University of Kerala

Discipline	**PHYSICS**				
Course Code	**UK4DSEPHY204**				
Course Title	**PHYSICAL ASPECTS OF DIAGNOSTICS**				
Type of Course	**DSE**				
Semester	**IV**				
Academic Level	**200 - 299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 Hrs	-	2 Hrs	5 Hrs
Pre-requisites	1. Sound and light waves-their properties, reflection and refraction 2. Torque acting on a magnetic moment, nuclear magnetic moment, X-ray and types of nuclear radiation				
Course Summary	In this course the application of various physical phenomena (such as sound, light, magnetic field, X ray and nuclear radiation) in medical diagnostics is discussed. For this purpose the basic physics of each phenomenon is introduced which is then developed to the application in medical diagnostics. Thus a thorough introduction to piezoelectricity, fiber optics, nuclear spin magnetic resonance, bremsstrahlung, nuclear radiation etc is given. Based on this, science of various medical imaging techniques and dosimetry are discussed.				

BOOKS FOR STUDY:

1. Medical Physics_ Physical Aspects of Diagnostics and Therapeutics-De Gruyter (2023) Hartmut Zabel –

BOOKS FOR REFERENCE:

1. Far's Physics for Medical Imaging-Elsevier (2024) Alim Yucel-Finn, Fergus McKiddie, Sarah Prescott, Rachel Griffiths –
2. Encyclopaedia of Medical Physics_ Two Volume Set-CRC Press (2021) Slavik Tabakov, Franco Milano, Magdalena S. Stoeva, Perry Sprawls, Sameer Tipnis, Tracy Underwood -

DETAILED SYLLABUS: THEORY

Module	Unit	Content	Hrs	CO No
I		**Sonography**	**9**	
	1	Introduction and overview - Ultrasound transducer , Piezoelectric effect, Ultrasonic head	1	1,2
	2	Medical imaging- A-mode scan, B-mode scan , C-scan ,M-mode, Shear wave sonography	3	1,2
	3	Scan characteristics -Dynamic focusing, Line density , Scan frequency Depth of view , Penetration depth ,Spatial resolution ,Axial resolution , Lateral resolution Artifacts	3	1,2
	4	Doppler method - Doppler shift, cw Doppler method , Pulsed Doppler method (duplex mode) , Duplex scan of umbilical cord	2	1,2
II		**Endoscopy**	**9**	
	5	Standard uses of medical endoscopes , Fiber optics (Basic Idea Only)	1	1,3
	6	Endoscope optics , Resolution and magnification	1	1,3
	7	Specialized endoscopes ,Narrowband imaging ,Chromoendoscopy ,Endomicroscopy	2	1,3
	8	Confocal laser endoscopy -General working principle	1	1,3
	9	Optical coherence tomography endoscopes , Basic principle of OCT , Resolution and scan range , Additional methods and applications ,	3	1,3
	10	Capsule endoscopy, Future trends	1	1,3
III		**Magnetic resonance imaging**	**10**	
	11	Nuclear spin basics, Nuclear magnetic resonance basics	1	4
	12	NMR and MRI procedures, Saturation, Chemical shift, Standard nomenclature	1	4

	13	Contrast generation, T1 contrast, T2 contrast , PD contrast ,Inversion recovery (IR) ,Short time inversion recovery (STIR)	2	5
	14	MR signal localization , Slice encoding gradient ,Frequency encoding gradient (FEG) , Phase encoding gradient (PEG) K-map , Data acquisition	2	5
	15	Magnets and coils , Main coil , Gradient coils , rf-coils , MRI machine specifications	2	5
IV	**X-ray**		**8**	
	16	Introduction , General components of x-ray tubes	1	6,7
	17	Bremsstrahlung radiation	1	6,7
	18	Characteristic radiation , Atomic transitions , Energy dispersive x-ray chemical analysis ,Target material	3	6,7
	19	X-ray generators , X-ray tubes for radiography , Linear accelerators for radiotherapy , Synchrotron radiation	3	6,7
V*	**Dosimetry**		**9**	
	20	Introduction , Definitions of dose and dose rate	1	8
	21	Kerma , Flux and fluence , Energy fluence , Mass energy transfer coefficient ,Mass energy absorption coefficient , Definition of kerma , Examples	4	8
	22	Dosimeters and radiation monitors , Ionization chamber, Proportional counters, Geiger-Müller detectors, Dead time	3	8
	23	Radiation exposure ,Radiation protection	1	8

DETAILED SYLLABUS: PRACTICALS

Part A – At least 5 Experiments to be performed		**CO No**
Sl No	**Name of Experiment**	
1	To study of Digital multimeter. a) Measurement of AC and DC voltages	9

	b) Measurement of Current c) Measurement of resistance d) Measurement of parameters of diodes and transistors.	
2	To study Cathode Ray Oscilloscope (CRO). a) To study of controls ofCRO b) To measure amplitude, time period and frequency of time varying signals. c) To study Lissajous figures to know about the phase difference between the two signals and the ratio of their frequencies	9
3	To study function generator. a) Study of controls of Function generator b) To configure the function generator to output a 10Vpp, 1 KHz different types of wave	9
4	To study the performance of Biosensor (Pulse measurement technique) https://sl-coep.vlabs.ac.in/exp/performance-bio-sensor/index.html	9
5	Determine the blood oxygen level and pulse rate using Pulse oximeter, compare the results by placing the oximeter at various parts of the human body	9
6	Determine the blood pressure of human body by Auscultatory Method using BP apparatus at (a) Rest (b) after walking 10 min (c) Jogging 5 min	9
7	Determine the pulse rate using stethoscope	10
8	Determine the temperature of human body using contact and non-contact thermometer. Compare it by placing on different parts of the body.	10
9	Study of the characteristics of a GM tube and determination of its operating voltage, plateau length/slope	10
10	Estimation of Efficiency of the GM detector for (a) Gamma source (b) Beta source	10
Part B* – At least One Experiment to be performed		
11	To measure the resistivity and energy band gap of the given sample with the given four-probe arrangement	9
12	Determine the refractive index of air - Michelson interferometer	9

13	To determine the inter-planar spacing of graphite from the relationship between the radius of diffraction rings and the wavelength hence to understand the wave-particle duality of matter.	9
14	Demonstration of Nucleonic level gauge principle using GM Counting System & Detector	9

COURSE OUTCOMES

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand/revise the basic physics behind various medical diagnostic methods	R,U	PSO-1
CO-2	Know ultrasonics, Piezo electricity and various sound based medical imaging techniques	U,R	PSO-1,7
CO-3	Understand the role of Fiber optics in medical endoscopes. Classification of endoscope and their functioning	U, Ap	PSO-1,3,7
CO-4	Learn the basics of NMR and its different aspects.	R,U	PSO-1
CO-5	Implementation of NMR in MRI and its features. Application of MRI in medical diagnostics.	U	PSO-1,7
CO-6	Understand the basic physics behind the generation of X-ray and its interaction with matter.	R,U	PSO-1
CO-7	Introduce X-ray production technologies and radiotherapy	U	PSO-1,7
CO-8	Introduce the fundamentals of dosimetry and its quantitative analysis. Radiation counters, detectors and radiation safety.	U	PSO-1,7
CO-9	Practice of basic electric measurement instruments	U, An	PSO-1,5
CO-10	Practice basic medical instruments such as stethoscope,	U, Ap, An	PSO-5

	oximeter, medical thermometer, nuclear detection etc		
CO-11	Practice and learn basic physics ideas such as refractive index, band gap and nuclear radiation etc	U, An	PSO-5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: PHYSICAL ASPECTS OF DIAGNOSTICS

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO / PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Understand/revise the basic physics behind various medical diagnostic methods	PO1,4,6/ PSO 1	R,U	F	L	-
CO-2	Know ultrasonics, Piezo electricity and various sound based medical imaging techniques	PO1,2,4, 5,6,8/ PSO 1,7	U,R	F,C	L	-
CO-3	Understand the role of Fiber optics in medical endoscopes. Classification of endoscope and their functioning	1,2,3,4,5, 6,8/ PSO 1,3,7	U, Ap	F,C	L	-
CO-4	Learn the basics of NMR and its different aspects.	PO1,4,6/ PSO 1	R,U	F	L	-
CO-5	Implementation of NMR in MRI and its features. Application of	PO1.2.4. 5.6.8/ PSO 1,7	U	F,C	L	-

	MRI in medical diagnostics.					
CO-6	Understand the basic physics behind the generation of X-ray and its interaction with matter.	PO1,4,6/ PSO 1	R,U	F	L	-
CO-7	Introduce X-ray production technologies and radiotherapy	PO1,2,4, 5,6,8/ PSO 1,7	U	F,C	L	-
CO-8	Introduce the fundamentals of dosimetry and its quantitative analysis. Radiation counters, detectors and radiation safety.	PO1,2,4, 5,6,8/ PSO 1,7	U	F,C	L	-
CO-9	Practice of basic electric measurement instruments	PO1,2,3, 4,6,7/ PSO 1,5	U, An	F,P	-	P
CO-10	Practice basic medical instruments such as stethoscope, oximeter, medical thermometer, nuclear detection etc	PO1,2,3, 7/ PSO 5	U, Ap, An	F,P,M	-	P
CO-11	Practice and learn basic physics ideas such as refractive index, band gap and nuclear radiation etc	1,2,3,7/ PSO 5	U, An	F,P	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO-1	3	-	-	-	-	-	-	2	-	-	2	-	2	-	-
CO-2	3	-	-	-	-	-	2	2	2	-	2	2	2	-	2
CO-3	2	-	3	-	-	-	2	2	2	-	2	2	2	-	2
CO-4	3	-	-	-	-	-	-	2	-	-	2	-	2	-	-
CO-5	3	-	-	-	-	-	2	2	2	-	2	3	2	-	2
CO-6	3	-	-	-	-	-	-	2	-	-	2	-	-	2	-
CO-7	3	-	-	-	-	-	2	2	2	-	2	3	3	-	2
CO-8	3	-	-	-	-	-	2	2	2	-	2	2	2	-	2
CO-9	3	-	-	-	3	-	-	2	2	2	2	-	2	2	-
CO-10	-	-	-	-	3	-	-	2	2	2	-	-	-	2	-
CO-11	-	-	-	-	2	-	-	2	2	3	-	-	-	3	-

Correlation Levels:

Level	-	1	2	3
Correlation	Nil	Slightly / Low	Moderate / Medium	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Mapping of COs to Assessment Rubrics:

CO No	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	✓	-	✓
CO-2	✓	✓	-	✓
CO-3	✓	-	✓	✓
CO-4	-	✓	-	✓
CO-5	✓	-	✓	✓
CO-6	✓	✓	-	✓
CO-7	✓	✓	-	✓
CO-8	✓	-	✓	✓
CO-9	-	-	-	✓
CO-10	-	-	-	✓
CO-11	-	-	-	✓