

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
HYDERABAD CAMPUS
FIRST SEMESTER 2019-2020
Course Handout

01.08.2019

In addition to general handout for all courses appended to the time table, this portion gives further specific details regarding the course.

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| Course No. | : EEE F211, ECE F211, INSTR F211 |
| Course Title | : ELECTRICAL MACHINES |
| Instructor-in-charge | : Dr. Alivelu M Parimi |
| Team of instructors | |
| Lecture | : Dr. Alivelu M Parimi, Dr. Mithun Mondal |
| Tutorial | : Dr. Alivelu M Parimi, Dr. Mithun Mondal |
| Practical | : Dr. Alivelu Manga Parimi, Dr. Mithun Mondal, Dr. Radhika Sudha, Dr. Syed Ershad Ahmed |

1. **Scope and objective of the Course:** To obtain an insight on the principles and performance of the Electrical Machines. To obtain a thorough knowledge on the performance and control of transformers, induction machines, dc machines, synchronous machines during normal and extreme working conditions.

Transformer: Constructional features, Equivalent circuit and phasor diagram, Regulation and efficiency, Parallel operation, Three phase transformer connections, Testing - open circuit, short circuit and Sumpner's test, Phase conversion – Scott Connection, Autotransformer.

DC Machines: Construction, principle of operation, armature windings, armature voltage and torque equations, classification and applications. DC generators- armature reaction and performance characteristics; DC motors - torque/speed characteristics, speed control and braking, Testing and efficiency.

Induction machines: Constructional features and classification, Rotating magnetic field, Equivalent circuit model. Steady state characteristics. Testing, starting and speed control. Wound rotor induction motors, Single phase induction motors - classification and equivalent circuit.

Synchronous machines: Constructional features and classification, Synchronous generators and motors, Armature Reaction, Equivalent circuit and phasor diagram, Power and torque characteristics, Parallel operation. Synchronous impedance and its determination, Starting and speed control of synchronous motors.

2. **Text Book :**

1. Nagrath I J and D P Kothari - Electric Machines – Tata McGraw Hill, 4th edition, 2010.
2. Electrical Machines Laboratory Manual.

3. **Reference Books :**

1. Edward Hughes, Electrical and Electronics Technology, Pearson, 5th edition 2012
2. Stephen J. Chapman, Electric Machinery Fundamentals, McGraw Hill, 4th Edition, 2005
3. P.C. Sen, Principles of Electric Machines and Power Electronics, John Wiley & Sons, 2nd Edition 1996
4. M.G. Say – Performance and Design of AC machines – Pitman

4. **Course Plan :**

| Lec. No. | Learning Objectives | Topic to be covered | Chapter in the Text Book |
|-----------------|--|--|--|
| 1-2 | Overview of the course and Study of magnetic circuits, | Magnetic Circuits Review | 2.1 to 2.2 , 5.1 of T1 7.1 to 7.8 of R1 1.1 to 1.3 of R3 |
| 3-6 | To learn working of DC Machines | DC Machines principle of operation, Construction and classification, Armature winding, Armature reaction | 7.1 to 7.11 of T1 41.1 to 41.6 of R1 4.2 to 4.3 of R3 |
| 7 | To review principle of operation of DC motor and its characteristics | Shunt, series & compound motors | 7.12 to 7.15 of T1 42.1 to 42.6 of R1 4.4 of R3 |
| 8-9 | Starting , Braking and Speed Control of DC motors | Shunt motor starter step calculation, Speed control, Plugging, Dynamic & Regenerative braking | 7.16 to 7.18 of T1 42.7 of R1 9.4 of R2 4.4 of R3 |
| 10-11 | Performance evaluation of DC machines | Efficiency & Testing of DC machines | 7.19, 7.20 of T1 |
| 12-15 | Transformer operation | Construction, Principle of operation, Equivalent circuit, Phasor diagrams, voltage regulation, efficiency, No-load, full-load and Sumpner's test | 3.1 to 3.9, 3.12 of T1 34.1 to 34.19, of R1 2.1 to 2.4 of R3 |
| 16 | To learn about Auto-transformer | Use & Analysis | 3.11 of T1 34.21 of R1 2.5 of R3 |
| 17-18 | To learn three phase transformer operation | Connections, Phasor groups ,Applications and per unit system | 3.13 of T1 2.10 of R2 2.6 to 2.8 of R3 |
| 19 | To learn parallel operation of transformers | Parallel operation and Load sharing | 3.14 of T1 |
| 20 | To learn about phase conversions and tap changing in transformers | Three phase to two phase conversions (Scott connection) and Tap changing in transformers | 3.16 to 3.17 of T1 2.11 of R2 |
| 21-24 | To learn about principle of | Construction, Classification, Rotating | 9.1 to 9.3 of T1 |

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| | operation of three phase induction machine | Magnetic Field , Slip and frequency of rotor currents ,Equivalent Circuit Model , Power Flow and Torque slip characteristics. | 36.5 to 36.6 and 38.1 to 38.5 of R1 5.1 to 5.7 and 5.9 to 5.10 of R3 |
| 25-29 | To learn about testing starting , speed control and braking of three phase induction motor | No-Load and short circuit tests, Starting, Speed control, plugging and regeneration | 9.6 to 9.10 of T1 38.6 to 38.10 of R1 5.8 , 5.13 to 5.14 of R3 |
| 30-31 | Single phase induction motor | Operation & characteristics of single phase induction motor | 10.1 to 10.2 of T1 38.11 to 38.14 of R1 7.1 and 7.3 of R3 |
| 32-35 | To learn about synchronous machines | Operation, circuit model, armature reaction, synchronous impedance and its determination | 8.1 to 8.6 of T1 36.1 to 36.4 and 37.1 to 37.3 of R1 6.1- 6.2 and 6.4 of R3 |
| 36-40 | To learn about synchronizing , operating characteristics of and Power transfer in a synchronous generator | Synchronizing to infinite bus bar, Operating characteristics, Power angle characteristics, Operation at constant load with variable excitation, Power flow equation, power angle characteristics and Parallel operation | 8.7 to 8.9 of T1 37.4 of R1 6.5 of R3 |
| 41-42 | To learn about starting and speed control of synchronous motor. | Starting and speed control techniques of synchronous motor , Application of Synchronous condenser | 8.10 to 8.12 of T1 37.6 of R1 6.3,6.7 and 6.10.1 of R3 |

5. **Evaluation Scheme:**

| Component | Duration | Weightage | Date & Time | Nature of Component |
|------------------------------|--------------------------|------------------------|---------------------------|----------------------------|
| Midterm | 90 mins | 75 Marks (25%) | 5/10, 9.00 -- 10.30 AM | CB |
| LAB Component | Day to Day Evaluation | 30 Marks (10%) | Timetable | OB |
| | Lab Exam | 30 Marks (10%) | Will be announced | CB |
| Quizzes (3) | Will be announced | 45 Marks (15%) | Will be announced | CB |
| Comprehensive Examination | 3 Hrs | 120 Marks (20%+20%) | 13/12 FN | CB+OB |

6. **Make-up Policy:** Only those who apply (with genuine reason) **before the start of test** (prior to 24 hours) will be granted permission for make-up.
7. **Notices:** Notices concerning this course will be displayed on CMS.
8. **Academic Honesty and Integrity Policy:**
Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor-in-charge
EEE F211/ECE F211/INSTR F211