Program Name : **Diploma in Medical Electronics**

Program Code : **MU**

Semester : **Fifth**

Course Title : **Medical Imaging Equipment**

Course Code : **22547**

1. RATIONALE

The influence of the medical imaging in healthcare is constantly growing. The diseases are detected earlier and treatment becomes more effective. Medical imaging refers to several different technologies that are used to view the human body in order to diagnose, monitor, or treat medical conditions. These techniques employs radiation source of X-rays, gamma rays, IR rays, magnetic waves and ultrasound waves. This subject will provide students the details of different imaging modalities, quality of image formation and radiation safety.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain different types of imaging equipment.**

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

a. Maintain X ray machines.
b. Maintain Fluoroscopy and angiography machine.
c. Maintain CT and MRI machine.
d. Maintain ultrasound scanner machine.
e. Maintain nuclear imaging techniques.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
				Theory							Practical					
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

'': 10 out of 20 marks in PA is for micro-projects (i.e. 50%) to facilitate attainment of COs*
***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **ESE** - End Semester Examination; **PA** - Progressive Assessment*

5. **COURSE MAP** (with sample COs, PrOs, UOs, ADOs and topics)
This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

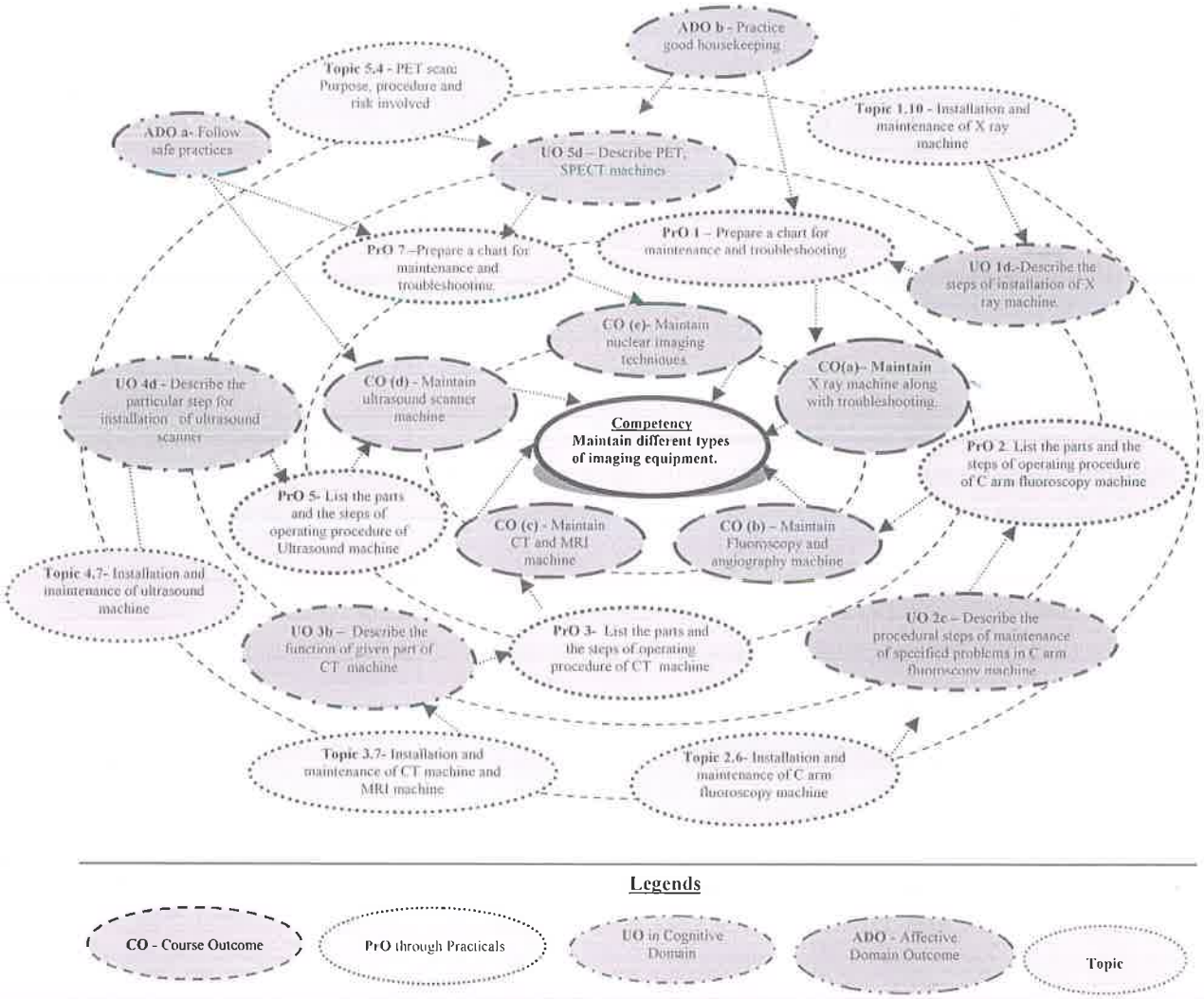

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Medical Imaging Equipment		
	Demonstration type experiments to be performed in hospitals/healthcare industries or using models in the lab.		
1	**X-ray machine**	I	
	a. List the parts of machine and the steps of operating procedure of machine.		02
	b. Prepare a chart for maintenance and troubleshooting.		02
2	**C arm fluoroscopy machine.**	II	
	a. List the parts of machine and the steps of operating procedure of machine.		02
	b. Prepare a chart for maintenance and troubleshooting.		02
3	**CT machine**	III	
	a. List the parts of machine and the steps of operating procedure of		02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	machine.		
	b. Prepare a chart for maintenance and troubleshooting.		02
4	**MRI machine**	**III**	
	a. List the parts of machine and the steps of operating procedure of machine.		02
	b. Prepare a chart for maintenance and troubleshooting.		02
5	**Ultrasound Machine**	**IV**	
	a. List the parts of machine and the steps of operating procedure of machine.		02
	b. Prepare a chart for maintenance and troubleshooting.		02
6	**Thermography Machine**	**V**	
	a. List the parts of machine and the steps of operating procedure of machine.		02
	b. Prepare a chart for maintenance and troubleshooting.		02
7	**PET machine**	**V**	
	a. List the parts of machine and the steps of operating procedure of machine.		02
	b. Prepare a chart for maintenance and troubleshooting.		02
8	**SPECT machine**	**V**	
	a. List the parts of machine and the steps of operating procedure of machine.		02
	b. Prepare a chart for maintenance and troubleshooting.		02
	Total		**32**

Note

i. Given in above tables is suggestive list of practical exercises. Teachers can design other similar exercises.

ii. To attain the COs and competency, a judicial mix of 10 or more practicals/exercises from the above listed LOs need to be performed to achieve up to the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy'.

Assessment of the 'Process' and 'Product' related skills in the laboratory/workshop/field work should be done as per suggested sample below:

S. No.	Performance Indicators	Weightage in %
a.	Experimental set up sketch and description	20
b.	Write-up regarding setting and operation	20
c.	Safety measures	10
d.	Observations and Recording	10
e.	Interpretation of result and Conclusion	20
f.	Answer to sample questions	10
g.	Submission of report in time	10
Total		**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

a. Follow safety practices.
b. Practice good housekeeping.

c. Practice energy conservation.
d. Work as a leader/a team member.
e. Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

S. No.	Equipment Name with Broad Specifications	Exp. S. No.
1	Demo model of X -Ray fluoroscopy	1
2	Demo model of X-Ray Radiography	1
3	Ultrasound scanner	5
4	Image intensifier 'C'arm	2
5	Linear array transducer	5
6	Phase array transducer	5

8 UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I X ray machine	1a. Explain with sketches the given concept related with electromagnetic radiation. 1b. Explain with sketches the function and principle of working of specified component of X ray machine. 1c. Describe the steps of installation of the given X ray machine. 1d. Describe the procedural steps of maintenance of given component of X-ray machine. 1e. Describe the specified risk involved in handling X-Ray machine.	1.1 Electromagnetic radiation, types of radiation, wavelength and properties. 1.2 X rays properties, X ray spectrum 1.3 Medical applications of X rays. 1.4 X ray assembly and circuits:X ray tubes (stationary and rotating): principle ,Construction, operation and specifications Function of Filter,Collimator, X ray table, Bucky grids ,trays, cassettes 1.5 X ray tube rating: electric and thermal 1.6 Control circuit: High voltage (KV), Current (mA), exposure timer circuit 1.7 Block diagram of X ray machine 1.8 Benefits of Mobile X ray technology 1.9 Installation and maintenance of X ray machine. 1.10 Risk involved in handling X-Ray machine
Unit – II Radiograp	2a. Compare fluoroscopy with radiography on the basis of	2.1 Radiography: X ray film construction, intensifying screens.

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
hy and Fluoroscopy	specified aspects. 2b. Describe the particular step for installation of C arm fluoroscopy machine. 2c. Describe the procedural steps of maintenance of specified problems in C arm fluoroscopy machine 2d. Describe the particular step for installation of angiography machine. 2e. Describe the procedural steps of maintenance of specified problems in angiography machine.	radiographic grid, concept of digital radiography 2.2 Fluoroscopy: Image intensifier and television camera, Image intensifier artifacts 2.3 fluoroscopy machine :Principle, block diagram 2.4 C arm fluoroscopy, Safety tips for C arm fluoroscopy, 2.5 Difference between fluoroscopy and radiography 2.4 Angiography technique and its block diagram. 2.5 Installation and maintenance of angiography machine 2.6 Installation and maintenance of C arm fluoroscopy machine
Unit – III CT and MRI	3a. Describe with sketches the given technique of image reconstruction. 3b. Describe with sketches the function of given part of CT machine. 3c. Describe with sketches the function of given part of MRI machine 3d. Compare CT machine with MRI machine with respect to specified aspect. 3e. Describe the procedural steps of maintenance of specified problems CT machine. 3f. Describe the particular steps for installation of the given MRI machine. 3g. Describe the procedural steps of maintenance of specified problems in MRI machine.	3.1 Computed Tomography: Principle of CT,CT number, CT generations, CT detectors, spiral CT 3.2 Block diagram of CT machine, clinical application 3.3 Image reconstruction techniques i. Back projection ii. Iterative projection iii. Filtered back projection 3.4 Ring artifact 3.5 Basic definition- RF shielding, shimming 3.6 Magnetic Resonance Imaging: Principle, Block diagram, Types of magnets, Biological effects of MRI imaging, Advantages of MRI system 3.7 Installation and maintenance of CT machine and MRI machine 3.8 Risk involved in handling CT and MRI.
Unit – IV Ultrasound Imaging	4a. Describe the distinct specified property of ultrasound. 4b. Describe with sketches the given image display of ultrasound. 4c. Explain a given technical specification of ultrasound scanner. 4d. Describe the procedural steps of maintenance of specified problems in ultrasound	4.1 Ultrasound: Properties, Ultrasound transducer, ultrasound wave zones. Block diagram and clinical applications, Technical specification 4.2 Pulse echo techniques 4.3 Displays of Ultrasound: A scan, B scan, TM scan and real time B scan. 4.4 Ultrasound artifacts 4.5 Transducer arrays: linear switched array and linear phased array annular array 4.6 Principle of Doppler ultrasound

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	scanner.	4.7 Installation and maintenance of ultrasound machine.
Unit– V Nuclear Medicine	5a. Explain with sketches the working of the given nuclear transducer 5b. Describe with sketches the given type of scanning machines. 5c. Describe the particular step for installation of the given type of thermograph machine. 5d. Describe with sketches the procedural steps of maintenance of specified problems in thermograph machine.	5.1 Nuclear imaging: Principle, Radio isotope, gamma camera 5.2 Nuclear transducer (scintillation counter, Geiger Muller tube). 5.3 Thermography machine: Principle and block diagram. 5.4 PET scan: Purpose, procedure and risk involved 5.5 SPECT scan: Purpose, procedure and risk involved 5.6 SPECT scan versus PET scan 5.7 Installation and maintenance of thermography machine

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	X ray machine	12	04	06	06	16
II	Radiography and Fluoroscopy	08	04	06	04	14
III	CT and MRI	10	04	04	06	14
IV	Ultrasound Imaging	08	04	04	06	14
V	Nuclear Medicine	10	04	04	04	12
Total		48	20	**24**	**26**	**70**

Legends: *R = Remember U = Understand; A = Apply and above (Bloom's Revised taxonomy).*

Note: *This specification table is a general guideline for students and teachers to test the attainment of the LOs. The actual distribution of marks in the question paper may vary slightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare a chart of different medical imaging equipment's based on their construction, working, specifications and application.
b) Collect the technical specifications of different imaging equipment's from different manufacturing companies.
c) Gather information related to advancement in medical imaging equipment.
d) Prepare a presentation related to advancement in medical imaging equipment.
e) Participate in Quiz and paper presentation competition related to imaging modalities.

11. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

a) Guide student(s) in undertaking micro-projects.
b) Use flash/animations to explain the construction and working of imaging equipment.
c) Guide students to develop interesting micro projects.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be ***individually*** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than ***16 (sixteen) student engagement hours*** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty.

a) Design and Build timer circuit of X ray machine.
b) Visit the hospital/diagnostic Centre. Prepare preventive maintenance chart of any one medical imaging equipment being used in hospital/diagnostic centre.
c) Visit the hospital/diagnostic Centre. Prepare trouble shooting chart of any one medical imaging equipment being used in hospital/diagnostic centre.
d) Prepare a lab plan for installation of available equipment in institute based on physical and electrical parameters.
e) Prepare a video/report on developing of x ray film in dark room.
f) Design variable voltage power supply with 500mA capacity.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Diagnostic Radiology Physics Handbook for Teachers and Students.	Dance, D.R.; Christofides S.; Maidment A.D.A., McLean, I.D. and K.H. Ng.	IAEA publications *ISBN*978–92–131010–1
2	A Handbook of Biomedical Instrumentation	Khandpur, R.S.	Mc Graw Hill Education, ISBN: 139789339205430
3	Medical Imaging Physics	Hendee , William R.; Ritenour, E. Russell	Wiley – Liss Publication *ISBN*: 978-0-471-38226-3
4	Biomedical Instrumentation and Measurement	Anand natrajan, R.	Prentice Hall of India *ISBN* 13: 9788120352155.
5	Christensen's Physics of Diagnostic Radiology	Curry, Thomas S; Dowdey, James E. and Murray Robert C.	Les & Febiger,U.S. ISBN13:978-0812113105

S. No.	Title of Book	Author	Publication
6	The Physics of Diagnostic Imaging	Dowsett, David S.; Kenny, Patric A. and Johnton, R. Eugene	CRC press, ISBN:9780340808917

14. SOFTWARE/LEARNING WEBSITES

a) www.aerb.gov.in
b) www.medindia.net/patients/patientsinfo
c) www.worldcatlogue.com