**University**: Benha University

**Faculty**: Faculty of Engineering at Shoubra

**Department offering the program**: Mechanical Engineering Department

**Department offering the course**: Energy and Sustainable Energy Engineering Program

**1- Course Data (Basic Information)**

**Course Code & Title:** EPM401 Electrical Machines  **Semester/Year: First** / 2020-2021

**Prerequisite Course(s):** EPM301 Electrical Engineering II **Core or Elective:** Core Course

**Credit Hours:** 3 **Weekly Contact Hours**: **Lecture:** 2 **Tutorial:** 0 **Laboratory:** 3

**2- Course Aims**

The aim of this course is to provide students with the basics knowledge of DC machines, AC machines, and transformer. Moreover, employ the methods of speed control of DC motors and induction motor. Finally, determine the performance and efficiency of different electrical machines.

**3- Course Contents** (As indicated in the program Bylaw)

D.C. Generators (Types and Characteristics), Open Circuit Characteristic of a D.C. Generator, Characteristics of a Separately Excited D.C. Generator, Voltage Build-Up in a Self-Excited Generator, Critical Field Resistance for a Shunt Generator, Critical Resistance for a Series Generator, Characteristics of Series Generator, Characteristics of a Shunt Generator, Critical External Resistance for Shunt Generator, Critical Speed (NC), Compound Generator Characteristics, Voltage Regulation, Parallel Operation of D.C. Generators, D.C. Motors, Back E.M.F., Voltage and power equations of D.C. Motor, Condition For Maximum Power, Types of D.C. Motors, Armature and shaft Torque of D.C. Motor, Brake Horse Power, Speed of a D.C. Motor, Efficiency of a D.C. Motor, Speed Control of D.C. Motors, Transformer, Theory of an Ideal Transformer, Practical Transformer, Practical Transformer on Load, Equivalent circuit, Voltage Regulation, Transformer Tests, Efficiency of a Transformer, Condition for Maximum Efficiency, All-Day Efficiency, Types of Transformers, Cooling of Transformers, Autotransformer, Parallel Operation of Single-Phase Transformers, Three-Phase Transformer. Three-phase synchronous machines: types, characteristics phasor diagram, power, torque, voltage regulation and efficiency, modes of operation. Three-phase induction machines: theory and principles, equivalent circuit and phasor diagram, characteristics, power, torque, efficiency, stability and dynamic behavior, modes of operation.

**4- Program Competencies Served by The Course (A.2, A.3 and B.3)**

**Level (A) Engineering Competencies**

|  |  |
| --- | --- |
| A.2 | Develop and conduct appropriate experimentation and/or simulation, analyze and interpret data, assess and evaluate findings, and use statistical analyses and objective engineering judgment to draw conclusions. |
| A.3 | Apply engineering design processes to produce cost-effective solutions that meet specified needs with consideration for global, cultural, social, economic, environmental, ethical and other aspects as appropriate to the discipline and within the principles and contexts of sustainable design and development. |

**Level (B) Mechanical Engineering Competencies**

|  |  |
| --- | --- |
| **B.3** | Select, model and analyze electrical power systems applicable to the specific discipline by applying the concepts of: generation, transmission and distribution of electrical power systems. |

**5- Learning Outcomes (LO’s)**

*At the end of the course, the student will be able to:*

|  |
| --- |
| Cognitive Domain |
| LO1 | Recognize various types of electrical machines |
| LO2 | Analyze the equivalent circuits of different electrical machines. |
| LO3 | Determine the performance and efficiency of the electrical machines.  |
| Psychomotor Domain |
| LO4 | Execute the speed and torque control of Motors  |
| LO5 | Perform the several tests of the machines to determine the machine parameters  |
| Affective Domain |
| LO6 | Perform some applications using Lab.  |

**6- Mapping Learning Outcomes (LO’s) with Competencies**

|  |  |  |  |
| --- | --- | --- | --- |
| **LO’s NARS** | **A2** | **A3** | **B3** |
| Cognitive Domain |
| LO1 |  |  | ◼ |
| LO2 |  |  | ◼ |
| LO3 |  | ◼ |  |
| Psychomotor Domain |
| LO4 |  | ◼ |  |
| LO5 | ◼ |  |  |
| Affective Domain |
| LO6 | ◼ |  |  |

**7- Lecture Plan**

1. Topics to be Covered weekly & Matrix of LO’s

| Week | Topics | Planned Hours | Learning Outcomes |
| --- | --- | --- | --- |
| LO1B3-1 | LO2B3-2 | LO3A3-3 | LO4A3-4 | LO5A2-5 | LO6A2-6 |
| W1 | * DC Machines Construction,
* Magnetic circuit and Windings, Armature Reaction and commutation,
* **Lab: Simulation Videos for the construction of DC machines and the operation of armature reaction.**
 | **2****3** | ◼ |  |  |  |  |  |
| W2 | * Principles and Types of DC Machines,
* DC Machines Applications, E.M.F. Equation,
* **Lab: No-load and rated load Characteristics of a DC generator.**
 | **2****3** | ◼ | ◼ |  |  |  |  |
| W3 | * Torque Equation of DC machines, Modeling and Characteristic of DC machines.
* **Lab: No-load and rated load Characteristics of a DC motor.**
 | **2****3** |  |  | ◼ |  |  |  |
| W4 | * Energy Losses, Power flow, Efficiency, Speed control and Direction control of DC machines.
* **Lab: performance of a DC motor at different speed.**
 | **2****3** |  |  | ◼ |  |  |  |
| W5 | * What is a transformer – Its construction – Its classifications,
* Principle of operation, Ideal transformer, Equivalent circuit of 1-φ real transformer,
* **Lab:**  **Simulation Videos for the construction of a transformer**
 | **2****3** |  | ◼ | ◼ |  |  |  |
| W6 | * Performance characteristics and voltage regulation of single-phase transformer
* Transformer losses and Efficiency,
* **Performance ch/s of a single-phase transformer.**
 | **2****3** |  | ◼ | ◼ |  |  |  |
| W7 | * Tests of Transformer, Auto transformer
* **Lab: Performance ch/s of an auto- transformer.**
 | **2****3** |  |  |  |  | ◼ |  |
| W8 | * 3-φ transformers
* Parallel operation of 3-φ transformers, Load sharing of 3-φ transformers
* **Lab: Performance ch/s of a three-phase transformer.**
 | **2****3** |  |  |  |  | ◼ |  |
| W9 | * Three-phase synchronous machines: types, characteristics phasor diagram,
* **Lab:**  **Simulation Videos for the construction of a**  **synchronous machines**
 | **2****3** |  |  |  |  | ◼ |  |
| W10 | * power, torque, voltage regulation and efficiency,
* **Lab: Performance ch/s of a synchronous generator.**
 | **2****3** |  |  |  | ◼ |  |  |
| W11 | * Modes of operation.
* **Lab: Performance ch/s of synchronous machine at different modes.**
 | **2****3** |  |  |  | ◼ |  |  |
| W12 | * Three-phase induction machines: theory and principles, equivalent circuit and phasor diagram,
* **Lab:**  **Simulation Videos for the construction of a**  **Three-phase induction machines.**
 | **2****3** | ◼ |  |  |  |  | ◼ |
| W13 | * Characteristics, power, torque, efficiency,
* **Lab: Performance ch/s of an induction motor.**
 | **2****3** |  |  |  |  |  | ◼ |
| W14 | * Stability and dynamic behavior, modes of operation
* **Lab: Performance ch/s of induction machine at different modes.**
 | **2****3** |  |  |  |  |  | ◼ |

1. Additional private study/learning hours expected for students per week is Three hours

**8) Teaching and Learning Methods**

| **Learning Outcomes** | **Teaching and Learning Methods** |
| --- | --- |
| Face-to-face Lecture | Online Lectures | Tutorial / Exercise | Group Discussions | Laboratory | Self-Reading | Presentation | Collaborate Learning (Team Project) | Research and Reporting | Brain Storming  |
| **Cognitive Domain** | LO1 | ⚫ |  | ⚫ |  |  | ⚫ |  |  |  | ⚫ |
| LO2 | ⚫ |  | ⚫ | ⚫ |  |  |  |  |  | ⚫ |
| LO3 | ⚫ |  | ⚫ |  |  |  | ⚫ |  |  |  |
| **Psychomotor Domain** | LO4 | ⚫ |  |  |  | ⚫ |  |  | ⚫ |  |  |
| LO5 | ⚫ |  |  |  | ⚫ |  |  |  |  |  |
| **Affective Domain** | LO6 |  |  | ⚫ |  | ⚫ |  |  | ⚫ |  |  |

**Student Academic Counseling and Support**

* Students are directed to contact teaching staff for academic support during specific office hours.
* Regarding this course, Instructor and TA will be available two hours a week as indicated on the timetable declared for students from the beginning of the semester.

**9- Student Assessment**

**a) Student Assessment Methods**

| **Learning Outcomes** | **Assessment Methods** |
| --- | --- |
| Written Exams | Online Exams | Oral Exam | Pop Quizzes |  In-class Problem Solving | Take-Home Exam | Research Assignments | Reporting Assignments | Project Assignments | In-class Questions |
| **Cognitive Domain** | LO1 | ⚫ |  |  | ⚫ |  |  | ⚫ |  |  | ⚫ |
| LO2 | ⚫ |  |  |  | ⚫ |  |  | ⚫ |  | ⚫ |
| LO3 | ⚫ |  |  | ⚫ |  |  |  |  |  |  |
| **Psychomotor Domain** | LO4 | ⚫ |  |  |  |  |  |  | ⚫ |  |  |
| LO5 | ⚫ |  |  |  |  |  |  | ⚫ |  |  |
| **Affective Domain** | LO6 | ⚫ |  | ⚫ |  |  |  | ⚫ |  | ⚫ |  |

**b- Assessment Schedule and Weight**

|  |  |  |
| --- | --- | --- |
| **Assessment Tools** | **Week** | **Weight** |
| First Midterm Examination | 7 | 30 % |
| Research and reports discussion  | 12 | 20% |
| Final Examination | (As Scheduled) | 40 % |
| In class questions  | All weeks | 10 % |
| **Total** |  | **100** % |

**10- Facilities**

The following facilities are needed for this course:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ■ | Classroom | □ | Smart Board | ■ | Computer with software |
| □ | Lecture Hall | ■ | White Board | ■ | MIS system |
| □ | Sound and Microphone | ■ | Data Show | ■ | Internet Access |
| □ | Other: ………………… |  |  |  |  |

**11- List of References**

**a- Course Notes**

1. Course notes prepared by instructor

**b- Books**

1. Sahdev, S. K, “Electrical machines”, Cambridge University Press, Year: 2018.
2. Vibhav Kumar Sachan, “Electrical Machines: Principles, Designs & Applications”, Smt. Jay Devi Sachan Memorial Publication House, Year: 2019.

**c- Recommended Books**

1. Electrical Machine Design, SAY, 2005.

**d- Web Sites**

1. [www.electrical.edu.eg](http://www.electrical.edu.eg)

**- Course Coordinator: Prof. Dr. Mhmoud Al-ahmar Signature**

**Dr. Islam Mohamed Signature:**

**- Program Coordinator: Prof. Dr. Ahmed Reda Elshamy Signature:**