Course Objectives

CMR Institute of Technology, Bangalore		
Department(s): Electrical and Electronics Engineering		
Semester: 04	Section: A, B	Lectures/week: 05
Subject: Engineering Mathematics IV		Code: 15MAT41
Course Instructors: Dr.K.Meenakshi & R.Revathi		
Course duration: 05 Feb 2018 – 23 May 2018		
Course Site: https://sites.google.com/a/cmrit.ac.in/dr-k-meenakshi-maths/home/engg-maths iv		

- The purpose of this course is to make students well conversant with numerical methods to solve ordinary differential equations, complex analysis, sampling theory and joint probability distribution and stochastic processes.

Prerequisites

- Basic Differential and Integral Calculus
- Power series expansions of functions
- Limits, Continuity and differentiability of functions of real variables
- Complex numbers-Representation in Cartesian and polar forms, algebra of complex numbers
- De Moivre theorem
- Basics of Probability
- Mean, Standard deviation of ungrouped data.

Lesson Plan

Lecture #	Book & Sections	Topics	Portions coverage	
			Teaching Aids	% of Syllabus Covered
1-8	TB1: 32.1,32.3, 32.5,32.7, 32.9, 32.10 TB1: 32.12	**Numerical Methods (Module-1 & 2)** Numerical Solution of 1st Order ODE- Taylor Series method, Modified Euler method, Runge-Kutta method, Milne's and Adams Bashforth methods Solution of second order differential equations- Runge-Kutta method, Milne's method	Chalk and Talk	20

Links to some useful online lectures:

- Introduction to complex functions: https://www.youtube.com/watch?v=iUhwCfz18os
- Conformal maps: https://www.youtube.com/watch?v=CMMrEDIFPZY

09-25	TB2: 13.1,13.2 TB1: 20.1-20.5, 20.7-20.10, 20.12-20.14, 20.18	**Complex Variables (Module-3)** Function of a complex variable, limits, continuity, differentiability Cauchy-Riemann equations in polar form, problems, Evaluation of line integrals, Cauchy's theorem, Evaluation of integrals, Evaluation of residues at poles, Evaluation of integrals using residue theorem Problems on BLT, The mapping $w = e^z$, $w = z + 1/z$, $(z \neq 0)$	Chalk and Talk	27
Links to some useful online lectures: ➢ Euler Method for Differential Equations - the basic idea: https://www.youtube.com/watch?v=RGtCw5E7gBc				
26-40	TB1 26.7 - 26.16, 2.19(6) TB2:24.2, 24.3 RB2:31.1	**Probability Distributions (Module-4)** Probability- prerequisites, Random variables and probability distributions, Discrete probability distributions- mean and variance, problems. Continuous probability distributions- mean and variance, problems. Binomial Distribution, mean and variance of binomial distribution, Problems on binomial distribution, Poisson distribution, mean variance of Poisson distribution, Exponential distribution, Normal distribution, mean and variance of normal distribution Problems on normal distribution. **Joint probability distributions:** expectation, covariance, correlation coefficient Problems on joint probability distributions.	Chalk and Talk	20
Links to some useful online lectures: ➢ Prerequisites: https://www.youtube.com/watch?v=uzkc-qNVoOk&list=PLC58778F28211FA19 ➢ Random variables: https://www.youtube.com/watch?v=IYdiKeQ9xEI				
41-51	RB2: 31.2 TB1: 27.1 - 27.18	**Stochastic processes and Sampling theory (Module-5)** Stochastic processes- Introduction, regular stochastic matrix, Markov chain, transition matrix, problems on Markov Chain. Sampling theory- Introduction, sampling distribution of means and proportions , problems. Test of hypothesis and confidence intervals for means and proportions, problems. Test of hypothesis for difference of means and proportions, problems. Small samples- Student's t-distribution. Test of goodness of fit : Chi-square distribution.	Chalk and Talk, Video lectures (flipped class)	20
Links to some useful online lectures: ➢ Sampling distribution : https://www.youtube.com/watch?v=olK80ngCbXc ➢ Confidence Intervals: https://www.youtube.com/watch?v=9jTJD5SLweY ➢ Testing hypotheses: https://www.youtube.com/watch?v=vwWEa8wU_6U				

➢ Introduction to Markov chains: https://www.youtube.com/watch?v=AaP8Zr0yoF4&t=151s				
52-60	TB1:16.1, 16.2,16.4-16.8,16.11,16.13,16.14	**Special Functions (Module-2)** Series solution of Legendre's differential equation leading to $P_n(x)$, Rodrigue's formula, Legendre polynomials, problems. Series solution of Bessel's differential equation leading to $J_n(x)$ by Frobenius method, properties of Bessel functions, recurrence relations, problems, Orthogonality of Bessel functions.	Chalk and Talk	13
Links to some useful online lectures: ➢ Series solution of o.d.e: https://www.youtube.com/watch?v=c3XtwTsE7QY ➢ Legendre's o.d.e: https://www.youtube.com/watch?v=3e5BUrtUKZc&t=11s ➢ Introduction to the Frobenius method: https://www.youtube.com/watch?v=_qQLuxYClA4				

Text Books	
1. 2.	B.S.Grewal: Higher Engineering Mathematics, Khanna Publishers, 43rd edition, 2015 E.Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 10th Edition, 2015.
Reference Books	
1.	N.P.Bali and Manish Goyal: A Text Book of Engineering Mathematics, Laxmi Publishers,
2.	*B.V.Ramana: "Higher Engineering M athematics" Tata McGraw-Hill, 2006.*
3.	*H. K. Dass and Er. RajnishVerma: "Higher Engineerig Mathematics", S. Chand publishing, 1st edition, 2011.*

Syllabus for Internal Assessment Tests (IAT*)

IAT #	Syllabus
IAT-1	Class # 01 – 20
IAT-2	Class # 21– 41
IAT-3	Class # 42– 60

*See calendar of events for IAT schedule.

Course Outcomes
By the end of this course, students will be able to
1. Use appropriate single-step and multi-step numerical methods to solve first and second order ordinary differential equations.
2. Use Power Series method and Frobenius method to find the solution of second order differential equations such as Legendre and Bessel differential equations.
3. Apply the idea of analyticity and the calculus of residues to evaluate real and complex integrals and to describe conformal transformations.
4. Describe random variables and probability distributions using rigorous statistical methods and translate real-world problems into probability models.
5. Explain and successfully apply parametric testing techniques including single and multi-sample tests for mean and proportion.
6. Estimate the nature and strength of relationship between two variables of interest using joint probability distribution and describe a discrete time Markov chain in terms of a transition matrix.

**Based on table 01, 02, 03 in appendix, following are the Course outcomes.

Course Outcomes		Modules covered	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Use appropriate single-step and multi-step numerical methods to solve first and second order ordinary differential equations.	**1,2**	3	3	1	1	-	1	-	-	1	-	-	1	1	-	1
CO2	Use Power Series method and Frobenius method to find the solution of second order differential equations such as Legendre and Bessel differential equations.	**2**	1	3	-	-	-	-	-	-	1	-	-	2	1	-	1
CO3	Apply the idea of analyticity and the calculus of residues to evaluate real and complex integrals and to describe conformal transformations.	**3**	2		-	-	-	-	-	-	1	-	-	-	-	-	1
CO4	Describe random variables and probability distributions using rigorous statistical methods and translate real-world problems into probability models.	**4**	3	2	-	2	-	-	-	-	1	-	-	-	-	-	1
CO5	Explain and successfully apply parametric testing techniques including single and multi-sample tests for mean and proportion.	**5**	2	2	-	1	2	-	-	-	1	-	-	2	1	-	1
CO6	Estimate the nature and strength of relationship between two variables of interest using joint probability distribution and describe a discrete time Markov chain in terms of a transition matrix.	**5**	3	2	-	1	-	-	-	-	1	-	-	-	1	1	1

Note: Assignments, study material, Question bank and other course related content would be posted on site mentioned above.

Signature with date: | **Course Instructor** **Program Coordinator** **Head-CSE**

Appendix

Table 01: Cognitive Levels

Cognitive Levels	
Cognitive level	**Revised Blooms Taxonomy Keywords**
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.

L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

Table 02: Program Outcomes (PO) and Program Specific Outcomes (PSO)

Program Outcomes (PO), Program Specific Outcomes (PSO)	
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Apply electrical and electronic principles to circuits, machines, power systems and control systems
PSO2	Develop solutions in the areas of industrial automation, green energy systems and smart grids
PSO3	Able to contribute to project teams in the core and associated domains of electrical and electronic technology

Table 03: Correlation Levels

Correlation Levels	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High

CMR Institute of Technology, Bangalore		
Department(s): Electrical & Electronic Engineering		
Semester: 04	Section(s): A&B	Lectures/week: 04
Subject: Power Generation & Economics		Code: 15EE42
Course Instructor(s): Sudhakar Vitta		
Course duration: 05 Feb 2018 – 25 May 2018		
Course Site: https://sites.google.com/a/cmrit.ac.in/sudhakar-vitta/		

Course Objectives

- Explain the arrangement and operation of hydroelectric, steam, diesel, gas turbine and nuclear power plants and working of major equipment in the plants.
- Classification of substation and explain the operation of different substation equipment.
- Explain the importance of grounding and different grounding methods used in practice.
- Explain the economics of power generation and importance of power factor.

Pre requisites

- Basic Electrical Engineering

Lesson Plan

Lecture #	Book & Sections	Topics	Portions coverage	
			Teaching Aids	% of Syllabus Covered
1-10	TB1: 2.1- 2.17	**Module-1 Hydroelectric Power Plants:** Hydrology, Run off and stream flow, Hydrograph, Flow duration curve, Mass curve, Reservoir capacity, Dam storage. Hydrological cycle, Merits and demerits of hydroelectric power plants, Selection of site. General arrangement of hydel plant, Elements of the plant, Classification of the plants based on water flow regulation, Water head and type of load the plant has to supply. Water turbines – Pelton wheel, Francis, Kaplan and propeller turbines. Characteristic of water turbines Governing of turbines, Selection of water turbines. Underground, Small hydro and pumped storage plants. Choice of size and number of units, Plant layout and auxiliaries.	Chalk and Talk Video Lectures/ Display	20

- https://www.youtube.com/watch?v=-hooifWJ1jY
- https://www.youtube.com/watch?v=q8HmRLCgDAI
- https://www.youtube.com/watch?v=JMh4s3UKPxU
- https://www.youtube.com/watch?v=tpigNNTQix8

11-20	TB1 3.1 - 3.20 TB1 5.1 - 5.9 TB1 6.1 - 6.12	**Module-2 Steam Power Plants:** Introduction, Efficiency of steam plants, Merits and demerits of plants, Selection of site. Working of steam plant, Power plant equipment and layout, Steam turbines, Fuels and fuel handling, Fuel combustion and combustion equipment, Coal burners, Fluidized bed combustion, Combustion control, Ash handling, Dust collection, Draught systems, Feed water, Steam power plant controls, Plant auxiliaries. **Diesel Power Plant:** Introduction, Merits and demerits, Selection site, Elements of diesel power plant, Applications. **Gas Turbine Power Plant**: Introduction, Merits and demerits, Selection site, Fuels for gas turbines, Elements of simple gas turbine power plant, Methods of improving thermal efficiency of a simple steam power plant, Closed cycle gas turbine power plants. Comparison of gas power plant with steam and diesel power plants.	Chalk and Talk Video Lectures/ Display	20

Links to some useful online lectures:

- https://www.youtube.com/watch?v=IdPTuwKEfmA
- https://www.youtube.com/watch?v=lh5_7sHyLU4
- https://www.youtube.com/watch?v=xokHLFE96h8
- https://www.youtube.com/watch?v=uFDb9AQQSgo
- https://www.youtube.com/watch?v=D0i1E_lE_TE
- https://www.youtube.com/watch?v=rEJKiUYjW1E
- http://www.dailymotion.com/video/x2w45o9
- https://www.youtube.com/watch?v=vQQ6ENLeC5Q
- https://www.youtube.com/watch?v=IVHyKg6sydk
- https://www.youtube.com/watch?v=r9q80sSHxKM

21-30	TB1 4.1 - 4.15	**Module-3 Nuclear Power Plants:** Introduction, Economics of nuclear plants, Merits and demerits, selection of site, Nuclear reaction, Nuclear fission process, Nuclear chain reaction, Nuclear energy, Nuclear fuels, Nuclear plant and layout, Nuclear reactor and its control, Classification of reactors, Power reactors in use, Effects of nuclear plants, Disposal of nuclear waste and effluent, Shielding.	Chalk and Talk Video Lectures/ Display	20

Links to some useful online lectures:

- https://www.youtube.com/watch?v=_UwexvaCMWA
- https://www.youtube.com/watch?v=1U6Nzcv9Vws
- https://www.youtube.com/watch?v=yx_XoqXNtRM

31-40	TB1 17.1- 7.11 of Part-III TB1 15.12-15.24 of Part-III	**Module-4 Substations:** Introduction to Substation equipment; Transformers, High Voltage Fuses, High Voltage Circuit Breakers and Protective Relaying, High Voltage Disconnect Switches, Lightning Arresters, High Voltage Insulators and Conductors, Voltage Regulators, Storage Batteries, Reactors, Capacitors, Measuring Instruments and power line carrier communication equipment. Classification of substations – indoor and outdoor, Selection of site for substation, Busbar arrangement schemes and single line diagrams of substations. Interconnection of power stations. Introduction to gas insulated substation, Advantages and economics of Gas insulated substation. **Grounding:** Introduction, Difference between grounded and ungrounded system. System grounding – ungrounded, Solid grounding, Resistance grounding, Reactance grounding and resonant grounding. Earthing transformer. Neutral grounding and neutral grounding transformer.	Chalk and Talk Video Lectures for some topics	20
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=5RwtTbAtH9I ➢ https://www.youtube.com/watch?v=ZU4y6vsabP4				
41-50	TB1 11.1 - 11.9	**Module-5 Economics:** Introduction, Effect of variable load on power system, classification of costs, Cost analysis. Interest and Depreciation, Methods of determination of depreciation, Economics of Power generation, different terms considered for power plants and their significance, load sharing. Choice of size and number of generating plants. Tariffs, objective, factors affecting the tariff, types. Types of consumers and their tariff. Power factor, Disadvantages and causes of low power factor, Methods of improving power factor, Economics of power factor improvement and comparison of methods of improving the power factor. Choice of equipment.	Chalk and Talk	20

Text Book	
1.	A Course in Power Systems: J.B. Gupta: Katson Publications: 10th Edition: 2010
Reference Books	
2.	Generation of Electrical Energy: B.R.Gupta: S. Chand Publications: 2015
3.	Electrical power Generation, Transmission and Distribution: S.N. Singh: PHI: 2nd Edition: 2009
4.	Power Plant Engineering: P.K. Nag: Mc Graw Hill: 4th Edition: 2014
5.	Electrical Power Distribution Systems: V. Kamaraju: Mc Graw Hill: 1st Edition: 2009
6.	Electrical Distribution Engineering: Anthony J.Pansini: CRC Press: 3rd Edition: 2006
7.	Electrical Distribution Systems: Dale R Patrick Et al: CRC Press: 2nd Edition: 2009
8.	A Text Book on Power System Engineering: A.Chakrabarti, et al: Dhanpath Rai: 2nd Edition: 2010

Syllabus for Internal Assessment Tests (IAT*)

IAT #	Syllabus
IAT-1	Class # 01 – 20
IAT-2	Class # 21– 40
IAT-3	Class # 41– 50

*See calendar of events for IAT schedule.

Course Outcomes
By the end of this course, students will be able to
1. Describe the working of hydroelectric, steam, nuclear power plants and state functions of major equipment of the power plants
2. Classify various substations and explain the importance of grounding.
3. Understand the economic aspects of power system operation and its effects.
4. Explain the importance of power factor improvement.

**Based on table 01, 02, 03 in appendix, following are the Course outcomes.

Course Outcomes		Modules covered	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Describe the working of Hydro Electric power plant and its Equipments	**1**	1	-	2	-	2	-	-	-	1	-	-	-	-	1	-
CO2	Describe the working of Steam ,diesel and Gas Turbine power plants	**2**	1	-	2	-	2	-	-	2	1	-	-	-	-	1	1
CO3	Analyze the working of a Nuclear power plant and give the function of its various Equipments	**3**	2	-	2	-	2	-	-	2	1	-	-	-	-	2	2
CO4	Classify various substations and explain the importance of Grounding	**4**	3	-	3	-	-	-	-	-	1	-	-	-	3	2	2
CO5	Understand the economic Aspects of power system	**5**	3	-	3	-	-	-	-	-	1	-	-	-	3	2	2
CO6	Explain the importance of power factor improvement.	**5**	2	-	3	-	-	2	-	-	1	-	-	-	2	2	2

Note: Assignments, study material, Question bank and other course related content would be posted on site mentioned above.

Signature with date: | **Course Instructor** | **Program Coordinator** | **Head-CSE**

Appendix

Table 01: Cognitive Levels

Cognitive Levels	
Cognitive level	**Revised Blooms Taxonomy Keywords**
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

Table 02: Program Outcomes (PO) and Program Specific Outcomes (PSO)

Program Outcomes (PO), Program Specific Outcomes (PSO)	
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PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1	Apply the Electrical and electronic principals to circuit, machines, power systems and control systems.
PSO2	Develop solutions in the areas of industrial , automation, green energy systems and smart grids.
PSO3	Able to contribute to project teams in the core and associated domains of electrical and electronic technology

Table 03: Correlation Levels

Correlation Levels	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High

CMR Institute of Technology, Bangalore		
Department(s): Electrical and Electronics Engineering		
Semester: 04	Section(s): A&B	Lectures/week: 04
Subject: Transmission and Distribution		Code: 15EE43
Course Instructor(s): Jagadish Kumar Patra		
Course duration: 01 Jan 2018 – 25 May 2018		
Course Site: https://sites.google.com/a/cmrit.ac.in/jagadish-kumar-patra/		

Course Objectives

- To understand the concepts of various methods of generation of power organizations.
- To understand the importance of HVAC, EHVAC, UHVAC and HVDC transmission.
- To design insulators for a given voltage level.
- To calculate the parameters of the transmission line for different configurations and assess the performance of the line.
- To study underground cables for power transmission and evaluate different types of distribution systems.

Prerequisites

- Basic mathematical operations.
- Basic Electrical.
- Circuit Theory.

Lesson Plan

Lecture #	Book & Sections	Topics	Portions coverage	
			Teaching Aids	% of Syllabus Covered
1-12	TB1: - 7	**UNIT – 1 Introduction to power system:** Structure of electric power system: Generation, Transmission and distribution. Advantages of high voltage transmission: HVAC, EHVAC, UHVAC and HVDC. Interconnection. Feeders, Distributors and service mains. **Overhead transmission lines:** A brief introduction to types of supporting structures and line conductors-Conventional conductors; Aluminium Conductor steel reinforced (ACSR), All –aluminium alloy conductor (AAAC) and All – aluminum conductor (AAC). High temperature conductors; Thermal resistant aluminium alloy (ATI),Super thermal resistant aluminium alloy (ZTAI), Gap type thermal resistant aluminum alloy conductor steel reinforced (GTACSR), Gap type super thermal resistant aluminium alloy conductor steel reinforced (GZTACSR). Bundle conductor and its advantages. Importance of sag, Sag calculation – supports at same and different levels, Effect of wind and ice. Line vibration and vibration dampers.	Chalk and Talk	20

		Overhead line protection against lightening; ground wires. **Overhead line Insulators:** A brief introduction to types of insulators, Material used- porcelain, toughened glass and polymer (composite). Potential distribution over a string of suspension insulators. String efficiency, Methods of increasing string efficiency. Arcing horns.		
13-23	TB1:-9	**UNIT- 2 - Line parameters:** Introduction to line parameters- Resistance, Inductance and capacitance. Calculation of inductance of single phase and three phase lines with equilateral spacing, Unsymmetrical spacing, Double circuit and transposed lines. Inductance of composite – conductors, Geometric mean radius (GMR) and geometric mean distance (GMD). Calculation of capacitance of single phase and three phase lines with equilateral spacing, Unsymmetrical spacing, Double circuit and transposed lines. Capacitance of composite – conductor, Geometric mean radius (GMR) and geometric mean distance (GMD). Advantages of single circuit and double circuit lines.	Chalk and Talk	20
24-35	TB1:-10	**UNIT 3- Performance of transmission lines:** Classification of lines – Short, Medium and Long lines. Current and voltage relations, Line regulation and Ferranti effect in short length lines, Medium length lines considering Nominal T and nominal π circuits, and long lines considering hyperbolic form equations. Equivalent circuit of a long line. ABCD constants in all cases.	Chalk and Talk	20
36-42	TB1:-11	**UNIT 4- Corona:** Phenomena, Disruptive and visual critical voltages, Corona loss. Advantages and disadvantages of corona. Methods of reducing corona. **Underground cable:** Types of cables, Constructional features, Insulation resistance, Thermal rating, Charging current, Grading of cables – capacitance and inter-sheath. Dielectric loss. Comparison between ac and dc cables. Limitations of cables. Specification of power cables.	Video Lectures	20
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=1Ym2OviN0XM&list=PLD4ED2FAF3C155625&index=18 ➢ http://www.nexans.no/Norway/2007/Underground_power_cables.pdf ➢ https://www.youtube.com/watch?v=_4BK9Kjw-ZY ➢ https://www.youtube.com/watch?v=73IBJi46ApY ➢ http://www.uomisan.edu.iq/eng/ar/admin/pdf/47204569447.pdf				
42-52	TB1 12	**UNIT 5 - Distribution:** Primary AC distribution systems – Radial feeders, parallel feeders, loop feeders and interconnected network system. Secondary AC distribution systems – Three phase 4 wire system and single phase 2 wire distribution, AC distributors with concentrated and uniform loads. Effect of disconnection of neutral in a 3 phase four wire system. **Reliability and Quality of Distribution system:** Introduction, Definition of reliability, failure, Probability concepts, Limitation of distribution systems, Power quality, Reliability aids.	Chalk and Talk	20

Text / Reference Books	
1.	V.K. Mehta, Rohit Mehta, "Principles of Power System", S. Chand Publishers, 1st Edition 2013.
2.	J. Duncan Glover at el, "Power System Analysis and Design", Cengage Learning, 4th Edition 2008.
3.	Soni, Gupta and Bhatnagar, "A Course in Electrical Power", Dhanpat Rai.
4.	S.N. Singh, "Electrical power Generation, Transmission and Distribution", PHI, 2nd Edition, 2009.
5.	S.L.Uppal, "Electrical Power", Khanna Publication.
6.	C. L. Wadhwa, "Electrical power systems", New Age International, 5th Edition, 2009.
7.	A.S. Pabla, "Electric Power Distribution", Mc Graw-Hill, 6th Edition, 2011.

Syllabus for Internal Assessment Tests (IAT*)

IAT #	Syllabus
IAT-1	Class # 01 – 23
IAT-2	Class # 24 – 38
IAT-3	Class # 39 – 52

*See calendar of events for IAT schedule.

Course Outcomes
By the end of this course, students will be able to
1. Analyze the performance of Short and Medium transmission line.
2. Describe a power system.
3. Design AC and DC distribution systems.
4. Formulate and solve the mathematical models describing steady-state physical behavior of transmission and distribution lines.
5. Design a transmission line.
6. Design methods to improve the efficiency of insulator strings.

**Based on table 01, 02, 03 in appendix, following are the Course outcomes.

Course Outcomes		Modules covered	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Analyze the performance of Short and Medium transmission line.	**3**	3	-	2	-	-	2	-	-	-	-	-	-	3	3	3
CO2	Describe a power system.	**1**	2	-	0	-	-	-	-	-	-	-	-	-	3	2	3
CO3	Design AC and DC distribution systems.	**5**	3	-	3	-	-	-	-	-	-	-	-	-	3	3	3
CO4	Formulate and solve the mathematical models describing steady-state physical behavior of transmission and distribution lines.	**2**	3	-	3	-	-	-	-	-	-	-	-	-	3	2	3
CO5	Design a transmission line.	**2,3**	3	-	3	-	-	-	-	-	-	-	-	-	3	3	3
CO6	Design methods to improve the efficiency of insulator strings.	**1**	3	-	3	-	-	3	-	-	-	-	-	-	3	3	3

Note: Assignments, study material, Question bank and other course related content would be posted on site mentioned above.

Signature with date:	**Course Instructor**	**Program Coordinator**	**Head-EEE**

Appendix

Table 01: Cognitive Levels

Cognitive Levels	
Cognitive level	**Revised Blooms Taxonomy Keywords**
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

Table 02: Program Outcomes (PO) and Program Specific Outcomes (PSO)

Program Outcomes (PO), Program Specific Outcomes (PSO)	
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the

	engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Apply electrical and electronic principles to circuits, machines, power systems and control systems.
PSO2	Develop solutions in the areas of industrial automation, green energy systems and smart grids.
PSO3	Able to contribute to project teams in the core and associated domains of electrical and electronic technology.

Table 03: Correlation Levels

Correlation Levels	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High

CMR Institute of Technology, Bangalore			
Department(s): Electrical & Electronics Engineering			
Semester: 04	Section(s): A&B	Lectures/week: 04	
Subject: Electric Motors		Code: 15EE44	
Course Instructor(s): Reba Kundu			
Course duration: 01 Jan 2018 – 25 May 2018			
Course Site: https://sites.google.com/a/cmrit.ac.in/reba-kundu-4632/			

Course Objectives

- To study the constructional features of Motors and select a suitable drive for specific application.
- To study the constructional features of Three Phase and Single phase induction Motors.
- To study different test to be conducted for the assessment of the performance characteristics of motors.
- To study the speed control of motor by a different methods.
- Explain the construction and operation of Synchronous motor and special motors.

Prerequisites

- Basic concept of rotating electrical machines.

  Electromachanical energy conversion principles.

Lesson Plan				
Lecture #	**Book & Sections**	**Topics**	**Portions coverage**	
			Teaching Aids	% of Syllabus Covered
1-8	TB1: - 1.1, 2.1- 2.5	**Module 1** **DC Motors:** Classification, Back emf, Torque equation, and significance of back emf, **10** Characteristics of shunt, Series & Compound motors. Speed control of shunt, Series and Compound motors. Application of motors. DC motor starters – 3 point and 4 point. **Losses and efficiency-** Losses in DC motors, Power flow diagram, Efficiency, Condition for maximum efficiency. ■	Chalk and Talk Video Lectures for some topics	20
Links to some useful online lectures: ➢ http://nptel.ac.in/courses/108105017/ ➢ https://www.youtube.com/watch?v=LATPHANEfQ0 https://www.electrical4u.com/dc-motor-or-direct-current-motor/				
9-16	TB1 3.1 - 3.2 4.4- 4.5	**Module 2** **Testing of dc motors:** Direct & indirect methods of testing of DC motors-Brake test, **10** Swinburne's test, Retardation test, Hopkinson's	Chalk and Talk Video Lectures	20

		tes t, Field's test, Merits and demerits of tests. **Three phase Induction motors:** Review of concept and generation of rotating magnetic field, Principle of operation, construction, classification and types; squirrel-cage, slip-ring (No question shall be set from the review portion). Slip, Torque equation, Torque-slip characteristic covering motoring, Generating and braking regions of operation. Maximum torque, Significance of slip. ■	for some topics	
Links to some useful online lectures: ➢ https://www.youtube.com/watch?v=KsxMxVPicvo *https://www.electrical4u.com/working-principle-of-three-phase-induction-motor/*				
17-21	TB1 5.1 - 5.6	**Module 3** **Performance of three-phase Induction Motor:** Phasor diagram of induction motor on no- **10** load and on load, Equivalent circuit, Losses, Efficiency, No-load and blocked rotor tests. Performance of the motor from the circle diagram and equivalent circuit. Cogging and crawling. High torque rotors-double cage and deep rotor bars. Equivalent circuit and performance Evaluation of double cage induction motor. Induction motor working as induction generator; Standalone operation and grid connected operation**.** ■	Chalk and Talk	20
Links to some useful online lectures: *nptel.ac.in/courses/108106072/* *https://www.marineinsight.com/.../construction-and-working-of-3-phase-induction-m* *https://www.youtube.com/watch?v=DsVbaKZZOFQ*				
22-30	TB1 7.1- 7.4 8.1 -8.3	**Module 4** **Starting and speed Control of Three-phase Induction Motors:** Need for starter. Direct on voltage, Frequency and rotor resistance methods. Construction and operation of split-phase, Capacitor start, Capacitor run, and shaded pole. **Single-phase Induction Motor:** Double revolving field theory and principle of operation. Construction and operation of split-phase, Capacitor start, Capacitor run, and shaded pole motors. Comparison of single phase motors and applications.	Chalk and Talk Video Lectures for some topics	20

Links to some useful online lectures: https://www.youtube.com/watch?v=awrUxv7B-a8 *https://www.electrical4u.com/single-phase-induction-motor/*				
31-40	TB1 9.1- 9.4 10.1 -10.3	**Synchronous motor:** Principle of operation, Phasor diagrams, Torque and torque angle.		
40-52	TB1 10.4- 10.9	Blondel diagram, Effect of change in load, Effect of change in excitation, V and inverted V curves. Hunting and damping, starting of synchronous motors. Construction and operation of universal motor, AC servomotor, stepper motor, linear induction motor.	Chalk and Talk Video Lectures for some topics	20
Links to some useful online lectures: https://www.youtube.com/watch?v=Vk2jDXxZIhs *https://www.electrical4u.com/synchronous-motor-working-principle/*				

Text Books	
1.	D. P. Kothari, I. J. Nagrath: Electric Machines, Mc Graw Hill, 4th Edition
Reference Books	
1.	M.V. Deshpande: Electrical Machines, PHI Learning, 2013
2.	R.K. Srivastava: Electrical Machines, Cengage Learning, 2 nd Edition,2013

Syllabus for Internal Assessment Tests (IAT*)

IAT #	Syllabus
IAT-1	Class # 01 – 16
IAT-2	Class # 17–30
IAT-3	Class # 31–52

*See calendar of events for IAT schedule.

Course Outcomes
By the end of this course, students will be able to

- Explain the constructional features of Motors and select a suitable drive for specific application.
- Analyze and assess the performance characteristics of DC motors by conducting suitable tests and control the speed by suitable method.
- Explain the constructional features of Three Phase and Single phase induction Motors and assess their performance.
- Control the speed of induction motor by a suitable method.
- Explain the operation of Synchronous motor and special motors.

**Based on table 01, 02, 03 in appendix, following are the Course outcomes.

Course Outcomes		Modules covered	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Describe the role of important elements of discrete event simulation and modeling paradigm.	**1**	2	2	1	1	-	1	-	-	-	-	-	1	1	-	1
CO2	Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.	**1,2**	2	3	-	1	-	1	2	1	2	-	-	2	1	-	1
CO3	Interpret the model and apply the results to resolve critical issues in a real world environment.	**2,3,4**	2	3	2	2	2	2	1	-	1	-	-	1	1	-	1
CO4	Apply random numbers and variates to develop simulation models	**5,6**	1	2	1	-	2	1	-	-	-	-	-	1	1	-	1
CO5	Analyze output data produced by a model and test validity of the model	**7**	2	2	-	-	2	-	-	-	-	-	-	2	1	-	1
CO6	Explain the concepts of verification and validation	**8**	-	-	-	-	1	-	-	-	-	-	-	-	1	-	1

Note: Assignments, study material, Question bank and other course related content would be posted on site mentioned above.

Signature with date: | **Course Instructor** | **Program Coordinator** | **Head-EEE**

Appendix

Table 01: Cognitive Levels

Cognitive Levels	
Cognitive level	**Revised Blooms Taxonomy Keywords**
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
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Table 02: Program Outcomes (PO) and Program Specific Outcomes (PSO)

Program Outcomes (PO), Program Specific Outcomes (PSO)	
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
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PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
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PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Apply the Electrical and electronic principals to circuit, machines, power systems and control systems.
PSO2	Develop solutions in the areas of industrial , automation, green energy systems and smart grids.
PSO3	Able to contribute to project teams in the core and associated domains of electrical and electronic technology

Table 03: Correlation Levels

Correlation Levels	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High

CMR Institute of Technology, Bangalore		
Department(s): Electrical & Electronics Engineering		
Semester: 04	Section(s): A&B	Lectures/week: 04+01
Subject: Electromagnetic Field Theory		Code: 15EE45
Course Instructor(s): Suganya Jeyaprakash		
Course duration: 05 Feb 2018 – 25 May 2018		
Course Site: https://sites.google.com/a/cmrit.ac.in/suganyaj/courses-offered/15ee45-electromagnetic-field-theory		

Course Objectives

- To study different coordinate systems for understanding the concept of gradient, divergence and curl of a vector.
- To study the application of Coulomb's Law and Gauss Law for electric fields produced by different charge configurations.
- To evaluate the energy and potential due to a system of charges.
- To study the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.
- To study the magnetic fields and magnetic materials.
- To study the time varying fields and propagation of waves in different media.

Prerequisites

- Vector Calculus
- Integral Calculus
- Differential Calculus

Lesson Plan

Lecture #	Book & Sections	Topics	Portions coverage	
			Teaching Aids	% of Syllabus Covered
1-12	TB1: - Chapters 1, 2 TB2: - Chapters 1, 2,3, 4.1-4.6	**Module-1** **Vector Analysis:** Scalars and Vectors**,** Vector algebra, Cartesian co-ordinate system, Vector components and unit vectors. Scalar field and Vector field. Dot product and Cross product, Gradient of a scalar field. Divergence and Curl of a vector field. Co – ordinate systems: cylindrical and spherical, Relation between different coordinate systems. Expression for gradient, Divergence and curl in rectangular, Cylindrical and spherical coordinate systems. Problems. **Electrostatics:** Coulomb's law, Electric field intensity and its evaluation for (i) point charge (ii) line charge (iii) surface charge (iv) volume charge distributions. Electric flux density, Gauss law and its applications. Maxwell's first equation (Electrostatics). Divergence theorem. Problems.	Chalk and Talk Video Lectures for some topics	20%

Links to some useful online lectures:

- https://ocw.mit.edu/resources/res-6-001-electromagnetic-fields-and-energy-spring-2008/index.htm
- http://nptel.ac.in/courses/108106073/
- http://nptel.ac.in/courses/108104087/

13-24	TB1: - Chapters 4, 5, 6.1 – 6.4 TB2: - Chapters 4.7-4.10, 5	**Module-2** **Energy and Potential:** Energy expended in moving a point charge in an electric field. The line integral. Definition of potential difference and potential. The potential field of a point charge and of a system of charges. Potential gradient. The dipole. Energy density in the electrostatic field. Problems. **Conductor and Dielectrics:** Current and current density. Continuity of current. Metallic conductors, Conductor's properties and boundary conditions. Perfect dielectric materials, capacitance calculations. Parallel plate capacitor with two dielectrics with dielectric interface parallel to the conducting plates. Capacitance of two wire line. Problems.	Chalk and Talk Video Lectures for some topics	20%
Links to some useful online lectures: ➢ https://ocw.mit.edu/resources/res-6-001-electromagnetic-fields-and-energy-spring-2008/index.htm ➢ http://nptel.ac.in/courses/108106073/ ➢ http://nptel.ac.in/courses/108104087/				
25-36	TB1: - Chapters 6.6 – 6.8, 7 TB2: - Chapters 6, 7	**Module-3** **Poisson's and Laplace equations:** Derivations and problems, Uniqueness theorem. **Steady magnetic fields:** Biot - Savart's law, Ampere's circuital law. The Curl. Stokes theorem. Magnetic flux and flux density. Scalar and vector magnetic potentials. Problems.	Chalk and Talk Video Lectures for some topics	20%
Links to some useful online lectures: ➢ https://ocw.mit.edu/resources/res-6-001-electromagnetic-fields-and-energy-spring-2008/index.htm ➢ http://nptel.ac.in/courses/108106073/ ➢ http://nptel.ac.in/courses/108104087/				
37-48	TB1: - Chapter 8 TB2: - Chapter8	**Module-4** **Magnetic forces:** Force on a moving charge and differential current element. Force between differential current elements. Force and torque on a closed circuit. Problems. **Magnetic materials and magnetism:** Nature of magnetic materials, Magnetisation and permeability. Magnetic boundary conditions. Magnetic circuit, Inductance and mutual inductance. Problems.	Chalk and Talk Video Lectures for some topics	20%
Links to some useful online lectures: ➢ https://ocw.mit.edu/resources/res-6-001-electromagnetic-fields-and-energy-spring-2008/index.htm ➢ http://nptel.ac.in/courses/108106073/ ➢ http://nptel.ac.in/courses/108104087/				

49-60	TB1: - Chapters 9.1 – 9.4, 11.1- 11.4 TB2: - Chapters 9, 10.1-10.7	**Module-5** **Time varying fields and Maxwell's equations:** Faraday's law, Displacement current. Maxwell's equations in point form and integral form. Problems. **Uniform plane wave:** Wave propagation in free space and in dielectrics. Pointing vector and power considerations. Propagation in good conductors, skin effect. Problems.	Chalk and Talk Video Lectures for some topics	20%

Links to some useful online lectures:

- https://ocw.mit.edu/resources/res-6-001-electromagnetic-fields-and-energy-spring-2008/index.htm
- http://nptel.ac.in/courses/108106073/
- http://nptel.ac.in/courses/108104087/

Text Books	
1.	Engineering Electromagnetics, William H Hayt et al, Mc Graw Hill, 8th Edition, 2014
2.	Principles of Electromagnetics, Matthew N. O. Sadiku, Oxford University Press, 6th Edition, 2015
Reference Books	
1.	Electromagnetics, J. A. Edminister, Mc Graw Hill, 3rd Edition, 2010

Syllabus for Internal Assessment Tests (IAT*)

IAT #	Syllabus
IAT-1	Class # 01-20
IAT-2	Class # 21-40
IAT-3	Class # 41–60

*See calendar of events for IAT schedule.

Course Outcomes
By the end of this course, students will be able to
1. Use different coordinate systems to explain the concept of gradient, divergence and curl of a vector.
2. Use Coulomb's Law and Gauss Law for the evaluation of electric fields produced by different charge configurations.
3. Calculate the energy and potential due to a system of charges.
4. Explain the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics.
5. Explain the behavior of magnetic fields and magnetic materials.
6. Assess time varying fields and propagation of waves in different media.

**Based on table 01, 02, 03 in appendix, following are the Course outcomes.

Course Outcomes		Modules covered	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Use different coordinate systems to explain the concept of gradient, divergence and curl of a vector	1	3	2	1	2	-	-	-	-	-	1	-	2	1	-	-
CO2	Use Coulomb's Law and Gauss Law for the evaluation of electric fields produced by different charge configurations	1	3	2	1	2	-	-	-	-	-	1	-	2	1	1	-
CO3	Calculate the energy and potential due to a system of charges	2	3	2	1	2	-	-	-	-	-	1	-	2	2	-	-
CO4	Explain the behavior of electric field across a boundary between a conductor and dielectric and between two different dielectrics	2,3	3	2	1	2	-	-	-	-	-	1	-	2	1	-	-
CO5	Explain the behavior of magnetic fields and magnetic materials	3,4	3	2	1	2	-	-	-	-	-	1	-	2	2	1	1
CO6	Assess time varying fields and propagation of waves in different media	5	3	2	1	2	-	-	-	-	-	1	-	2	2	1	1

Note: Assignments, study material, Question bank and other course related content would be posted on site mentioned above.

Signature with date: | **Course Instructor** **Program Coordinator** **Head-EEE**

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Table 01: Cognitive Levels

Cognitive Levels	
Cognitive level	**Revised Blooms Taxonomy Keywords**
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L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
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PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
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PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
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PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1	Apply the Electrical and electronic principles to circuit, machines, power systems and control systems.
PSO2	Develop solutions in the areas of industrial, automation, green energy systems and smart grids.
PSO3	Able to contribute to project teams in the core and associated domains of electrical and electronic technology.

Table 03: Correlation Levels

Correlation Levels	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High

CMR Institute of Technology, Bangalore		
Department(s): **Electrical and Electronics Engineering**		
Semester: 04	Section(s): A&B	Lectures/week: 04
Subject OPERATIONAL AMPLIFIERS AND LINEAR ICs		Code: 15EE46
Course Instructor(s): Prof.Anju Das		
Course duration: 5 Feb 2018 – 25 May 2018		
Course Site: https://sites.google.com/a/cmrit.ac.in/anjudas/		

Course Objectives

- To explain the representation, characteristics, equivalent circuit and application of OP-Amp.
- To explain designing of first and second order filters of different types and DC voltage regulators using Op-Amp and integrated circuits.
- To explain the use of Op-Amp in signal generation, comparator and converter circuits.
- To explain the use of Op-Amp in signal processing, A/D and D/A converter circuits.
- To discuss phase locked loop, its components and performance factors
- To discuss 555 timer and its application in signal generation.

Prerequisites

- Basics of Op-Amp working
- Basics of transistor working
- Basics of digital electronics

Lesson Plan

Lecture #	Book & Sections	Topics	Portions coverage	
			Teaching Aids	% of Syllabus Covered
1-11	TB1:1.1,1.2,1.5,2.3 to 2.6,3.3,6.2 to 6.6	*Module 1***Operational amplifiers**: Introduction, Block diagram representation of a typical Op-amp, schematic symbol, characteristics of an Op-amp, ideal op-amp, equivalent circuit, ideal voltage transfer curve, open loop configuration, differential amplifier, inverting & non –inverting amplifier, Op-amp with negative feedback ; voltage series feedback amplifier-gain, input resistance, output resistance, voltage shunt feedback amplifier- gain, input resistance, output resistance. **General Linear Applications**: D.C. & A.C amplifiers, peaking amplifier, summing, scaling & averaging amplifier, inverting and non-inverting configuration, differential configuration, instrumentation amplifier.	Chalk and Talk	20%

12-22	TB1:7.3 to 7.10 TB2:13.1 to 13.3,13.5	*Module 2:***Active Filters**: First & Second order high pass & low pass Butterworth filters, higher order filters Band pass filters, Band reject filters & all pass filters. **DC Voltage Regulators**: voltage regulator basics, voltage follower regulator, adjustable output regulator, LM317 & LM337 Integrated circuits regulators. ■	Chalk and Talk	20%
23-33	TB2:10.1 to 10.6,8.2 to 8.4	*Module 3*:**Signal generators:** Triangular / rectangular wave generator, phase shift oscillator, Wien bridge oscillator, oscillator amplitude stabilization, signal generator output controls. **Comparators & Converters**: Basic comparator, zero crossing detector, inverting & non-inverting Schmitt trigger circuit, voltage to current converter with grounded load, current to voltage converter and basics of voltage to frequency and frequency to voltage converters	Chalk and Talk	20%
34-44	TB2:7.1 to 7.6 TB3:Chapter 7	*Module 4:***Signal processing circuits**: Precision half wave & full wave rectifiers limiting circuits, clamping circuits, peak detectors, sample & hold circuits. **A/D & D/A Converters**: Basics, R–2R D/A Converter, Integrated circuit 8-bit D/A, successive approximation ADC, linear ramp ADC, dual slope ADC, digital ramp ADC	Chalk and Talk	20%
45-55	TB2:16.1 to 16.5 10.6	*Module 5:***Phase Locked Loop (PLL):** Basic PLL, components, performance factors, applications of PLL IC 565. **Timer:** Internal architecture of 555 timer, Mono stable, Astable multivibrators and applications	Chalk and Talk Video Lectures for some topics	20%

Links to some useful online lectures:

- https://www.youtube.com/watch?v=QH9iKOM-wGY
- https://www.youtube.com/watch?v=pln5ajN94C0

Text Books	
1.	Op-Amps and Linear Integrated Circuits Ramakant A Gayakwad, Pearson, 4 th Edition 2015
2.	Operational Amplifiers and Linear ICs David A. Bell Oxford 3 rd Edition 2011
3.	Linear Integrated Circuits;Analysis, Design and ApplicationsB. Somanthan Nair Wiley India 2013

Reference Books	
1.	Linear Integrated Circuits, D Choudhury Roy, New Age Science Limited, 2011
2.	Linear Integrated Circuits S. Salivahanan, et al McGraw Hill 2 nd Edition,2014
3.	Linear Integrated Circuits Muhammad H Rashid Cengage Learning 1 st Edition,2014

Syllabus for Internal Assessment Tests (IAT*)

IAT #	Syllabus
IAT-1	Lecture# 1-15
IAT-2	Lecture# 16-35
IAT-3	Lecture# 35-55

*See calendar of events for IAT schedule.

Course Outcomes
By the end of this course, students will be able to
1.Demonstrate Opamp characteristics and linear applications of Opamp.
2.Explain the necessity and working of A/D & D/A Converters
3.Interpret the different signal processing circuits using Op-amps.
4.Experiment the different switching applications of Op-amps
5.Design triangular, sine and square waveform generators with the given frequency.
6.Demonstrate the working of active filters, voltage regulators and special application of Op-amps.

**Based on table 01, 02, 03 in appendix, following are the Course outcomes.

Course Outcomes		Modules covered	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	Demonstrate Opamp characteristics and linear applications of Opamp.	**1.2**	3	1	3	2	-	-	-	-	1	-	-	1	3	2	2
CO2	Explain the necessity and working of A/D & D/A Converters	**4**	2	1	3	2	-	-	-	-	1	-	-	1	2	2	2
CO3	Interpret the different signal processing circuits using Op-amps.	**4**	3	1	3	2	-	-	-	-	1	-	-	1	3	2	2
CO4	Experiment the different switching applications of Op-amps	**3**	3	1	3	2	-	-	-	-	1	-	-	1	3	3	3
CO5	Design triangular, sine and square waveform generators with the given frequency.	**3**	3	1	3	2	-	-	-	-	1	-	-	1	3	2	2
CO6	Demonstrate the working of active filters, voltage regulators and special application of Op-amps.	**2,5**	3	1	3	2	-	-	-	-	1	-	-	1	3	2	2

Note: Assignments, study material, Question bank and other course related content would be posted on site mentioned above.

Signature with date: | **Course Instructor** **Program Coordinator** **Head-EEE**

Appendix

Table 01: Cognitive Levels

Cognitive Levels	
Cognitive level	**Revised Blooms Taxonomy Keywords**
L1	List, define, tell, describe, identify, show, label, collect, examine, tabulate, quote, name, who, when, where, etc.
L2	summarize, describe, interpret, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend
L3	Apply, demonstrate, calculate, complete, illustrate, show, solve, examine, modify, relate, change, classify, experiment, discover.
L4	Analyze, separate, order, explain, connect, classify, arrange, divide, compare, select, explain, infer.
L5	Assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, conclude, compare, summarize.

Table 02: Program Outcomes (PO) and Program Specific Outcomes (PSO)

Program Outcomes (PO), Program Specific Outcomes (PSO)	
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PSO1	Apply the Electrical and electronic principals to circuit, machines, power systems and control systems.
PSO2	Develop solutions in the areas of industrial , automation, green energy systems and smart grids.
PSO3	Able to contribute to project teams in the core and associated domains of electrical and electronic technology

Table 03: Correlation Levels

Correlation Levels	
0	No Correlation
1	Slight/Low
2	Moderate/ Medium
3	Substantial/ High