Program Name : **Diploma in Medical Electronics**

Program Code : **MU**

Semester : **Fifth**

Course Title : **Energy and Biomedical Waste Management**

Course Code : **22549**

1. RATIONALE

This course will facilitate students to understand the basics of energy resources and biomedical waste management. The students need to appreciate the significance of green and clean energy with renewable energy based applications through solar photovoltaic, wind energy system, etc. and the need for energy conservation for sustainable development. Biomedical waste management is a vital area about which any medical electronics personnel should be well acquainted with.

2. COMPETENCY

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

- **Implement energy conservation for sustainable environment ensuring safe handling of biomedical waste.**

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. Correlate the present scenario of conventional and non-conventional energy in India
b. Use renewable energy resources for energy conservation.
c. Use energy conservation techniques for different applications.
d. Manage biomedical waste effectively.
e. Apply safety and precautionary measures during waste management.

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	

(*): 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.

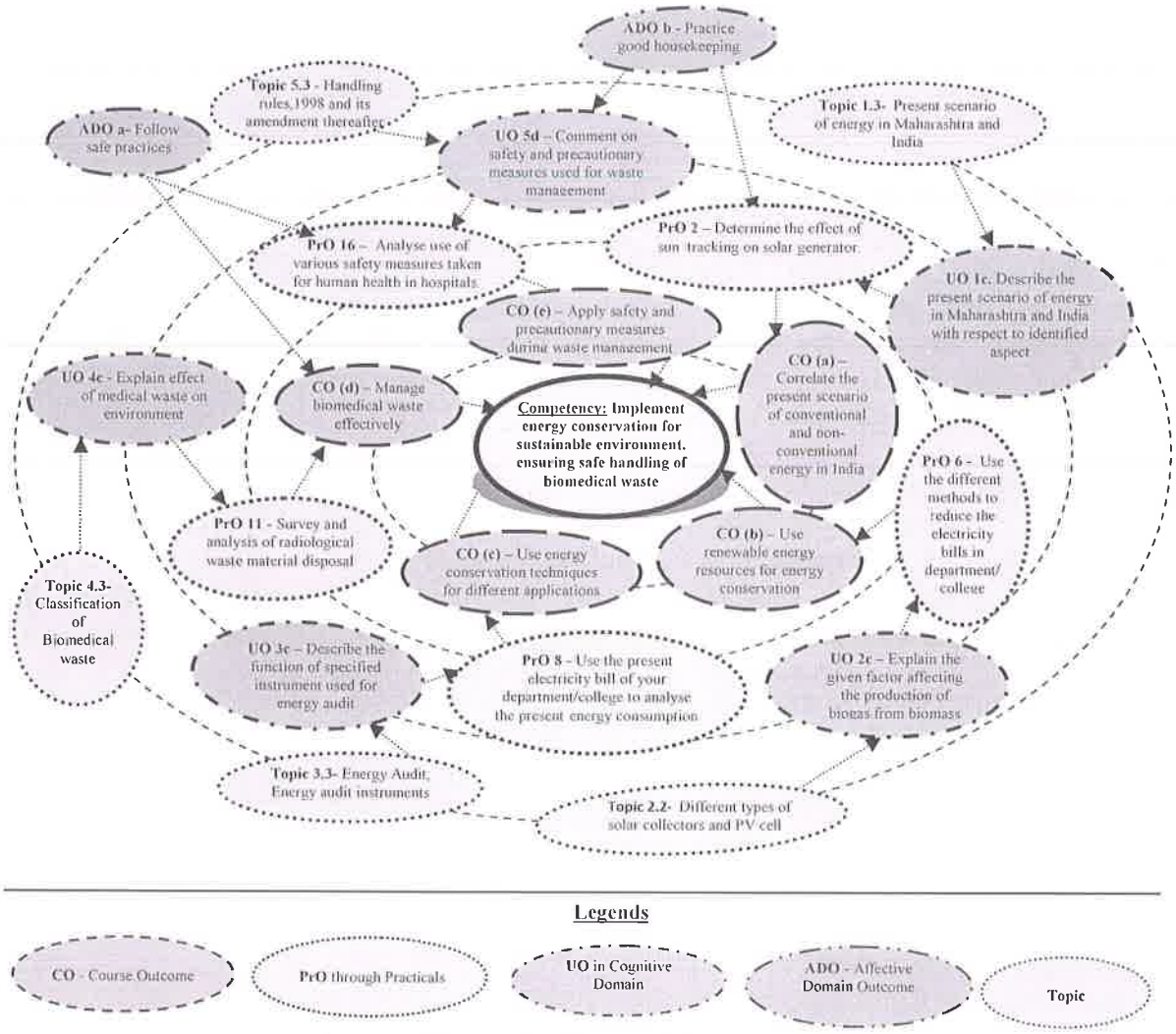

Figure 1 - Course Map

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	Measure V-I characteristics of PV module.	I	02*
2	Determine the effect of sun tracking on solar generator.	II	02
3	Test the thermal performance of solar water heater.	II	02
4	Analyse the charging and discharging cycle of solar battery.	II	02
5	Test the thermal performance of solar dryer.	III	02
6	Use the different methods to reduce the electricity bills in department/college.	III	02
7	Use the electricity act 2001 and 2003, and find the difference between them.	III	02
8	Use the present electricity bill of your department/college to analyse the present energy consumption.	III	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
9	Perform analysis of various hospital biomedical waste sources.	IV	02
10	Perform analysis of pathological waste material disposal.	IV	02
11	Perform analysis of radiological waste material disposal.	IV	02*
12	Perform analysis of hospital chemical waste material disposal.	IV	02
13	Interpret the nature of care and maintenance of various biomedical waste management devices.	IV	02*
14	Perform analysis of various biochemical waste hazards on human health.	V	02
15	Simulate the collection and handling of Biomedical waste processes	V	02
16	Practice the safety measures taken for human health in hospitals.	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 %
a.	Preparation of experimental set up	20
b.	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
- 'Organizing Level' in 2nd year

- 'Characterizing 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.	A photovoltaic panel (BP Solar 10W, 12V), A solar panel rack (support and change positions of a PV panel) , 2 multi-meters (or an ammeter and a voltmeter) or a AVO meter , Insulated wires with alligator clips or other cables, A resistor panel (1Ω, 4.7Ω, 10Ω, 22Ω, 32Ω, 47Ω, 51Ω, 82Ω, 100Ω, 220Ω, 10W), The system can convert solar rays into AC power 230V/ 50Hz.	1,4
2.	Solar tracker system: 1pcs 18inch linear actuator with 2pcs bracket.(12V option), 1pcs single axis solar tracker controller.	2
3.	Trainer kit for solar water heater with inbuilt meter-board.	3
4.	A pyranometer (Kipp & Zonen model CM 11, accuracy ± 0.50%) was placed on the top of dryer to measure solar radiation Relative humidity from ambient and in any parts of dryer were employed, used hygrometer (Electronic, model EE23, accuracy ± 2%). Temperatures in the collectors, product container, air duct and ambient were measured by Thermocouple Type K (accuracy ± 0.1°C). Moreover, the air speed in the dryer also measured by anemometers (Airflow, model TA5, accuracy ± 2%).	5
5.	THD meter, power analyzer, Lux-meter, energy meter and wattmeter	8
6.	Various equipment available at Pathologies, radiology and chemical labs from nearest hospitals.	13,14, 15,16

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	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Energy Sources	1a. Compare conventional and non-conventional Energy sources with respect to specified aspect. 1b. Explain with sketches the working of given type of conventional power plants 1c. Describe the present scenario of energy in Maharashtra and India with respect to identified aspect.	1.1 Non-conventional energy and conventional energy sources, Advantages and disadvantages 1.2 Overview of different types of conventional power plants 1.3 Present scenario of energy in Maharashtra and India.
Unit– II Renewable energy	2a. Describe with sketches the use of specified type of solar collector. 2b. Explain with sketches the function of given component of wind energy turbine. 2c. Explain with sketches the given factor affecting the production of biogas from biomass.	2.1 Solar energy and its applications. 2.2 Different types of solar collectors and PV cell. 2.3 Wind energy, principle of wind power , basic components of wind turbine 2.4 Bio-fuel, Principle of biogas production from waste biomass.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-III Energy Conservation for Sustainable Environment	3a. Explain need of energy conservation 3b. State the features of energy Conservation act 2001. 3c. Describe the function of specified instrument used for energy audit. 3d. State the features of electricity act 2003. 3e. Explain rules, regulation laws regarding environment protection.	3.1 Need of energy conservation. 3.2 Energy conservation act 2001 and its features. 3.3 Energy Audit, Energy audit instruments 3.4 Electricity act 2003, Industrial energy policies, energy vision, rules, regulation 3.5 Laws regarding environment protection
Unit –IV Hospital waste management.	4a. List the precaution to 4b. Describe remedies for managing the specified hospital waste. 4c. Explain effect of specified medical waste on the environment. 4d. Describe WHO guidelines for management of a specific waste of medical hospital	4.1 Hospital waste management introduction, sources of biomedical waste, Need of biomedical waste management system 4.2 Classification of Biomedical waste (Pathological, microbiological and radiological, chemical waste etc.). 4.5 Environmental pollution due to medical waste, Health impact of biochemical waste. 4.6 International scenario, World Health Organisation guidelines on management of wastes from hospitals wastes.
Unit-V Biomedical waste treatment	5a. Explain flow chart of biomedical waste management process. 5b. Explain Incineration technology in detail. 5c. Describe microwave irradiation process used in biomedical waste treatment. 5d. Comment on safety and precautionary measures used for waste management.	5.1 Biomedical waste management Processes. (waste collection, segregation, transportation and storage, treatment and disposal) 5.2 Biomedical Waste Treatment and Disposal (Incineration Technology, Non-Incineration Technology, Autoclaving, Microwave Irradiation, Chemical Methods, Plasma Pyrolysis) 5.3 Handling rules, 1998 and its amendment thereafter.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above 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	Energy Sources	10	04	07	03	14
II	Renewable energy	10	04	08	02	14
III	Energy Conservation for	08	02	06	04	12

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
	Sustainable Environment					
IV	Hospital Waste Management	10	04	08	04	16
V	Biomedical Waste Treatments	10	04	06	04	14
Total		**48**	**18**	**35**	**17**	**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 to various conventional and non conventional power plants.
b) Visit to multi-specialty hospitals for waste management methods.
c) Write report on accidental power off/shut down problem in Hospitals.
d) Read and prepare chart for the safety precautions for disposal of biomedical waste.
e) Prepare a report regarding use of various laws concerned with biomedical waste treatment.
f) Visit to nearby biogas plant.

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) Guide student(s) in undertaking micro-projects.
f) Correlate subtopics with power system utility and electrical equipments.
g) Use proper equivalent analogy to explain different concepts.
h) Use Flash/Animations to explain various theorems in circuit analysis.
i) Use open source PSpice/Matlab models to explain different concepts of electric circuit.

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 is given here. Similar micro-projects could be added by the concerned faculty:

a. **Construct Simple PV system using PV cell.**
The purpose of this activity is to construct a simple photovoltaic (PV) system, using a PV cell(s) and a DC ammeter, in order to learn:
- How the amount and wavelength of light affect the generation of electricity
- How PV systems are connected to produce different voltages and currents
- How temperature affects the efficiency of a PV cell

b. **Pinwheel Wind Turbine**
Make a pinwheel model to see how a very basic turbine works, and then use it to create electricity.

c. **Knowledge and awareness regarding biomedical waste management in dental teaching institutions in India**
Literature review should contain:
- Knowledge, awareness and practice regarding biomedical waste management among staff and students in dental teaching institutions in India.
- Attitude of staff towards disposal of biomedical waste.
- To suggest possible remedial measures if required.

d. **Evaluate the economic feasibility of producing biogas from nearby Dairy farm.**
It should contain:
- Process Flowchart
- Suitable conditions for anaerobic digestion.
- Biogas potential from selected livestock manure.
- Check the following: Applicability, re-plicability, marketability, affordability, reliability, feasibility.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Non-Conventional Energy Resources	Khan, B.H.	Mc Graw Hill, New Delhi, 2015 IBSN:0070606544
2	Energy Management Handbook	Wayne, C. Turner	The Fairmont Press, Inc.) 0-8493-8234-3 (Taylor & Francis Ltd.)
3	Hospital Waste management and its monitoring	Sharma, Madhuri	Jaypee Brothers Medical Publishers(P) Ltd. ISBN-9789386056788
4	Hospital Administration and Management	Gupta, Joydeep Das	Jaypee Brothers Medical Publishers(P) New Delhi, 2015 Ltd. ISBN-9789352501328
5	Memories in Hospital Management	Parmar ,H.B.	Jaypee Brothers Medical Publishers(P) New Delhi, 2015 Ltd. ISBN-

S. No.	Title of Book	Author	Publication
			9789352700967
6	Hospital Administration	Francis, C.M.; De Souza, Mario C.	Jaypee Brothers Medical Publishers(P) New Delhi, 2015 Ltd. ISBN-8171797210
7	Biomedical Waste Disposal	Singh, Anantpreet; Kaur Sukhjit	Jaypee Brothers Medical Publishers(P) New Delhi, 2015 Ltd. ISBN-9789350255544

14. SOFTWARE/LEARNING WEBSITES

a) www.mornsun-power.com/html/product/Photovoltaic-Power-Supply
b) https://energy.gov/science-innovation/energy-sources
c) www.youtube.com /Biomedical waste management
d) www.dreamtechpress.com /ebooks
e) www.nptelvideos.in/ renewable energy sources
f) www.cwejournal.org
g) Mpcp.gov.in/biomedical/pdf
h) https://beeindia.gov.in/