should be carried out individually and personally by the student.
- The Field Training Report should demonstrate the learning of the students.
- The training certificate copy must be enclosed in the Report.
- The training report should be submitted to the department with enclosed copy of training certificate.

Based on the performance marks will be awarded as follows:

Internal Marks	External Marks (Report & Viva - voce)	Total Marks
40	60	100

Internal Marks Distribution:

The internal mark will be awarded based on the field training report

The guide will give the marks for internal marks as per the norms stated below:

Work Diary - 10 Marks

Attendance - 10 Marks

Report - 20 Marks

Total - 40 Marks

External Marks Distribution:

Presentation and Viva-voce Examination:

The evaluation for the report will be done as per the norms given below:

Presentation - 40 Marks

Viva-Voce Examination - 20 Marks

Total - 60 Marks

Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Fourth Semester										
192MP2A4CA	Core-XII	Radiation Hazards Evaluation and control	4	-	-	3	25	75	100	4
192MP2A4CP	Core Practical-IV	Machine Acceptance and Quality Assurance (QA)	-	-	6	6	40	60	100	3
192MP2A4DA	DSE-IV	Quality Control, Acceptance Testing And Calibration of Radiation System	**4**	**-**	**-**	**3**	**25**	**75**	**100**	**4**
192MP2A4DB		Applications of Radiation and Radioisotopes in Health and Agriculture								
192MP2A4DC		Biosensors								
192MP2A4CV	Project	Project and Viva Voce	-	-	16		80	120	200	8
Total			**8**	**-**	**22**	**-**	**-**	**-**	**500**	**19**
GRAND TOTAL									**2400**	**90**

Course Code	Course Name	Category	L	T	P	Credit
192MP2A4CA	RADIATION HAZARDS EVALUATION AND CONTROL	CORE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The basic concepts of radiation protection standard system.
- The monitoring and protection principle of internal and external radiation hazards.
- Radiation safety codes for transport and waste disposal of radioisotopes and radiation emergencies and its management.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Explain the hazards of radiation and its protection system.	K5
CO2	Explain the monitoring and protection principle of internal and external radiation exposure	K5
CO3	Interpret the types of installations and Safety requirements on radiation sources and equipment	K5
CO4	Discuss about the radioactive waste disposal and transport of radioactive material.	K5
CO5	Outline the radiation safety legislation, radiation emergencies and medical management.	K3

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A4CA	RADIATION HAZARDS EVALUATION AND CONTROL	SEMESTER IV

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Radiation Protection Standards 10 h

Radiation dose to individuals from natural radioactivity in the environment and manmade sources-basic concepts of radiation protection standards – historical background – International Commission on Radiological protection and its recommendations – ICRP 60 and 103 – The system of radiological protection – justification of practice, optimization of protection and individual dose limits – potential exposures, dose and constraints - 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 Principles of Monitoring and Protection 9 h

Evaluation of external radiation hazards – effects of distance, time and shielding– shielding calculations – personnel and area monitoring – internal radiation hazards– radio toxicity of different radionuclide and classification of laboratories– control of contamination – bioassay and air monitoring – chemical protection– radiation accidents – disaster monitoring.

Unit III Safety in the Medical Uses of Radiation 10 h

Planning and shielding calculations of medical radiation installation – general considerations – design of diagnostic, deep therapy, telegamma, accelerators and installations, brachytherapy facilities, SPECT, PET/CT and medical cyclotron in the nuclear medicine department and medical radioisotope laboratories-evaluation of radiation hazards in medical diagnostic therapeutic installations – radiation monitoring procedures – protective measures to reduce radiation exposure to staff and patients – radiation hazards in brachytherapy department and teletherapy departments and radioisotope laboratories – particle accelerators protective equipment – handling of patients – radiation safety during sources transfer operations special safety features in accelerators, reactors.

Unit IV Radioactive Waste Disposable and Transport of Radioisotope 10 h

Radioactive waste – sources of radioactive waste – classification of waste – treatment techniques for solid, liquid and gaseous effluents – concept of delay tank and various Waste disposal Methods used in nuclear medicine. 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- transportation of radioactive substances – historical background – general packing requirements – transports documents – labeling and marking of packages – regulations applicable for different modes of transport – transports by post –transport emergencies – special requirements for transport of large radioactive sources and fissile materials– exemptions from regulations – shipments approval – shipment exclusive use– transports under special arrangement – consignors and carriers responsibilities.

Unit V Radiation Safety Legislation and Radiation Emergencies and Their Medical Management 9 h

Atomic Energy Act-1962, RPR-2004 and applicable safety codes- radiation accidents and emergencies in the use of radiation sources and equipment industry and medicine - radiographic cameras and teletherapy units – loading and unloading of sources – loss of radiation sources and their tracing – typical accidents cases, radiation injuries, their treatment and medical management – case histories- eLORA.

Text Books

1 Alan Martin, 1998. "Radiation Protection" 3 rd Edition, published by Champman & Hall.

2 Thayalan. K, 2010. "Textbook of Radiological protection" 1st Edition, published by Jaypee Brothers.

References

1 Shapiro J. 1994. "Radiation Protection" 3rd Edition, Harvard University Press.

2 Mckenzie, 1986. "Radiation protection in Radiotherapy", 3rd Edition, Institute of Physics and Engineering in Medicine

3 Herman Cember, 2008. "Introduction to Health Physics", 4th Edition, McGraw-Hill Medical.

4 AERB Radiation Protection Rules 2004, ICRP 1990 Recommendations and ICRP 2007 Recommendations.

192MP2A4CP	CORE PRACTICAL: MACHINE ACCEPTANCE AND QUALITY ASSURANCE	SEMESTER IV

Total Credits: 3
Total Instructions Hours: 72 h

S.No	List of Experiments
1	Quality assurance (QA) tests procedures of Teletherapy machines.
2	Quality-assurance (QA) test procedures of brachytherapy machine.
3	Radiation survey of linear accelerator to find the adequacy of shielding on safety point of view.
4	Verify the relation between HVL and TVL.
5	Radiation exposure: Effect of distance, Shielding and time.
6	Room lay out planning of linear accelerator teletherapy unit.
7	Room lay out planning and radiation survey of a HDR brachytherapy unit.
8	Quality Assurance of Multileaf Collimator.
9	Autoradiography test for Brachytherapy source in Remote Afterloader unit.
10	Survey of a radioisotope laboratory and study of surface and air contamination.
11	Comparison of manual treatment planning and computerized treatment planning irregular fields (Using Clarkson's method.)
12	Manual Treatment Planning of four fields.

Note: 10 OUT OF 12

References

1. Monograph on Radiation Physics Practical's for Medical Physics Students by Dr.S. Sathiyan, 2014
2. FaizM. Khan, 5th Edition, 2015, The Physics of Radiation Therapy Lippincott Williams and Wilkins, U.S.A.
3. Thayalan. K, 2010. Textbook of Radiological protection 1st Edition, published by Jaypee Brothers
4. Podgarsak. E.B. 2005. Radiation Oncology Physics: Handbook for Teachers and Students, IAEA, Vienna publisher.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A4DA	QUALITY CONTROL, ACCEPTANCE TESTING AND CALIBRATION OF RADIATION SYSTEMS	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The quality assurance program for diagnostic radiology and radiation therapy equipments.
- The quality assurance procedures for Treatment planning systems
- The Acceptance, Commissioning and Decommissioning procedures for radioactive source and equipment.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Importance of the quality assurance program	K4
CO2	Discuss the Dosimetric protocols and quality assurance tests for radiation therapy.	K5
CO3	Explain the quality assurance test for various types of diagnostic equipments.	K5
CO4	Interpret the Acceptance and commissioning test for TPS.	K5
CO5	Explain the Commissioning and Decommissioning procedures for radioactive source and equipment.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A4DA	QUALITY CONTROL, ACCEPTANCE TESTING AND CALIBRATION OF RADIATION SYSTEMS	SEMESTER IV

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Quality Assurance 8 h

Purpose for quality assurance, Goals of QA, Personnel Requirements for Clinical Radiation Therapy, Roles and Responsibilities of Medical Physicists. Documentation and Quality Assurance, Definition of Terms - Quality Control, Quality Assurance, advantages of a Code of Practice based on standards of absorbed dose to water, Expression of uncertainties, The International Measurement System, The IAEA network of SSDLs, Standards of absorbed dose to water.

Unit II Dosimetric Protocols and QA for Radiation Therapy 10 h

Different Protocols For Dosimetry - TRS 277, TRS-398, TG 51 and TG-43, Correction for the Radiation Quality Of The Beam (Kqqo), Ionization Chambers, Phantoms and Calibration of Ionization Chambers.

Co-60: Mechanical Checks, Electrical checks, Radiation Checks, Radiation Protection survey, Linear Accelerator: Photon beam characteristics, Electron beam Characteristics, Dose monitoring system, Treatment table, Leakage radiation measurements, Survey of installation.

Brachytherapy – Machine Tests, QC of Applicator, QA of sources, Leakage and Contamination, Source Strength Verification, Uniformity and Symmetry, Dwell Position Verification, QC of treatment Unit, Radiation Safety, HDR Source Transport, Type A package, Source Transfer Process and safety Concern in HDR.

Unit III Quality Assurance tests in Diagnostic Radiology. 10 h

QA tests for diagnostic X-ray machine: Purpose of QA tests, test procedures, Congruence of optical and radiation fields, Central beam alignment, Focal spot size, Exposure time, Applied tube potential, Total filtration, Linearity of timer, Linearity of mA, Consistence of radiation output, Radiation leakage through tube houing exposure rate at table top, Resolution of the imaging system, Radiation protection survey, Intensifying Screen Cleaning Procedure, Darkroom Integrity or Fog Test.

Computed Tomography (CT) Unit: Tools required for QA tests of CT equipment, Categories of QA tests – Mechanical Tests- Alignment of table to gantry, Gantry tilt, Tests for high frequency generators, Radiation Dose test (CTDI) , Image Quality Parameters, Radiation leakage tests and Radiation protection survey.

Quality assurance tests of Mammography Unit, Magnetic resonance imaging (MRI): Phantom materials, resonance frequency, signal to noise ratio, image uniformity, spatial linearity, high contract spatial resolution, slice thickness, slice position/separation, image artifacts.

Unit IV Quality Assurance tests for TPS 10 h

Acceptance, commissioning and quality assurance of radiotherapy treatment planning systems using IAEA TRS 430 and other protocols. Digitizer Accuracy, Image Acquisition and Display, Hardcopy Output Accuracy, Monitor Unit Check – Open and Wedge Fields, Isodose Checks, Clinical Isodose/Monitor Unit Check, Electron Monitor Unit and PDD Check, Operating Consistency of IMRT Dose Optimization Software, HDR Treatment Planning QA, Prostate Seed Treatment Planning QA

Unit V Acceptance tests, Commissioning, and Decommissioning Procedures 10 h

Acceptance tests for Medical linear Accelerators and Remote Afterloader Brachytherapy. Commissioning: Linear accelerator – Central axis depth dose tables, Isodose curves, Monitor unit calculations, Multileaf collimators (MLC), Treatment Planning computer system, Essential Equipments for Commission and Decommission. Decommissioning Process for Radioactive Sources, Medical Linacs and Brachytherapy.

Text Books

1 FaizM. Khan, 5th Edition, 2015, The Physics of Radiation Therapy Lippincott Williams and Wilkins, U.S.A.

2 Thayalan. K, 2010. Textbook of Radiological protection 1st Edition, published by Jaypee Brothers

References

1 Podgarsak. E.B. 2005. Radiation Oncology Physics: Handbook for Teachers and Students, IAEA, Vienna publisher.

2 IAEA TRS-398,277."Absorbed Dose Determination in External Beam Radiotherapy An International Code of Practice for Dosimetry Based on Standards of Absorbed Dose to Water and Air". Vienna, Austria..

3 IAEA TRS-430, 2004. "Commissioning and Quality Assurance of Computerized planning systems for radiation treatment of Cancer", Vienna, Austria..

4 TG 51, TG 21, TG 43, TG 53 AAPM Task Group

Course Code	Course Name	Category	L	T	P	Credit
192MP2A4DB	APPLICATIONS OF RADIATION AND RADIOISOTOPES IN HEALTH AND AGRICULTURE	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The radioactivity and its behavior of natural and artificial radioactive sources.
- The medical uses of radiation in diagnostics and therapy
- Application of radiation and radioisotopes in agriculture and industry.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Understand the radioactivity and its types .	K2
CO2	Explain the application of radiation and radioisotopes in diagnostic radiology.	K5
CO3	Interpret the application of radiation and radioisotopes in radiation therapy.	K5
CO4	Importance of Radioisotopes in Agriculture.	K5
CO5	Discuss the uses of radiation in industry.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A4DB	APPLICATIONS OF RADIATION AND RADIOISOTOPES IN MEDICAL, AGRICULTURAL AND INDUSTRY	SEMESTER IV

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Environmental Radioactivity 8 h

Sources of environmental radioactivity – Natural, artificially produced and technologically enhanced radioactivity. The nuclear fuel cycle, nuclear power reactors, types of reactors, low level and high level radioactive waste, reactor accidents. Nuclear explosions: Short-term and worldwide effects. Impact on marine and terrestrial environments, Behavior of radioactive contaminants in terrestrial environment.

Unit II Medical Applications in Diagnostics and Medicine 10 h

Radiation: Sterilizing Medical Equipments, New drug testing – Medical Imaging– X-rays, Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Radioisotopes: lifespan of RBC, Thyroid uptake studies, Thyroid scanning, Bone scanning, Kidney scanning, Technetium for blood flow studies, Diagnostic Techniques in Nuclear Medicine – Single Photon Emission Tomography (SPECT) & Positron Emission Tomography (PET) scanning.

Unit III Medical Applications – Therapy 10 h

Therapeutic applications - Unsealed Sources, cancers, heart disease, gastrointestinal, endocrine, neurological disorders and other abnormalities within the body, external radiation therapy, internal radionuclide therapy - Sealed sources -Brachytherapy, Boron Neutron Capture Therapy (BNCT). Gamma Knife Radiosurgery (Cyber Knife). Nuclear medicine - radio nuclide production and radiopharmaceuticals, tracers in biological substances, radioisotopes tagging for therapeutic purposes.

Unit IV Agricultural applications 10 h

Importance of Radioisotopes in Agriculture, Radiotracers - fertilizers uptake, retention and utilization, nutrients and water requirement estimation, mineral and elemental uptake and distribution by plants and crops. Nuclear moisture density gauge – Soil moisture monitoring. Soil sterilization using ionizing radiation.

Insect pest management – Pesticide residue monitoring in food, soil, ground water and environment. Crop improvement – sterile insect technique (SIT), radiation

induce mutations to develop plants resistant to diseases, new crop breeding of improved variety (groundnut and black gram).

Food processing and preservation – reducing post-harvest loss, food preservation, extension of shelf life, irradiation from packaged food, postponing ripening of fruits. Animal diseases and their vectors. Animal production and health. Advantages of Isotopes in agriculture.

Unit V Industrial Applications 10 h

Industrial applications – Process Control, Plant Diagnostics, Materials Development, Materials Testing and Inspection, Materials Composition, Energy (non-nuclear power), Personal Care and Conveniences, Sealed radioactive sources and their applications in industry – industrial radiography, gauging applications and mineral analysis. Radio tracer techniques: Leak and block detection, flow rate and mixing measurements, Gamma Sterilization: medical supplies, bulk commodities.

Text Books

1 Hall Eric J., 1994. "Radiobiology for the radiologist" Lippincott Williams & Wikins, Philadelfia.

2 Eisenbud M. 1987. "Environmental Radioactivity" Academic Press Inc. (London) Ltd., 24-28 Oval Road, London NW1 7DX.

References

1 Bushong, Stewart C., 1997. " Radiological Science for technologists – physics, biology and protection, Mosby, St. Louis.

2 Edward L. Alphen, "Radiation Biophysics" Academic Press, Second Edition.

3 Radioisotopes and Radiation; Recent Advances in Medicine, Agriculture and Industry.

4 IAEA, 1995. "Induced Mutations and Molecular Techniques for Crop Production" Proceedings of a Symposium, Jointly organized by IAEA and FAO, Vienna, June 19-23.

Course Code	Course Name	Category	L	T	P	Credit
192MP2A4DC	BIOSENSORS	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The principles of various transducers.
- The various types of biosensors and its fabrication methods
- The uses of biosensors for medical applications.

COURSE OUTCOMES

On the successful completion of the course, students will be able to

CO Number	CO Statement	Knowledge Level
CO1	Classify the different types of transducers	K4
CO2	Explain the methods for biosensor fabrication.	K5
CO3	Distinguish the different types of biosensors.	K5
CO4	Explain the detection of biomolecules using biosensor.	K5
CO5	Discuss the application of biosensors in medicine.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	S	S	S	S	S
CO2	S	S	S	S	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S Strong M Medium L Low

192MP2A4DC	BIOSENSORS	SEMESTER IV

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Biosensor Transducers 8 h

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 10 h

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 10 h

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 of biomolecules by biosensors 10 h

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 10 h

Bio recognition 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.

Text Books

1 Tatsuo Togawa,Toshiyo Tamura, P. Ake Oberg, 1997. "Biomedical Transducers and Instruments", CRC Press, New York.

2 Jacob Kline, 2004. "Handbook of Bio Medical Engineering", Academic press Inc., Sandiego, Oxford University Press.

References

1 Jiri Janata, 1989. "Principles of Chemical Sensors", Plenum Press.

2 F. Schellr, F. Schubert, J. Fedrowitz, Birkhauser Verlag, 1995. "Frontiers in Biosensors".

3 Editors: F. Ligler, C. Rowe Taitt, 2002. "Optical Biosensor Present & Future". Elsevier.

4 G. K. Knoff, A. S. Bassi, 2006. "Smart Biosensor Technology" CRC Press.

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