**EMERGING TRENDS IN ELECTRICAL ENGINEERING** **Course Code : 316326**

| | |
|---|---|
| **Programme Name/s** | **: Electrical Engineering/ Electrical and Electronics Engineering/ Electrical Power System** |
| **Programme Code** | **: EE/ EK/ EP** |
| **Semester** | **: Sixth** |
| **Course Title** | **: EMERGING TRENDS IN ELECTRICAL ENGINEERING** |
| **Course Code** | **: 316326** |

## I. RATIONALE

Emerging technologies evolve rapidly in all the field of engineering and it is essential for technologists to stay updated on these aspects to face the day to day challenges in the industry as well as in the society. This course aims to prepare Diploma Engineers with insights into the emerging technological trends like smart systems, AI, intelligent motor controls and digitization.

## II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help the student to attain the following Industry identified outcome through various teaching learning experiences: .

- **Acquire relevant knowledge of Emerging techniques in electrical engineering fields.**

## III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Suggest the relevant IoT technologies for electrical systems.
- CO2 - Elaborate the use relevant IoT and SCADA for Automation of electrical Grid systems.
- CO3 - Implement electrical engineering related emerging trends to develop smart city.
- CO4 - Suggest the relevant IMCC for the given application (s).
- CO5 - Select the relevant improved tariff and billing solution for the specified type of consumer.

## IV. TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title | Abbr | Course Category/s | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Actual Contact Hrs./Week | | | SLH | NLH | | Paper Duration | Theory | | | | Based on LL & TL | | | | Based on SL | | Total Marks |
| | | | | | | | | | | | | | | | Practical | | | | | | |
| | | | | CL | TL | LL | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | |
| | | | | | | | | | | | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | |
| 316326 | EMERGING TRENDS IN ELECTRICAL ENGINEERING | ETE | DSC | 4 | - | - | - | 4 | 2 | 1.5 | 30 | 70*# | 100 | 40 | - | - | - | - | - | - | 100 |

**Total IKS Hrs for Sem. :** 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 1 | TLO 1.1 Explain the specified Industrial Revolution with respect to the driving force behind it.<br>TLO 1.2 Explain the Industrial Revolution 4.0 with respect to the specified component (s).<br>TLO 1.3 Explain the changes in Industry 4.0 with respect to AIML and 5G.<br>TLO 1.4 Explain the Importance of Industrial revolution 5.0.<br>TLO 1.5 Explain the Principle and features of IoT.<br>TLO 1.6 Apply the concepts of IoT in the given electrical systems. | **Unit - I Digitization beyond Automation**<br>1.1 Industrial Revolutions: Versions 1.0, 2.0, 3.0 and 4.0; the driving force for these revolutions.<br>1.2 Components of Industrial Revolution 4.0: Digitization, CPS (Cyber Physical Systems), IoT (Internet of Things), Cloud Computing and Cloud Manufacturing.<br>1.3 Role of 5G Communication, Machine learning (ML) and AI in Industry 4.0.<br>1.4 Industry Revolution 5.0: Introduction and Key Features.<br>1.5 IoT: Principle and features.<br>1.6 Applications of IoT in Industrial drives, Transmission System, Distribution System, Illumination system and Renewable energy. | Lecture Using Chalk-Board<br>Video Demonstrations<br>Flipped Classroom<br>Presentations |

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 2 | TLO 2.1 Describe the smart grid with respect to the need, layout and its components.<br>TLO 2.2 Explain the concept and formation of micro grid.<br>TLO 2.3 Explain the given Distributed Generation technology(ies) in the power sector.<br>TLO 2.4 Describe the role of Distributed Generation in the given Grid system.<br>TLO 2.5 Use features of Automation System in smart substation.<br>TLO 2.6 Identify specific application of IoT and SCADA for particular Grid. | **Unit - II Smart Grid**<br>2.1 Smart Grid: Need and evolution, layout and its components, advantages and barriers, Smart Grid projects in India.<br>2.2 Micro-Grid: Need and formation of Micro Grid.<br>2.3 Distributed Energy Resources: Distributed generation systems and distributed generation technologies.<br>2.4 Role of distributed generation in Smart Grid and Micro Grid.<br>2.5 Substation Automation System (SAS): Need, layout and components, salient features of substation automation.<br>2.6 IoT and SCADA application in Grid systems. | Lecture Using Chalk-Board<br>Video Demonstrations<br>Flipped Classroom<br>Presentations<br>Site/Industry Visit |
| 3 | TLO 3.1 Describe the smart city with respect to the needs, components and its challenges.<br>TLO 3.2 Explain relevant technology associated with Metro/ EV.<br>TLO 3.3 Compare various EV’s based on the given criteria (s).<br>TLO 3.4 Describe smart home on the basis of the given criteria (s).<br>TLO 3.5 Implement the Renewable energy related policies in smart city. | **Unit - III Smart City (Electrical Features)**<br>3.1 Smart City: Features, components, objectives and challenges of smart cities in India.<br>3.2 Intercity Transportation: EV / Metro: Types, data-driven operations, automated train operation (ATO), autonomous driving technology, efficient charging infrastructure, wireless charging: opportunities and challenges.<br>3.3 Comparison between various types of Electric Vehicles: technology, type of motor, efficiency, batteries etc.<br>3.4 Smart Home: Features and components, role of AI powered illumination system and advancement in luminaries. smart appliance control principles (block diagram/s).<br>3.5 Renewable Energy: Role, opportunities, government policies: center / state. | Lecture Using Chalk-Board<br>Video Demonstrations<br>Flipped Classroom<br>Presentations<br>Site/Industry Visit |

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 4 | TLO 4.1 Describe the conventional MCC considering the given points.<br>TLO 4.2 Explain the IMCC based on the given point (s).<br>TLO 4.3 Describe advantages and limitations of modern MCCs including lack of networking and diagnostics.<br>TLO 4.4 Describe the salient features of the given basic components of intelligent system.<br>TLO 4.5 Describe the salient features of the given components and devices of IMCC.<br>TLO 4.6 Compare intelligent and conventional MCC on the basis of the given criteria. | **Unit - IV Intelligent Motor Control Centers**<br>4.1 Conventional Motor Control Center (MCC): Role in motor protection and management, typical block diagram and architecture, components: symbols and functions.<br>4.2 Intelligent or Smart MCCs (IMCCs): Need and evolution from traditional MCCs. Functional block diagram and general arrangement, integration of industrial IoT (IIoT) and cloud-based real-time monitoring.<br>4.3 Applications, advantages and limitations in modern MCCs including lack of networking and diagnostics.<br>4.4 Basic Components of Intelligent Systems: Microprocessor / microcontroller-based control; networking technologies (Ethernet / IP, Modbus, PROFINET) replacing hard wiring, enhanced diagnostics, AI-based predictive maintenance, smart sensors, and edge computing for real-time diagnostics and wireless communication (Bluetooth, Zigbee) for remote control.<br>4.5 IMCC Components and Devices: Intelligent relays, digital fuses, cybersecurity features, dedicated software and advanced control devices.<br>4.6 Selection of MCC: Comparison between Intelligent and conventional MCC; Energy efficiency, cybersecurity, networking, and automation. Smart power management with power factor correction (PFC) and harmonic filtering for efficiency. | Lecture Using Chalk-Board<br>Video Demonstrations<br>Flipped Classroom<br>Presentations<br>Site/Industry Visit |
| 5 | TLO 5.1 Describe the given term(s) related to tariff economics.<br>TLO 5.2 Explain the key factors required for the given type of tariff design.<br>TLO 5.3 Explain the communication technologies used in the given type (s) of smart meters.<br>TLO 5.4 State the relevant MERC rules applicable for Net-metering billing.<br>TLO 5.5 Describe the use of deep learning model and communication methods in MRI / AMR. | **Unit - V Tariff and Smart Billing**<br>5.1 Tariff: Power purchase, Power purchase agreements (PPA), Power purchase cost.<br>5.2 Tariff 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>5.3 Smart Metering: Components working principle, types of smart meters, features, communication technologies, advantages, challenges, role in Grid System.<br>5.4 Metering and Bill Management: Working of net metering and gross metering, MERC rules for net-metering bill (Latest Amendment), application of net metering for integration of micro-generators with grid system.<br>5.5 Meter reading techniques: use of deep learning model and communication methods in MRI / AMR. | Lecture Using Chalk-Board<br>Video Demonstrations<br>Flipped Classroom<br>Presentations |

## VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

**Micro project**

- Prepare a report on grid maintenance by using Drone
- Prepare a report on Role of 3D printer in Electrical Model design.

- Prepare a report on Flexible Electricity Billing System
- Prepare a report on Role of Smart CCTV in Smart City

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

## VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|---|---|---|
| 1 | Not Applicable | All |

## IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

| Sr.No | Unit | Unit Title | Aligned COs | Learning Hours | R-Level | U-Level | A-Level | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | I | Digitization beyond Automation | CO1 | 12 | 6 | 6 | 2 | 14 |
| 2 | II | Smart Grid | CO2 | 10 | 6 | 6 | 2 | 14 |
| 3 | III | Smart City (Electrical Features) | CO3 | 12 | 4 | 6 | 4 | 14 |
| 4 | IV | Intelligent Motor Control Centers | CO4 | 14 | 6 | 6 | 2 | 14 |
| 5 | V | Tariff and Smart Billing | CO5 | 12 | 6 | 6 | 2 | 14 |
| **Grand Total** | | | | **60** | **28** | **30** | **12** | **70** |

## X. ASSESSMENT METHODOLOGIES/TOOLS

**Formative assessment (Assessment for Learning)**

- Formative assessment (Assessment for Learning) Two unit tests of 30 marks will be conducted and average of two unit tests considered.

**Summative Assessment (Assessment of Learning)**

- End semester assessment of 70 marks through Online mode of examination.

## XI. SUGGESTED COS - POS MATRIX FORM

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| Course Outcomes (COs) | Programme Outcomes (POs) | | | | | | | Programme Specific Outcomes* (PSOs) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | PO-1 Basic and Discipline Specific Knowledge | PO-2 Problem Analysis | PO-3 Design/ Development of Solutions | PO-4 Engineering Tools | PO-5 Engineering Practices for Society, Sustainability and Environment | PO-6 Project Management | PO-7 Life Long Learning | PSO-1 | PSO-2 | PSO-3 |
| CO1 | 3 | 1 | 2 | 1 | 2 | 1 | 1 | | | |
| CO2 | 3 | 1 | 2 | 1 | 2 | 1 | 1 | | | |
| CO3 | 3 | 1 | 2 | 2 | 2 | 2 | 2 | | | |
| CO4 | 3 | 1 | 2 | 2 | 1 | 1 | 1 | | | |
| CO5 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | | | |

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

| Sr.No | Author | Title | Publisher with ISBN Number |
|---|---|---|---|
| 1 | S K Bhattacharya | Control of Electrical Machines | New Age International ISBN13: 8122409970, 9788122409970 |
| 2 | Akihiko Yokoyama | Smart Grid: Fundamentals, Design, Technology, Applications, Communication and Security, An Indian Adaptation | Wiley, 1 April 2021 Edition ISBN-13: 978-9354243219 |
| 3 | Frank D. Petruzella | Electrical Motor Control Systems | McGraw-Hill College, 22 November 2019, ISBN-13: 978-1260439397 |
| 4 | Merizalde | Encyclopaedia of Applied Intelligent Control of Induction Motor Drives | Auris Reference (1 April 2018) ISBN-13: 978-1788022651 |
| 5 | P K Pandey | IOT (Internet of things) and Its Application | T Balaji Publication (1 January 2020) ISBN 13:978-8194136385 |
| 6 | Pandian Vasant | Artificial Intelligence in Industry 4.0 and 5G Technology | Wiley 30 June 2022 ISBN-13: 978-1119798767 |

## XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal | Description |
|---|---|---|
| 1 | 41.-30.12.2019-Grid-Interactive-RRE-Regulations2019-English. pdf | MERC rules for net-metering bill |
| 2 | https://youtu.be/Xpb9XKmRsyw?si=0oLY-lKVyvPWiBSE | History of Industrial Revolution |
| 3 | https://www.geeksforgeeks.org/introduction-to-internet-of-things-iot-set-1/ | Introduction to Internet of Things (IoT) |
| 4 | https://www.researchgate.net/publication/321529309_Sustainable_Smart_Cities_in_India_Challenges_and_Future_Perspectives | Sustainable Smart Cities in India: Challenges and Future Perspectives |
| 5 | https://www.iea.org/energy-system/electricity/smart-grids | Electricity smart grid |
| 6 | https://electricalengineerpro.com/latest-trends-in-electrical-engineering/ | Trends in Electrical Engineering |
| 7 | https://www.youtube.com/watch?v=MTqML_JCpsY | Intelligence motor control system for engineers (Hindi) |

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| Sr.No | Link / Portal | Description |
|---|---|---|
| 8 | https://www.youtube.com/watch?v=IEsmG83IxLs | IMCC Drawing, IMCC RDOL Drawing, IMCC Panel drawing, IMCC PRO V DRAWING, IMCC Simocode drawing |

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students