GUJARATECHNOLOGICALUNIVERSITY

Program Name: Bachelor of Engineering

Power Electronics Engineering

Level: UG

Subject Code: BE04024031

Subject Name: Electrical Machine and Applications- II

W.E.F. Academic Year:	2024-25
Semester:	4
Category of the Course:	PCC

Prerequisite:	Basic Electrical Engineering, Electrical Machines and Applications I
Rationale:	Electrical machines are the cornerstone of energy conversion systems and industrial automation. This course is designed to provide undergraduate engineering students with a comprehensive understanding of the construction, operation, performance, and applications of various electrical machines, including induction motors, synchronous machines, and special-purpose motors.

Course Outcomes:

After Completion of the Course, Student will be able to:

No	Course Outcomes	% Weigh tage
01	Analyze machine behavior under different operating conditions	20
02	Interpret performance characteristics using equivalent circuits and phasor diagrams	20
03	Apply testing methods to evaluate efficiency, losses, and voltage regulation	20
04	Understand control strategies and starting techniques for motors	20
05	Explore emerging technologies in special electrical machines	20

*RM:Remember,UN:Understand,AP:Apply,AN:Analyze,EL:Evaluate,CR:Create

Teaching and Examination Scheme:

Teaching-Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial/Practical			
L	T	P	TW/SL	TH		ESE (E)	PA (M)	PA/ (I)	TW/ SL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

* **Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.**

Course Content:

Sr.No.	Course Content	No.of Hours
1.	**Synchronous machines:** Constructional Details, Working Principle, Types of rotor (cylindrical and salient pole),Rotating Magnetic Field, EMF equation, Armature winding(Effect of distribution factor, pitch factor). Armature Reaction, its effects and remedies. AC Generator (Alternator): equivalent circuit &Phasor diagram of synchronous machine as generator in different load conditions (R,L,C), Armature reaction and its compensation, Power output equation. SCR and its effects, Voltage Regulation, Methods to find voltage regulation: Synchronous impedance method, MMF method, ZPF method, Operating characteristics of synchronous machines, Effects of harmonics on induced emf, Salient pole machine – two reaction theory, power angle characteristics, Sudden short circuit and unbalance conditions, Hunting, Losses and efficiency, Parallel Operation and Synchronization, Operation on load &infinite bus.	13
2.	**Synchronous motors:** Expression for torque, Phasor diagram of Synchronous motor, Starting methods of synchronous motor, Speed regulation, Effect of excitation, Losses and efficiency of motor, Application of synchronous motor as phase modifier and synchronous condensers. V-curvesof Synchronous motors, Power developed by Synchronous motors and stability, Power stages	06
3.	**Three Phase induction motor:** Construction, types, rotating magnetic field, principle of operation, slip, frequency of rotor current, rotor EMF, rotor current, expression for torque, conditions for maximum torque, torque slip characteristics, starting torque in squirrel cage and slip ring motors, effect of change in supply voltage on torque, slip and speed , relation between full load torque and maximum torque, Power stages in induction motor, vector diagram and equivalent circuit, circle diagram, construction and calculation, speed control of 3 phase motor, starting methods for 3 phase induction motors, need for starter and types of starter, applications Induction generator- Introduction & Operating Principle, Machine Construction & Types, Equivalent Circuit & Performance Characteristics, Grid Integration & Control Strategies, Applications	12
4.	**Single phase induction motor:** Double revolving field theory, starting methods, no load and block rotor test, equivalent circuit, types of single-phase motor, applications.	04

5.	**Special Machines:** General construction, Principle, working, characteristics and applications. AC & DC Servo motors. Amplidyne and Metadyne, Printed Circuit Motors, Synchros, Linear Induction Motor, Switched Reluctance Motors, Synchronous Reluctance Motors, Permanent Magnet Synchronous Motors.	10
Total		45

Reference Books:

1. Miller, T.J.E. “Brushless permanent magnet and reluctance motor drives”, Clarendon Press, Oxford, 1989.
2. Kenjo.T, “Stepping motors and their microprocessor control”, Oxford University Press, 1995.
3. R.Krishnan, “Electric Motor Drives - Modeling, Analysis and Control”, Prentice Hall of India Pvt. Ltd., New Delhi, 2009.
4. Kenjo.T and Naganori, S “Permanent Magnet and Brushless DC motors”, Clarendon Press, Oxford, 1989.
5. B.K. Bose, “Modern Power Electronics & AC drives”, Dorling Kindersley India, 2006.DigitalLogicandComputerDesignbyMMorrisManoFourthEdition,PrenticeHall Publication
6. E. Fitzgerald and C. Kingsley, "Electric Machinery”, New York, McGraw Hill Education, 2013.
7. I J Nagrath and D. P. Kothari, “Electric Machines”, McGraw Hill Education, 2010.
8. J B Gupta, “Theory and Performance of Electrical Machines”, Katson Publication, 2009.
9. B L Theraja, “Electrical Technology – Part II”, S Chand Publications, 2011
10. M. G. Say, “Performance and design of AC machines”, CBS Publishers, 2002.
11. P. S. Bimbhra, “Electrical Machinery”, Khanna Publishers, 2011.
12. G C Garg, “Electrical machines – II”, Khanna Publishers,
13. S K Sen, “Principle of Electrical Machine Design with Computer Programs” Oxford & IBH

Suggested Course Practical List:

1. To find out the voltage regulation of three phase alternator using direct load test.
2. To perform open circuit, short circuit and resistance measurement tests on alternator to find out its voltage regulation using synchronous impedance method and MMF method.
3. To perform open circuit, short circuit, zero power factor and resistance measurement tests on alternator to find out its voltage regulation using ZPF method.
4. To perform synchronization of two 3 phase Alternators.
5. To obtain direct axis and quadrature axis reactance of salient pole synchronous machine using slip test.
6. To plot V curves and inverted V curves of Synchronous Motor.
7. To perform Step Angle and Position Control of Switched Reluctance Motor (SRM)
8. Permanent Magnet Synchronous Machine (PMSM)
9. To find the voltage regulation of synchronous machines.
10. To study capacitors, start and capacitor run induction motor.

List of Laboratory/Learning Resources Required:

1. DC Power Source, Function Generator, DSO / Logic analyzer, Multimeter

2. Discretecomponentslikebreadboard,switches,LEDs,Buzzers,singleleadwires(connectors), various digital ICs or Trainer board
3. Open-source software: Pspice and NGspice based simulation software like KiCAD,Scilab,IITVirtualLaboratory
4. Learning resources:NPTELwebsite courses

nptel.ac.in/courses/108105017, nptel.ac.in/courses/108105155, nptel.ac.in/courses/108106071, nptel.ac.in/courses/108105131 , nptel.ac.in/courses/108106072

- **Activities suggested under Problem Based Learning:**

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/ Research laboratory visit	Visit = 5h, Report preparation = 5h Total= 10h	Based on report submitted. Report should contain observations and calculations based on industry/ labdata.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation=5h Total= 10h	Report /presentation based on video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total=10h	Based on the assignment submitted.
4.	Problem solving/Coding usingC, C++, Python, SCILAB, MATLAB,MS-EXCELorany other relevant software	5 small coding-based assignments of 2h each. Total = 10h	Based on the coding solution submitted.
5.	Self-learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course based on the certificate produced.
6.	Complex problem solving	Maximum 2 problems. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
7	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation=5h Total= 10h	Based on quiz/report submitted
8	Discussion on research paper based on relevant subject	5researchpapers =20 h	Summarize research paper and evaluation critical parameters

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
9.	Poster/chart /power point preparation on technical topics	Duration=6h	Based on poster / chart Preparation and presentation skills
10	Working/non-working model on technical topics	Working = 12 h non-working=8h	Based on inter department/ external evaluation
11	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/ environment/ health/ any other issue	Duration = 10 h for industrial exposure Problem identification and tentative solution = 10 h Total= 20 h	Based on evaluation of critical problems and solutions
12	Group Discussion on emerging/trending technical topics based on subject	Duration=1h each	Based on performance in group discussion, technical Depth knowledge etc.
13.	Real world case studies-based learning	Duration of data collection/study = 5h Report preparation=5h Total= 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
14.	Application/Software development	Duration=10h	Depending on the complexity of the Application/Software

Note:

- All the suggested activities should be related to the subject.
- Thenumberofhoursaresuggestive.Facultycansub-dividethenumberofhoursbasedonthe activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective record-keeping and to ensure transparency in the evaluation and assessment of self-learning activities.

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