National Institute of Technology Karnataka (NITK), Surathkal
Department of Electrical and Electronics Engineering

Course Plan and Evaluation Plan

1. **Course Code:** EE213
2. **Course Title:** Induction Motors and Transformers
3. **L-T-P:** 3-1-3
4. **Credits:** 6
5. **Pre-requisite:** EE101: Analysis of Electric Circuits
   MA11x: Engineering Mathematics
   EE143: Mathematics for Electrical Engineers
6. **Course Instructors:** Dr. Tukaram Moger (S1) and Prof. Debashisha Jena (S2)
7. **Teaching Department:** E&E, NITK
8. **Academic Year and Semester:** 2026-27/ 3rd Semester
9. **Course Outcomes:**
   a. Ability to analyze magnetic circuits for electrical machines.
   b. Demonstrate an understanding of transformer construction and working principles.
   c. Capability to analyze the transformer equivalent circuit and performance characteristics.
   d. Demonstrate an understanding of three-phase induction machine construction and working principles.
   e. Ability to analyze the performance and steady-state characteristics of three-phase induction machines.
   f. Knowledge of single-phase induction motors.
10. **Course Coverage**:

Unit	Syllabus covering or contents	Approx. no. of lectures hours	Reference Chapters
1	**Magnetic Circuits:** Introduction; magnetic flux and flux density, magnetic field intensity; Amperes circuital law and Biot-Savart's, Lorentz force and force on current carrying conductor, Faradays law-induced voltage from a varying magnetic field; Magnetic behavior of ferromagnetic materials (B-H curve), energy losses in ferromagnetic core (Eddy current and hysteresis losses); *Magnetic circuits:* MMF equation, reluctance, comparison between electric and magnetic circuits, flux leakage and fringing, flux linkage, inductance, mutual inductance and energy.	8 (2 weeks) W01 to W02	**[1]** Chapter-1 or **[2]** Chapter-2 or **[3]** Chapter-1 or **[4]** Chapter-1

2	**Transformers:** Introduction; Working principle: electromagnetic induction, mutual inductance, dot convention, transformer equation; Types and construction of transformers; ideal transformer under no load and load; real single phase transformer under no load and load; equivalent circuit of single phase transformer; determining equivalent circuit parameters: OC and SC test; transformer voltage regulation and efficiency; Auto-transformer: basic configuration, voltage and current relationship, apparent power rating; Three phase transformer: construction and working principle, Y-Y, Y-Δ, Δ-Y and Δ-Δ configurations, parallel operation; The per unit system and its application to analyzing transformers;	22 (6 weeks) W03 to 08	**[1]** Chapter-2 or **[2]** Chapter-3 Or **[3]** Chapter-2 or **[4]** Chapter-2
3	**Three Phase Induction Motors – Introduction, construction and operation:** *Introduction:* rotational mechanics, voltage induced in simple rotating loop, torque in current carrying loop. *Construction details:* stator, air-gap and rotor; slip ring and wound rotor induction motors. *Working principle:* rotating magnetic field (RMF), direction and speed of RMF; rotor induced emf, frequency of rotor induced emf, slip; Comparison of transformers and induction motors.	11 (3 weeks) W10 to 12	**[2]** Chapter 5 (5.1,5.2, 5.5, 5.6, 5.10), Chapter 9 (9.1 to 9.3) Or **[4]** chapter 4 (4.1, 4.2, 4.7), chapter 7 (7.1, 7.2)
4	**Analysis and performance of three phase induction motors:** Equivalent circuit of induction motors; Torque-speed characteristic, starting torque, condition for maximum torque; Power and torque in induction motors; losses and power flow diagram; determination of equivalent circuit parameters: no load and block rotor test; circle diagram; induction motor performance characteristics: load test. Starting of three phase induction motors; speed control of three phase induction motors; intro to solid state induction motor drive; breaking of induction motor. Induction generator.	15 (4 weeks) W13 to W16	**[2]** Chapter 9 Or **[1]** Chapter 6 Or **[4]** Chapter 7
5	**Single phase induction motors:** Introduction, double-revolving field, starting of single-phase induction motor, speed control of single-phase induction motors, circuit model of a single-phase inductor motor.	3 (1 weeks) W17	**[4]** Chapter-10 (10.1 to 10.5)

11. **Lab Coverage Plan & Details (Lab is integrated):**

- S1 Section: Tuesday (S1-B1) & Thursday (S1-B2), 2:00 PM – 4:45 PM.
- S2 Section: Monday (S2-B1) & Wednesday (S2-B2), 2:00 PM – 4:45 PM.

Lab Cycle	Syllabus covering or contents	Approx. no. of Lab classes
0	**4 Training Experiments (TE) – To gain familiarity with equipment, wiring, and lab practices:** • Verification of Superposition Theorem in a given AC circuit.	2 Lab Classes (2 weeks) W02 to W03

	• Verification of Thevenin's Theorem in a given AC circuit. • Voltage, Current, and Power Measurement in a given single-phase AC circuit. • Voltage, Current, and Power Measurement in a given three-phase AC circuit using the two-wattmeter method	
1	**Cycle-1 lab experiments: Transformers** • OC & SC tests on single-Phase transformers • Sumpner's test • Scott Connection • Open Delta connection of single-phase transformers	4 Lab Classes (4 weeks) W04 to W07
	Repetition of lab experiments	W08
2	**Cycle-2 lab experiments: Induction Motors** • Load Test of Three-Phase Induction Motor • Load Test on Three Phase Slip Ring Induction Motor • Circle Diagram of Induction Motor • Load Test on Single Phase Induction Motor	4 Lab Classes (4 weeks) W10 to W13
	Repetition of lab experiments	W14 & W15
	End Semester Lab Exam shall be held as per the lab schedule	W16

- Each lab session lasts 2.5-3 hours, during which students will complete one experiment per lab session for cycle 1 and 2, however, for cycle 0, the students must complete two experiments per lab session. Each student will attend one lab session per week.
- The lab will be organized into 4 Groups, each comprising a maximum of 7 to 8 students. If an experiment has two setups, each group will be further divided into two sub-groups of 3 to 4 students each.
- Students will conduct the experiments during their designated lab sessions.
- After completing the experiments, students will analyze their results and maintain a lab record with details of the experiments performed.

Batches/Groups	**TE (Cycle-0)**		**Cycle-1**				**Cycle-2**			
	W02	**W03**	**W04**	**W05**	**W06**	**W07**	**W10**	**W11**	**W12**	**W13**
B1/B2:Group-G1	Exp-1 & 2	Exp-3 & 4	Exp-1	Exp-2	Exp-3	Exp-4	Exp-1	Exp-2	Exp-3	Exp-4
B1/B2:Group-G2	Exp-2 & 3	Exp-4 & 1	Exp-2	Exp-3	Exp-4	Exp-1	Exp-2	Exp-3	Exp-4	Exp-1
B1/B2:Group-G3	Exp-3 & 4	Exp-1 & 2	Exp-3	Exp-4	Exp-1	Exp-2	Exp-3	Exp-4	Exp-1	Exp-2
B1/B2:Group-G4	Exp-4 & 1	Exp-2 & 3	Exp-4	Exp-1	Exp-2	Exp-3	Exp-4	Exp-1	Exp-2	Exp-3

12. **Text Books:**

[1] A.E. Fitzgerald, Charles Kingsley Jr., and Stephen D. Umans, "Electric Machinery," 7th Edition, McGraw-Hill Education, 2014

[2] D.P. Kothari and I.J. Nagrath, "Electric Machines," 4th Edition, McGraw-Hill Education (India), 2010.

[3] S. K. Sahdev, "Electrical machines," Cambridge University Press, 2018.

[4] S.J. Chapman, "Electric Machinery Fundamentals," 4th Edition, McGraw-Hill Education, 2010.

13. **Evaluation plan** (Details of evaluation plan including the weightages)

Quizzes (Two)	10%
Quiz-1: W06, Friday, 28th August 2026, 4:00 to 5:00pm	
Quiz-2: W15, Friday, 30th October 2026, 4:00 to 5:00pm	
Assignments	
Any homework exercises during the course delivery shall be created as Assignment	
Lab Component,	**30% [20%+10%]**
Mid-sem exam	20%
End-sem exam	40%

14. **Lab Component: Detailed Evaluation plan:**

Lab in-semester Performance		**Weightage**
Component	**Marks**	
Conduction & Observation Book	07	Per Experiment
Viva	08	
Lab Record	10	
*Compliance with Laboratory Instructions and Guidelines	05	
Total	30	20%
End Semester Lab Exam shall be held as per the lab schedule of W16	30	10%
Total		30%

***Compliance with Laboratory Instructions and Guidelines:** This component shall be evaluated based on the student's compliance with laboratory rules and instructions. A student shall be awarded **Zero (0) marks** out of **05 marks** under this component if any of the following is observed during the laboratory session:

- Carrying or using a mobile phone in the laboratory.
- Any disturbance caused by a mobile phone, including ringing, vibration, alarms, etc.
- Failure to follow laboratory safety instructions.
- Failure to follow the instructions of the Faculty Coordinator or Teaching Assistants (TAs).
- Any other act of indiscipline or non-compliance with laboratory regulations as determined by the Faculty Coordinator.

Signature of Instructor(s) (With Date)	Signature of Secretary DUGC	Signature of Chairman DUGC (With Dept-Seal & Date)