Program Name : **Electrical Engineering Program Group**

Program Code : **EE/EP/EU**

Semester : **Sixth**

Course Title : **Emerging Trends in Electrical Engineering**

Course Code : **22628**

1. RATIONALE

Every technological area is developing at an exponential rate. New applications are coming up and it's mandatory for all technologists to be well versed in these areas to survive and provide satisfactory and quality services to the society in respect of such technologies. This course aims to prepare the diploma graduates to be conversant with such emerging trends for staying in the race. The main areas in which such developments are in, encompass smart systems, intelligent motor controls, tariff and digitization beyond automation. The course gives a decent introduction of these areas and helps the students to be in a state of preparedness.

2. COMPETENCY

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

- **Use the trending practices in electrical engineering fields.**

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) Suggest the relevant IoT technologies for electrical systems.
b) Suggest the relevant components for implementing a smart grid.
c) Suggest different electrical systems for a smart city.
d) Suggest the relevant MCC or IMCC for the given application/s.
e) Propose the relevant improved tariff and metering for the specified type of consumer.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													Grand Total
				Theory Marks							Practical Marks						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
3	-	-	3	90 Min	70*#	28	30*	00	100	40	--	--	--	--	--	--	100

(#): Under the theory ESE; Total 70 marks of **online exam** will be conducted.*
*(*): Under the theory PA; Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 mark is the average of 2 tests (**MCQ type**) to be taken during the semester for the assessment of the 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, 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.

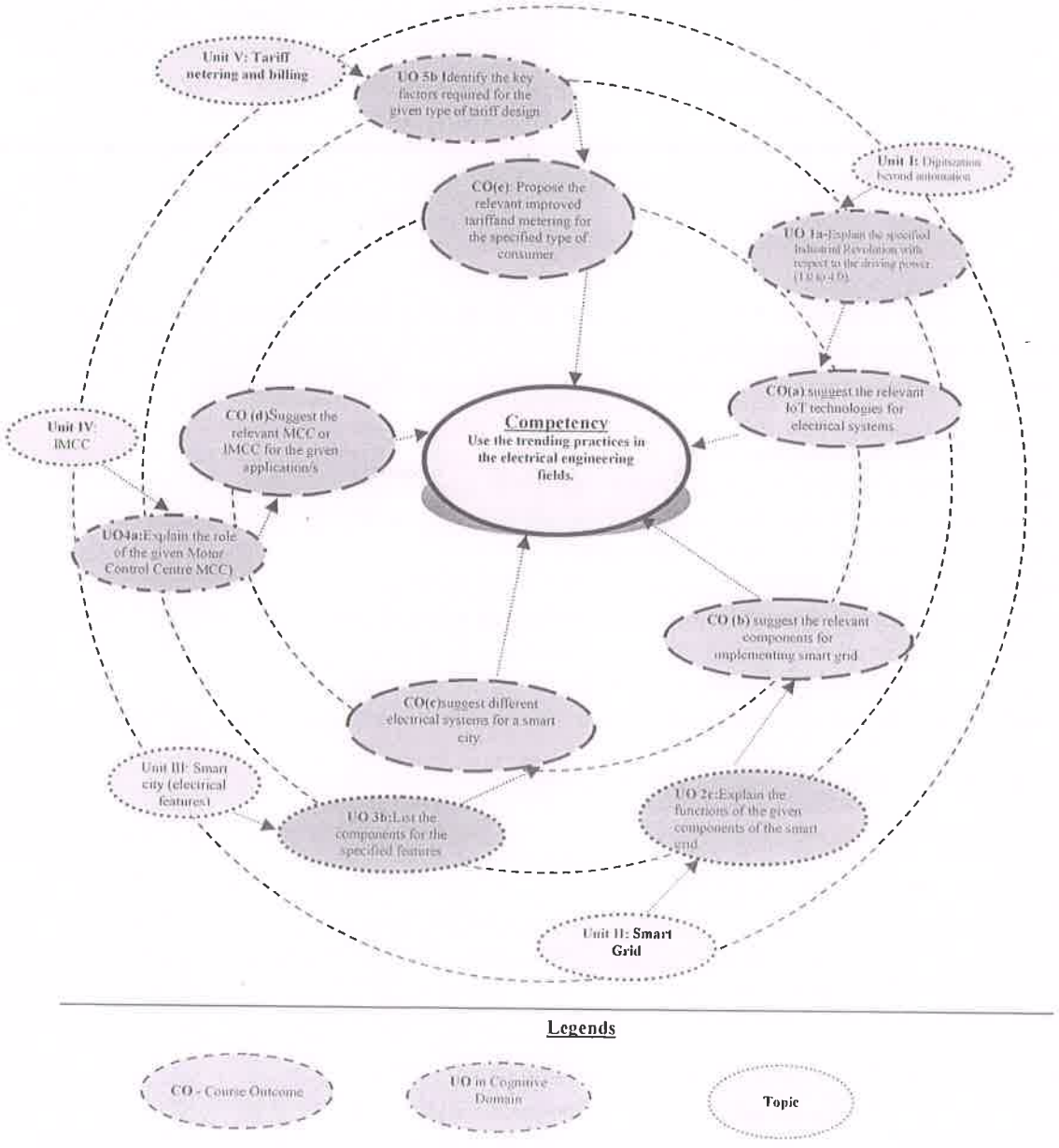

Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES: Not Applicable

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED: Not Applicable

8. UNDER-PINNING 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 Digitization beyond automation	**1a.** Explain the specified Industrial Revolution with respect to the driving power. (1.0 to 4.0). **1b.** Compare the specified Industrial revolutions with reference to the given points. **1c.** Explain the importance of the Industrial Revolution 4.0 with respect to the specified component/s. **1d.** Explain the principle of IoT used in the given application. **1e.** Explain the IoT used in the given electrical application. **1f.** Explain the specific demands on electrical power distribution in automated production plants.	**1.1 Industrial Revolutions:** • Introduction-Versions 1.0, 2.0, 3.0 and 4.0 • Benefits of Industry 4.0 • Challenges in implementation of Industry 4.0 • Comparison of I3.0 with I4.0 1.2 **Components of Industrial Revolution 4.0:** • CPS (Cyber Physical Systems), • IoT (Internet of Things), • Cloud Computing. IoT Cloud applications, Benefits of cloud in an IoT ecosystem. • Cloud Manufacturing, **1.3 IoT principle and features:** • Principle of IoT • Features of IoT 1.4 **IoT application areas in electrical systems:** • Building automation • SCADA, • Smart metering, • Illumination systems (public lighting). **1.5 Specific demands on electrical power distribution in automated production plants:** • Efficient engineering with digital twins • Fail-safe power supply • Incorporation into industrial automation • Integration in end-to-end energy efficiency concepts • Data management in the cloud.
Unit- II	**2a.** Explain the need for the	**2.1 Smart Grid:**

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Smart Grid	given smart grid. **2b.** Draw a labeled layout for the specified smart grid. **2c.** Explain the functions of the given components of the smart grid. **2d.** Identify the barriers for the given smart grid. **2e.** Identify the advantages for the given smart grid. **2f.** List the smart grid projects in the Indian grid. **2g.** Explain the need for the given micro grid. **2h.** Explain the general layout of the micro grid. **2i.** Explain the working of the given micro grid. **2j.** Explain the significance of the Distributed Generation Systems in the given power scenario. **2k.** Explain the given Distributed Generation Technology. **2l.** Explain the functions of the given components of the smart substation. **2m.** Compare the smart substation and conventional substation for the given criteria.	• Introduction: Need of smart grid • Stages in evolution of smart grid, • Layout and its components, • Comparison of smart grid and Conventional Power grid • Advantages, barriers, and challenges • Smart Grid activities and Projects in India. **2.2 Micro-Grid & Distributed Energy Resources**: • Introduction and Definition of Micro-grid • Difference between conventional grid and micro-grid • Difference between smart grid and micro-grid • Need and Significance of micro grid. • Major Components of Micro-grids. • Operation of micro grid - Grid connected mode, Islanded mode • Classification of Micro Grid based on types of supply, Sources, Scenario, and size • Distributed Generation Systems: Need and Significance of Distributed Generation • Distributed Generation Technologies, Role of Distributed Generation in Smart Grid, and Distributed generation in India. **2.3 Smart Substation**: • Introduction of Smart substation, features of substation automation • Layout and Components of smart substation. • Challenges in smart substations
Unit– III Smart City (Electrical Features)	**3a.** Explain the relevant features of the specified smart city. **3b.** List the components for the specified features. **3c.** Explain CCTV working with sensors on road. **3d.** Explain the importance of	**3.1 Smart City**: • Introduction, Features of comprehensive development in Smart Cities, • Core infrastructure elements in a smart city • Components of Smart City- Retrofitting, Redevelopment

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	e-vehicles in the given scenario (environment and energy). **3e.** Explain the working of the given type of e-car. **3f.** Explain the various types of batteries used in BEV. **3g.** Explain with sketch (block schematic) the working of the given type charging station. **3h.** Identify the features of the given fuel cell used in e-cars. **3i.** Identify the barriers for the adoption of e-cars in the specified scenario. **3j.** Explain the AR (Augmented Reality VR (Virtual Reality) with reference to EV. **3k.** Explain the smart braking system in case of unexpected incidents. **3l.** Identify the components required for the specified features in the given smart home. **3m.** Identify the illumination and its control components /devices for a specified room of a given smart home. **3n.** Explain with schematic sketch the working principle of the given appliance in a smart home.	Greenfield development, and Pan-city development • Objectives of Smart City • Challenges of smart Cities in India. • CCTV working with sensor on road to track down traffic and accidents. **3.2 Electric Vehicle**: • Role of Electric Vehicles in energy transition, key objectives of the EV policy • Basics of electric vehicle- Block diagram and major parts • Types of electric vehicles- Types, Advantages and limitations • Types of Batteries used in BEV- Features and limitations • Charging stations- AC and DC Charging • Fuel cell for electric vehicles, principle of fuel cell, its components, types, features, limitations, comparison of various fuel cells. • AR (Augmented Reality) VR (Virtual Reality) with EV • Smart braking system for unexpected incidents. **3.3 Smart Home**: • Common features of smart home. • Components of smart home.
Unit– IV Intelligent Motor Control Centers	**4a.** Explain the role of the given Motor Control Centre MCC). **4b.** List the devices and components used in (with functions) the given MCC.	**4.1 General/traditional Motor control center**: • Role in Motor protection and motor management. • General architecture or arrangement. • Components: symbols and functions. • Traditional MCCs: advantages and

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4c. Explain the roles of the components of the given motor control centre (MCC). **4d.** Explain the need for the given type of MCC. **4e.** Explain the roles and functions of the devices /components of the specified IMCC. **4f.** Prepare the outline with components of the IMCC suitable for a given application. **4g.** List the disadvantages of given type of MCC. **4h.** Explain the Basic Microcontrollers. **4i.** List the advantages of given type of IMCC. **4j.** Suggest an IMCC for a given set of applications.	disadvantages. **4.2 Intelligent or Smart MCCs:** • Need of IMCC, requirements of IMCCs, Role of IMCCs as compared to traditional MCCs. • Functional Block diagram/s with general arrangements. **4.3 Devices and Components typical to IMCCs:** • Intelligent relays, • Fuses, • Control devices, • Programmable Logic Controller (PLC) • AC drives • Power Monitoring Unit • Network cabling • Software. • Basic components of intelligent systems - Basic Microcontrollers **4.4 Selection of MCC:** • Basic Motor Operation functions • Enhanced Motor Operation functions • Selection Criteria
Unit– V Tariff, Metering and Billing	**5.a** Describe terms related to tariff economics. **5.b** Identify the key factors required for the given type of tariff design. **5.c** Identify the components for the given type of consumer's electricity bill. **5.d** Compare Average Billing Rate (ABR), Aggregate Revenue Requirement (ARR). **5.e** Suggest with justification the applicable type of tariff for the given type of consumer in the present-day scenario. **5.f** Explain the working principal of kVAh meter.	**5.1 Tariff:** • Power Purchase Agreements (PPA), • Power purchase cost. **5.2 Tariff Design:** • Key factors for Tariff Design, • Cross subsidy and various slabs in billing, • Major Components of an Electricity Bill. **5.3 Special tariffs:** • Average Billing Rate (ABR), • Aggregate Revenue Requirement (ARR), • Time of Day Tariff (ToD)- Recent ToD structure. • kVAh tariff- kVAh billing method for HT and LT Consumers, kVAh Metering methodology, kVAh based tariff calculation. **5.4 Metering and Bill Management:**

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	5.g Determine the electricity bill for the given type of consumer by kVAh billing methodology. **5.h** Differentiate between Net metering and Gross metering. **5.i** List out the relevant MERC rules for Net-metering billing. **5.j** Explain with schematic diagram the use of Net-metering principle for integration of micro-generators with grid system. **5.k** Explain with schematic diagram MRI/AMR reading techniques for the given consumer. **5.l** Explain the case study of the net metering bill.	• Working of Net metering and Gross metering, • MERC rules for Net-metering bill (Regulations 2015). • Case study of the net metering bill

***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 QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Digitization Beyond Automation	08	04	02	02	08
II	Smart Grid	08	04	04	04	12
III	Smart City	08	06	06	04	16
IV	Intelligent Motor Control Centers	12	04	06	08	18
V	Tariff, Metering and Billing	12	04	06	06	16
	Total	**48**	**22**	**24**	**24**	**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 (one activity by each group), also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

a. Perform general survey regarding the recent electrical technologies.
b. Prepare a power point presentation on IoT applications.
c. Perform Group discussion on new electricity tariff approaches.
d. Prepare a visit report on IMCC.

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. Show video demonstration on safety precautions.
g. Demonstrate the actions and care to be taken.
h. Arrange a visit to.
i. Arrange expert lecture of industry person.

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 year. In the first two years, the micro-project are group-based. However, in the third year, 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 as applicable. 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. Prepare a report on existing automation in an industry and suggest improvements.
b. Prepare a report on Smart Grid.
c. Prepare a report on any four Electrical Applications in Smart cities.

d. Present a power point presentation on various IMCCs.
e. Prepare a report on the procedure of meter reading by MRI and AMR techniques.
f. Conduct a survey and prepare a report on the IMCCs in one industry.
g. Prepare a report on mobile apps used for energy billing procedures.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Fundamentals of Smart Grid Technology	Bharat Modi, Anu Prakash, Yogesh Kumar	S.K. Kataria& Sons; 2015 EditionISBN-10: 9350144859, 13: 978-9350144855
2	Smart Grid: Technology and Applications	Janaka Ekanayake, Kithsiri Liyanage et al,	Wiley, 2015 Edition ISBN-10: 9788126557356, 13: 978-8126557356
3	Sustainable Smart Cities in India: Challenges and Future Perspectives	Sharma, Poonam, Rajput, Swati	Springer, ISBN 978-3-319-47145-7
4	Control of Electrical Machines	S K Bhattacharya	New Age International ISBN 8122409970, 9788122409970
5	Handbook of Electrical Motor Control Systems	U. S. Eshwar	Tata McGraw-Hill Education ISBN 0074601113, 9780074601112
6	Applied Intelligent Control of Induction motor Drives	Keli Shi and Tze Fun Chan	Wiley ISBN 10:0470825561, 13:978-0470825563
7	Art of Reading Electricity Bill	Mr. Yogendra Talware	Strom Energie Pvt. Ltd. Pune. (stromenergie.pune@gmail.com)

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. http://www.slideshare.net.in (search with relevant key words)
b. www.youtube.com (search with relevant key words)
c. https://en.m.wikipedia.org/wiki/Technological_revolution#Potential_future_technological_revolutions (general introduction to the new industrial revolution)
d. https://www.plm.automation.siemens.com/global/en/our-story/glossary/industry-4-0/29278 (Industrial revolution 4.0)
e. https://www.industry.siemens.com/topics/global/en/digital-enterprisesuite/Documents/PDF/PLMportal_Industrie-40-Internet-revolutionizes-the-economy.pdf (Industrial revolution 4.0)
f. https://www.trendmicro.com/vinfo/us/security/definition/industrial-internet-of-things-iiot (Internet of things)
g. https://www.computradetech.com/blog/iot-vs-iiot/
h. https://www.quora.com/Who-coined-the-term-internet-of-things
i. https://iot-analytics.com/the-leading-industry-4-0-companies-2019/
j. http://www.mercindia.org.in/pdf/Order%2058%2042/Order-195%20of%202017-12092018.pdf (MERC order on metering)