Program Name : **Diploma in Medical Electronics**

Program Code : **MU**

Semester : **Fourth**

Course Title : **Diagnostic Equipment**

Course Code : **22436**

1. RATIONALE

In the area of healthcare, diagnostic equipment play a vital role in either recording or monitoring information about different physiological parameters related to the human body like ECG, BP etc. Medical practitioners are provided with this vital information to diagnose the diseases and can therefore treat the patient in time. As the technology is advancing very fast, newer versions are appearing in the hospitals that will help students to understand principle, block diagram, applications and technical specifications of various diagnostic equipment.

2. COMPETENCY

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

- **Operate various diagnostic 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. Use the blood pressure meter.
b. Use the respiration rate meter.
c. Troubleshoot of ECG machine.
d. Operate the EEG and EMG machine.
e. Use the GSR meter and audiometer.

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	2	7	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the 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.

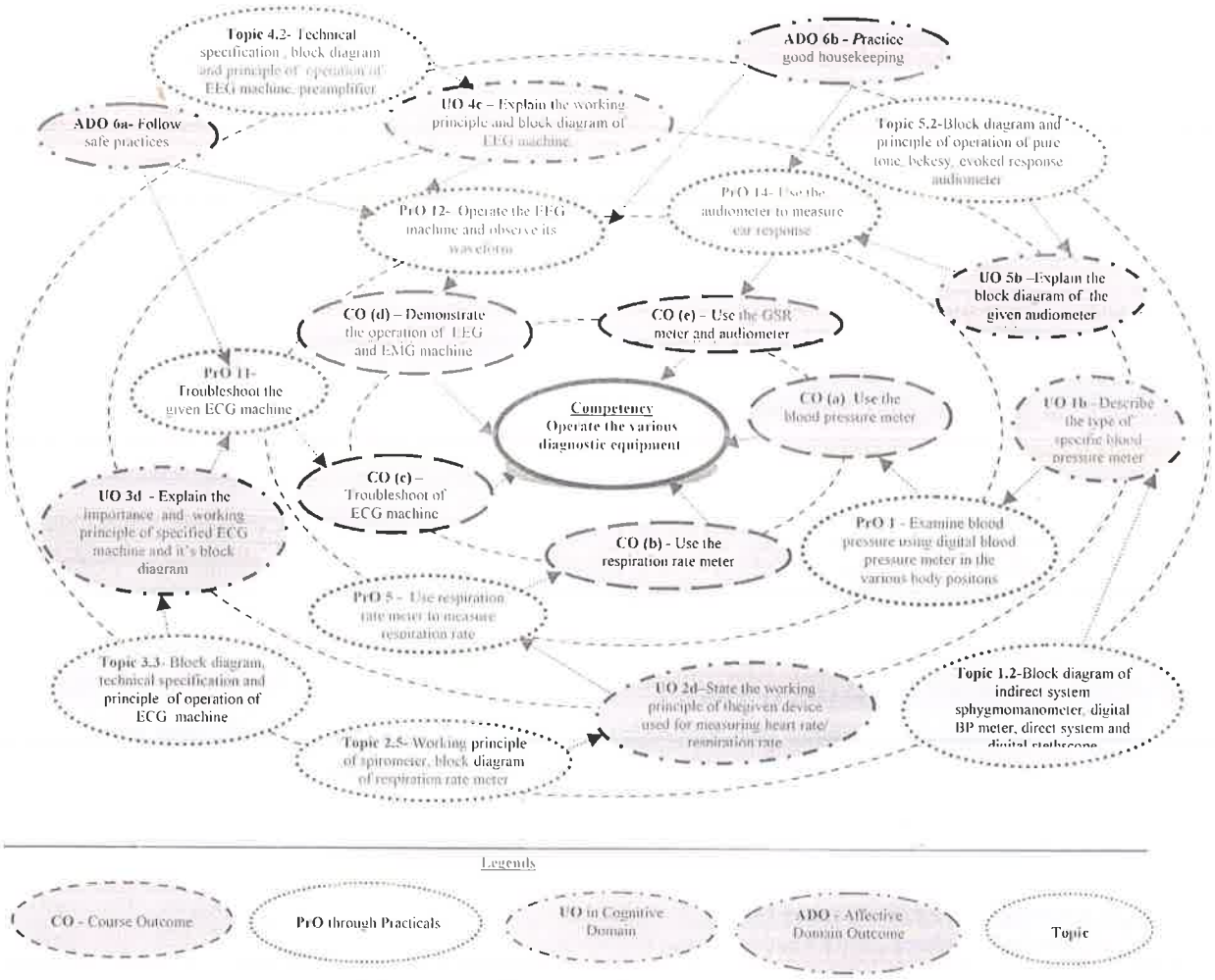

Figure 1 - Course Map

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
1	Use the digital blood pressure meter to determine the blood pressure in the following body position: i. Suping ii. Sitting iii. Standing	I	02
2	Use the pulse oxymeter to determine of SpO_2.	I	02
3	Use the plethysmograph to measure pulse rate, relative blood pressure and blood pressure waveform.	I	02
4	Use the digital temperature meter to determine body temperature.	I	02
5	Use the respiration rate meter to measure respiration rate.	II	02
6	Use the spirometer machine to record spirogram.	II	02
7	Record ECG using 12 lead configurations on patient.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
8	Measure various time interval between each segment of ECG, of R-R interval and calculation of heart rate.	III	02
9	using phonocardiogram Record the different heart sound by.	III	02
10	Measure of CMRR and gain of ECG preamplifier.	III	02
11	Troubleshoot the given ECG machine.	III	02
12	Operate the EEG machine.	IV	02
13	Operate the EMG machine .	IV	02
14	Use the audiometer to measure ear response.	V	02
15	Use the GSR meter to examine skin response.	V	02
16	Identify the components used in the given hearing aids along with specifications.	V	02
	Total		**32**

Note

i. *A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.*

ii. *The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:*

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental set up	20
2	Setting and operation	20
3	Safety measures	10
4	Observations and recording	10
5	Interpretation of result and conclusion	20
6	Answer to sample questions	10
7	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 safe practices.
b. Practice good housekeeping.
c. Practice energy conservation.
d. Demonstrate working as a leader/a team member.
e. Maintain tools and equipment.
f. 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

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	**Digital Blood Pressure Meter**: Fully automatic inflation, Measurement while inflation technology, Irregular heart beat detection, Large LCD, Measurement method: Oscillographic Testing, Pressure: 0-300 mm/Hg, Pulse: 40-199 beats/min. Measuring Resolution: 1 mmHg	1
2	**Pulse Oximeter**: Display – LCD,SPO2 range – 70-100% , Accuracy of SpO2 -3% , Pulserate: 30-240 bpm, Audiovisual Alarms- high/low SpO2 and pulse rate	2
3	**ECG machine:** Recording ECG Leads: 12 standard Leads, Recording Channels: 3/1 user selectable, Sensitivity, mm/mV: 5, 10, 20, Calibration signal: automatic and manual, Diagnostic frequency range 0.67–150 Hz or better. Filters for mains frequency, low frequency, high frequency. Recorder: Recording method: thermal paper. Recording speed, mm/sec: 25/ 50	7
4	**Phonocardiograph Trainer :**Frequency response : 1 Hz – 10 KHz, CMRR : Better than 80 db, Filters : 25 Hz - 100 Hz 50 Hz - 100 Hz 100 Hz - 750 Hz 250 Hz - 1.2 KHz, Gain adjustment : 800-2000 variable, Power supply : 230 V ±10 %, 50 Hz / 60 Hz, Power Consumption : 2 VA (approx.).	9
5	**EEG machine:** Sampling Rate : 1024 Hz ,Sensitivity : 1 to 1000 µV/mm,LF (Hz) : 0.01, 0.1, 0.3, 0.5, 1, 3, 5 Hz, HF (Hz) : 15, 35, 70, 200 and User definable (10-200Hz), Notch Filter : 50/60 hz, Input impedance : > 10 M ohm, CMRR : > 100 db, Noise level : < 0.3 µV RMS.	12
6	**GSR Meter:** Skin resistance range 1,000 ohms - 3,000,000 ohms. Variable frequency range 0 to 40.000 Hz, 9 volt battery.	15

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 Blood Pressure, Oxygen Saturation and Temperature Measurement	1a. Distinguish direct and indirect BP measurement with respect to given parameters. 1b. Explain with sketches the working of the given type of specified blood pressure meter. 1c. Explain with sketches the working of the given device. 1d. Prepare the technical specifications of the given meter	1.1 Concept of direct, indirect, relative BP measurement and BP waveform 1.2 Block diagram and technical specification of indirect system sphygmomanometer, digital blood pressure meter, direct system,digital stethoscope 1.3 Block diagram and principle of operation of pulse oxymeter, Beer and lamberts law, technical

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	for measuring blood pressure/ oxygen saturation / temperature .	specification of pulse oxymeter 1.4 Introduction of systemic and skin temperature, block diagram and technical specification of digital temperature meter
Unit-II Heart Rate and Respiration Rate Measurement	2a. Explain with sketches the specified method of heart rate calculations. 2b. Explain with sketches the importance of the given block of heart rate meter. 2c. Explain with sketches the working of the specified respiratory parameter along with its standard value. 2d. Explain with sketches the working of the given device. 2e. Prepare the technical specifications of the given meter used for measurement of heart rate/ respiration rate.	2.1 Methods of calculation of heart rate average, bit to bit, bit to bit and average 2.2 Block diagram and technical specification of heart rate meter 2.3 Concept of feotal heart rate and block diagram of ultrasonic FHR meter 2.4 Respiratory parameters with standard spirogram 2.5 Working principle of spirometer,block diagram and technical specification of respiration rate meter
Unit– III Electrocardiography and Phonocardiography	3a. Explain with sketches the working of the specified ECG wave/segment/interval 3b. Explain with sketches the working of the given lead configuration. 3c. Explain with sketches the working of the specified circuit of ECG machine. 3d. Explain with sketches the working of the specified cardiography along with it's block diagram. 3e. Differentiate between ECG, PCG and arterial blood pressure with reference to given aspect. 3f. Prepare the technical specifications of the given cardiac equipment.	3.1 Generation of ECG signal 3.2 12 lead configuration- unipolar and bipolar leads 3.3 Block diagram, technical specification and principle of operation of ECG machine, ECG preamplifier circuit, right led drive circuit, Wilson's network circuit, 1mV calibration circuit used in ECG machine 3.4 Concept of vectorcardiography 3.5 Troubleshooting and maintenance of ECG machine 3.6 Heart sound and its significance, technical specification, block diagram and principle of operation of phonocardiography 3.7 Relationship between ECG and PCG and arterial B.P
Unit– IV Electroencephalography and Electromyo	4a. Explain the generation of EEG signals of the specified recording technique. 4b. Describe the specified step for using 10-20 electrode system for	4.1 Generation of EEG signals,unipolar, bipolar and average recording techniques, EEG spectrum, 10-20 electrode system 4.2 Technical specification, block

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
graphy	EEG. 4c. Explain with sketches the working of the given EEG/EMG machine. 4d. Explain generation of signals of specified EEG/EMG machine. 4e. Describe with sketches the conduction of given type of nerve. 4f. Describe with sketches the specified circuit of EMG. 4g. Prpare technical specifications of the given equipment.	diagram and principle of operation of EEG machine, preamplifier circuit of EEG 4.3 Troubleshooting and maintenance of EEG machine 4.4 Generation of EMG signal , motor and sensory nerve conduction 4.5 Technical specification, block diagram and principle of operation of EMG machine, preamplifier circuit of EMG 4.6 Troubleshooting and maintenance of EMG machine
Unit –V Ear and Skin Responses	5a. Explain with sketches the block diagram of the given type of audiometer. 5b. Explain with sketches the working of the given transducer related to audiometer. 5c. Describe the block diagram of the given hearing aid. 5d. Describe the function of specific block of GSR meter, using the block diagram. 5e. Prepare technical specifications of the given equipment.	5.1 Concept of audiometer, speech audiometer, impedance audiometer, air and bone conduction,transducers in audiometry. 5.2 Block diagram and principle of operation of pure tone audiometer, bekesy audiometer, evoked response audiometer, conventional and digital hearing aid 5.3 Technical specification of audiometer, hearing aid 5.4 Concept of Galvanic skin reflex, block diagram and principle of operation of GSR meter

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.*

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	Blood Pressure, oxygen saturation and temperature measurement	10	04	04	06	14
II	Heart rate and respiration rate measurement	10	04	04	04	12
III	Electrocardiography and phonocardiography	12	04	04	08	16
IV	Electroencephalography and electromyography	10	04	06	08	18
V	Ear and skin responses	06	02	04	04	10
Total		**48**	**18**	**22**	**30**	**70**

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

***Note**: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary 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. Visit a hospital and prepare the report on following basis:
   i. Name of equipment, manufacturer,cost of the equipment.
   ii. Location of the equipment where it is utilized.
   iii. Problems frequently encountered in various diagnostic equipment.
b. Prepare a presentation on blood pressure measurement method.
c. Identify the component from the given scrap diagnostic equipment.
d. Prepare the fault finding chart of ECG machine.
e. Collect the videos/animations on working of given following equipment:
   i. Electroencephalograph.
   ii. Electromyograph.
   iii. Phonocardiography.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b. ***'L' in item No. 4*** does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
c. About ***15-20% of the topics/sub-topics*** which is relatively simpler or descriptive in nature is to be given to the students for ***self-directed learning*** and assess the development of the COs through classroom presentations (see implementation guideline for details).
d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
e. Use Flash/Animations to explain various theorems in circuit analysis.
f. Guide student(s) in undertaking 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. Prepare a model of audiometer.
b. Prepare a GSR meter circuit.
c. Design the skin temperature meter and prepare a report.
d. Design the Lie detector circuit.
e. Design the stethoscope circuit.

13. SUGGESTED LEARNING RESOURCES

S.No.	Title of Book	Author	Publication
1	Handbook of Biomedical Instrumentation	Khandpur , R. S.	McGraw-Hill Publishing Company New Delhi, 2014, Third Edition, ISBN:9789339205430
2	Medical Electronics	Patil, Ajitkumar G.	Excel Books, New Delhi, 2014, ISBN: 8174463259
3	Bioinstrumentation	Webster. John. G.	Wiley India Pvt.Ltd. New Delhi, 2014, ISBN:9788126513697
4	Medical Instrumentation Application and Design	Webster, John. G.	Wiley India Pvt.Ltd. New Delhi, 2014, ISBN:9788126553792

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. howmed.net/physiology/electrocardiogram
b. web.csulb.edu/~cwallis/482/eeg/eeg.html
c. imotions.com/blog/gsr/
d. www.lung.ca/lung-health/lung-disease/spirometry
e. www.medicwiz.com
f. imotions.com/blog/electromyography