**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, encompasssmart 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 |

*(*#): Online examination of 90 minutes duration.0*
*(*): 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 (of MCQ type) to be conducted 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#-External 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.

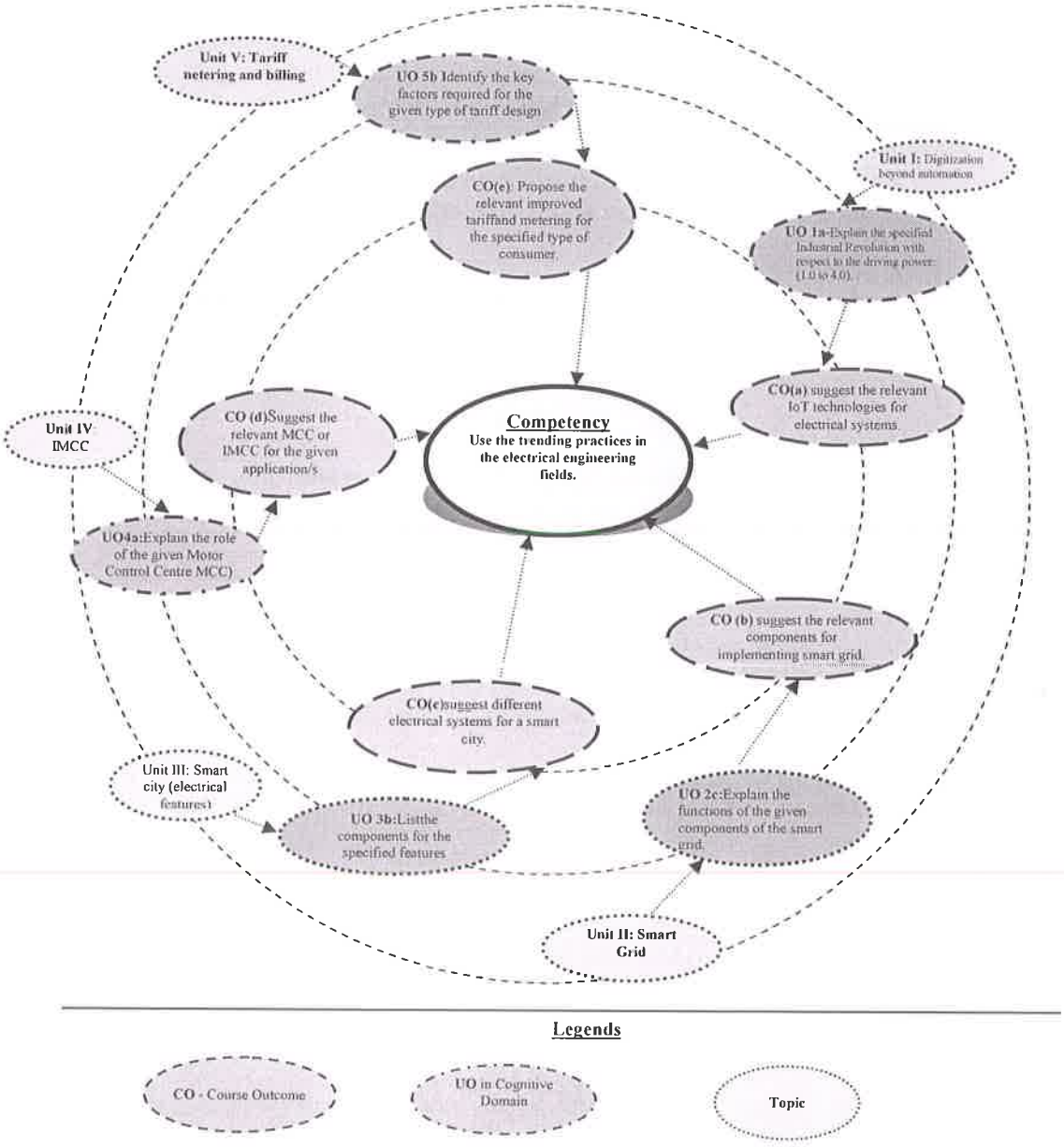


**Figure 1 - Course Map**

## 6. SUGGESTED PRACTICALS/ EXERCISES: Not Applicable

## 7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED: Not Applicable

## 8. UNDER-PINNING THEORY COMPONENTS

The following topicsare to betaught 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).<br>**1b.** Compare the specified Industrial revolutions with reference to the given points.<br>**1c.** Explain the importance of the Industrial Revolution 4.0 with respect to the specified component/s.<br>**1d.** Explain the principle of IoT used in the given application.<br>**1e.** Explain the IoT used in the given electrical application.<br>**1f.** Explain the IoT approach used in the given application for the power distribution system. | **1.1 Industrial Revolutions:** Versions 1.0, 2.0, 3.0 and 4.0; the driving energies/powers for these revolutions.<br>**1.2 Components of Industrial Revolution 4.0**: CPS (Cyber Physical Systems), IoT (Internet of Things), Cloud Computing and Cloud Manufacturing.<br>**1.3 IoT principle and features.**<br>**1.4 IoT application areas in electrical systems**: building automation SCADA, Smart metering, Illumination systems (public lighting).<br>**1.5 IoT initiatives in power distribution systems:** Mobile Apps, Geo coordinates of the network as well as consumer premises, Various digital service platforms for consumers. |
| **Unit- II Smart Grid** | **2a.** Explain the need for the given smart grid.<br>**2b.** Draw a labeled layout for the specified smart grid.<br>**2c.** Explain the functions of the given components of the smart grid.<br>**2d.** Identify the barriers for the given smart grid.<br>**2e.** Identify the advantages for the given smart grid.<br>**2f.** List the smart grid projects in the Indian grid.<br>**2g.** Explain the need for the given micro grid. | **2.1 Smart Grid**: Need and evolution, layout and its components,Advantages and barriers, Smart Grid Projects in India.<br>**2.2 Micro-Grid & Distributed Energy Resources**:Needand formation of micro grid, Distributed Generation Systems and Distributed Generation Technologies.<br>**2.3 Smart Substation**:Need, Layout and Components,Typical Specifications of existing substations. |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| | **2h.** Explain the general layout of the micro grid.<br>**2i.** Explain the working of the given micro grid.<br>**2j.** Explain the significance of the Distributed Generation Systems in the given power scenario.<br>**2k.** Explain the given Distributed Generation Technology.<br>**2l.** Explain the functions of the given components of the smart substation.<br>**2m.** Compare the smart substation and conventional substation for the given criteria. | |
| **Unit– III Smart City (Electrical Features)** | **3a.** Explain the relevant features of the specified smart city.<br>**3b.** List the components for the specified features.<br>**3c.** Explain the importance of e-vehicles in the given scenario (environment and energy).<br>**3d.** Explain the working of the given type of e-car.<br>**3e.** Explain with sketch (block schematic) the working of the given type charging station.<br>**3f.** Identify the features of the given fuel cell used in e-cars.<br>**3g.** Identify the barriers for the adoption of e-cars in the specified scenario.<br>**3h.** Identify the components required for the specified features in the given smart home.<br>**3i.** Identify the illumination and its control components /devices for a specified room of a given smart home.<br>**3j.** Explain with schematic sketch the working principle of the given appliance in a | **3.1 Smart City:**Features, components, Objectives and challenges of smart Cities in India.<br>**3.2 E-car:**Role of Electric Vehicles in energy transition, basics of electric car, types of electric cars, working principle, charging stations. Fuel cell for e-cars, types, features, limitations.<br>**3.3 SmartHome:**Features and Components.Illumination and smart appliance control principles (block diagram/s). |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| | smart home. | |
| **Unit– IV Intelligent Motor Control Centers** | **4a.** Explain the role of the given Motor Control Centre MCC).<br>**4b.** List the devices and components used in (with functions) the given MCC.<br>**4c.** Explain the roles of the components of the given motor control centre (MCC).<br>**4d.** Explain the need for the given type of MCC.<br>**4e.** Explain the roles and functions of the devices /components of the specified IMCC.<br>**4f.** Prepare the outline with components of the IMCC suitable for a given application.<br>**4g.** List the advantages of given type of MCC.<br>**4h.** List the disadvantages of given type of MCC.<br>**4i.** List the advantages of given type of IMCC.<br>**4j.** Suggest an IMCC for a given set of applications. | **4.1 General/traditional (conventional) Motor control center:** Role in Motor protection and motor management. Typical block diagram and general architecture or arrangement. Components: symbols and functions. Traditional MCCs: advantages and disadvantages.<br>**4.2 Intelligent or Smart MCCs:** Need and the requirements that lead to have IMCCs. Role as compared to traditional MCCs. Functional Block diagram/s with general arrangements.<br>**4.3 Devices and Components typical to IMCCs**: Intelligent relays, fuses, control devices, effective security and dedicated software.<br>**4.4 Basic components of intelligent systems**: Control by microprocessor/microcontroller-based systems; networking/technology replaces hard wiring and enhanced diagnostic/protective functionality.<br>**4.5 Selection of MCC**: intelligent and conventional types for typical applications. |
| **Unit– V Tariff, Metering and Billing** | **5.a** Describe terms related to tariff economics.<br>**5.b** Identify the key factors required for the given type of tariff design.<br>**5.c** Identify the components for the given type of consumer's electricity bill.<br>**5.d** Compare Average Billing Rate (ABR), Aggregate Revenue Requirement (ARR).<br>**5.e** Explain the suitability of ABT for the given type of | **5.1Tariff:**Power Purchase, Power Purchase Agreements (PPA), Power purchase cost.<br>**5.1.1Tariff Design**:Key factors for Tariff Design, Major Components of an Electricity Bill, various slabs in billing, electricity duty, tax on electricity and Cross subsidy.<br>**5.1.2Special tariffs**: Average Billing Rate (ABR), Aggregate Revenue Requirement (ARR), Availability based Tariff (ABT), Time of Day Tariff (ToD),Recent ToD structure |

| Unit | Unit Outcomes (UOs) (in cognitive domain) | Topics and Sub-topics |
|---|---|---|
| | consumer.<br>**5.f** Suggest with justification the applicable type of tariff for the given type of consumer in the present-day scenario.<br>**5.g** Explain the working principal of kVAh meter.<br>**5.h** Determine the electricity bill for the given type of consumer by kVAh billing methodology.<br>**5.i** Differentiate between Net metering and Gross metering.<br>**5.j** List out the relevant MERC rules for Net-metering billing.<br>**5.k** Explain with schematic diagram the use of Net-metering principle for integration of micro-generators with grid system.<br>**5.l** Explain with schematic diagram MRI/AMR reading techniques for the given consumer. | **5.1.3kVAhtariff:**kVAhbilling method for HT and LT Consumers, kVAh Metering methodology, kVAh based Billing calculation,<br><br>**5.2 Metering and Bill Management:** Working of Net metering and Gross metering, MERC rules for Net-metering bill (Regulations 2015), Application of Net Metering for integration of micro-generators with grid system. Recent Meter Reading techniques-MRI/AMR reading. |

***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 | 06 | 04 | 02 | 12 |
| III | Smart City (Electrical Features) | 08 | 08 | 06 | 02 | 16 |
| IV | Intelligent Motor Control Centers | 12 | 04 | 06 | 08 | 18 |
| V | Tariff, Metering and Billing | 12 | 04 | 08 | 04 | 16 |
| | **Total** | **48** | **26** | **26** | **18** | **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 reporton 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, AnuPrakash, Yogesh Kumar | S.K. Kataria& Sons; 2015 EditionISBN-10: 9350144859, 13: 978-9350144855 |
| 2 | Smart Grid: Technology and Applications | JanakaEkanayake, 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. YogendraTalware | Strom EnergiePvt. 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.leverege.com/blogpost/difference-between-iot-and-iiot
h. https://www.computradetech.com/blog/iot-vs-iiot/
i. https://www.quora.com/Who-coined-the-term-internet-of-things
j. https://iot-analytics.com/the-leading-industry-4-0-companies-2019/
k. http://www.mercindia.org.in/pdf/Order%2058%2042/Order-195%20of%202017-12092018.pdf (MERC order on metering)