An ISO 9001-2015 Certified Institute

SantGajananMaharaj College of Engineering, Mahagaon

Site- Chinchewadi, Tal- Gadhinglaj, Dist- Kolhapur

Department of Electrical Engineering

COURSE PLAN

Course Code	EE 224	Course Name	NAS
Prepared by	Prof.Kalas S V	Date	(AY-2018-19)
Verified by	Mr. M.B PATIL	Approved by	Academic Coordinator/ Principal
Objective	The student should know about the basic techniques of AC circuit analysis and filters.		

COURSE OUTCOMES

At the end of this course the students should be able to:

Sr. No.	CO	CO No.
1.	Use network techniques, like node analysis and mesh analysis, to write equations for various linear circuits	EE 224.01
2.	Apply network theorems to analyze various circuits and networks.	EE 224.02
3.	Apply the transform analysis to linear circuits and systems.	EE 224.03
4.	Calculate and correlate two port network parameters.	EE 224.04
5.	Synthesize an electrical network from a given impedance/admittance function.	EE 224.05
6.	Design various types of passive electrical filters.	EE 224.06

EXAMINATION SCHEME

Examination Scheme	Theory	Term Work	POE	Total
Maximum Marks	100	0	00	100
Contact Hours	4	0	00	04

MAPPING OF COs-Pos

POs / COs	a	b	c	d	e	f	g	h	i	j	k	l

EE 221.01	2	2										
EE 221.02	2	3										
EE 221.03	2		2		2							
EE 221.04	2	3		1	1							
EE 221.05	2			2								

Degree of Compliance of COs and POs 1:Low 2: Medium 3: High

COURSE CONTENTS

Chapter No.	Contents	No. of Hours
I	INTRODUCTION	**8**
II	NETWORK THEORAMS	**6**
III	TRANSFORM ANALYSIS	**8**
IV	NETWORK FUNCTION	**8**
V	NETWORK SYNTHESIS	**10**
VI	FILTER SYNTHESIS	**4**

EVALUATION SCHEME

Section	Maximum Marks	Question No.	Chapter No.
I	16	Question-1	Chapter-1
	24	Question-2	Chapter-2
	26	Question-3	Chapter-3
II	24	Question-4	Chapter-4
	24	Question-5	Chapter-5
	18	Question-6	Chapter-6

REFERENCES

Books

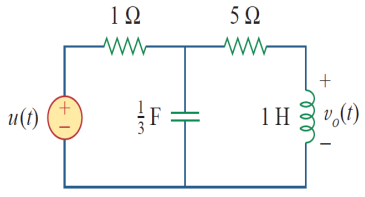
Sr.No.	Title of the Book	Author	Publisher/Edition
1.	"Network Analysis and Synthesis"	Franklin F Kuo	JhonWielySons
2.	"Network Analysis",	M.E. Van Valkenburg,	Prentice Hall of India
3.	"Electric Circuits", TMH	C. K. Alexander	Mcgraw hill
4.	"Networks and Systems"	D.RoyChoudhary,	New age,

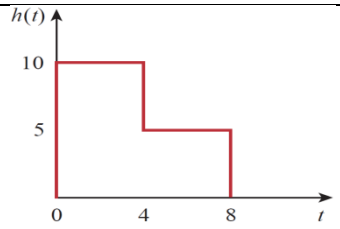
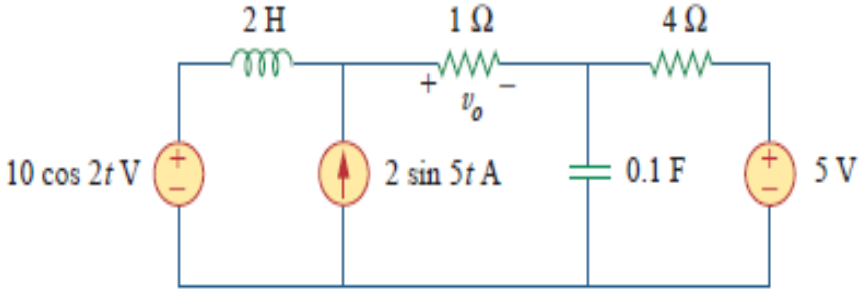
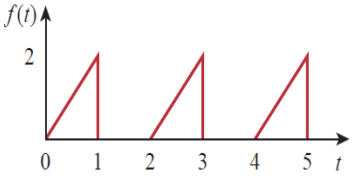
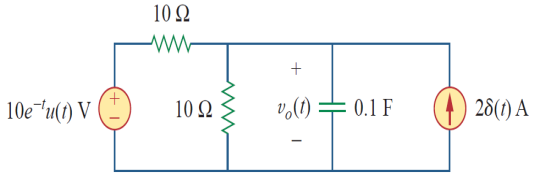
LIST OF ASSIGNMENTS

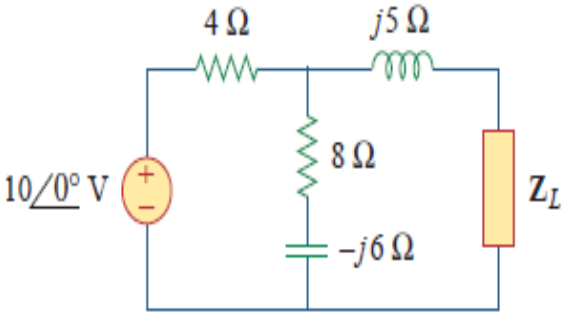
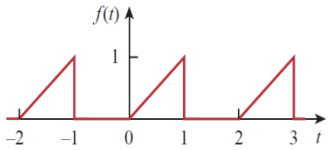
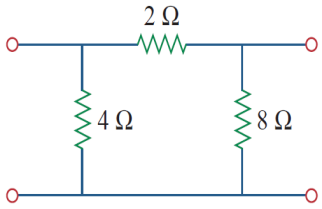
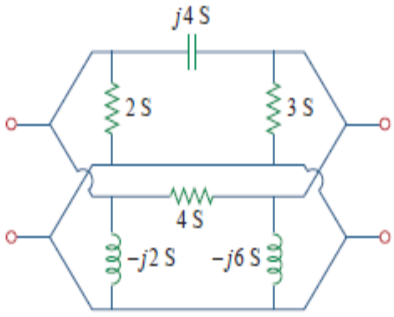
Asst. No.	Assignment Title	
A. Assignment Exercise		**CO No.**
1.	INTRODUCTION	EE 422.01
2.	NETWORK THEORAMS	EE 422.02
3	TRANSFORM ANALYSIS	EE 422.03
4.	NETWORK FUNCTION	EE 422.04
5.	NETWORK SYNTHESIS	EE 422.05
6	FILTER SYNTHESIS	EE 422.06

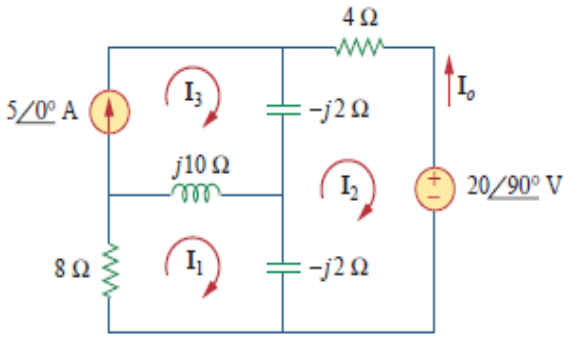
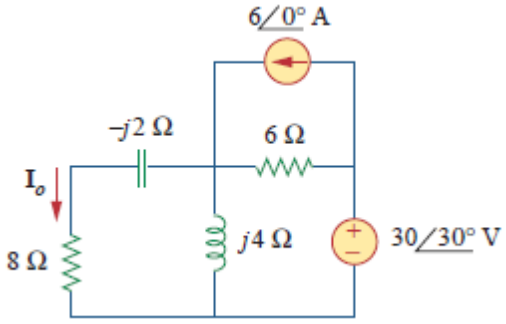
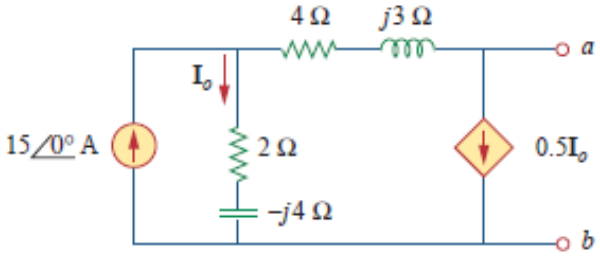
ASSIGNMENT QUESTIONS/QUESTION BANK

Unit- I (Assignment 1)INTRODUCTION

Que. No.	Question	CO No.	Remark
1.	**a)** FindV0(t) in the circuit assuming zero initial conditions for given Fig. 1  **Fig. 1** **b)** Obtain Laplace transform of h(t) for given Fig. 2	EE 422.01	Common for All

	 **Fig.2** **c)** Find voof the circuit of Fig. 3 [8M]  **Fig.3**		
Unit-II: (Assignment 2) NETWORK THEORAMS			
1.	**a)** Calculate the Laplace transform of the periodic function in Fig. 4  **Fig.4** **b)** Determine impedance parameters in terms of Admittance parameters. **c)**Determine ABCD parameters in terms of Impedance parameters.	EE 422.02	Common for All
Unit- III:(Assignment 3) TRANSFORM ANALYSIS			
Que. No.	**Question**	**CO No.**	**Remark**
1.	**a)**Use the Laplace transforms to solve the differential equation. $\frac{dy}{dt} + 5y(t) + \int_0^t y(\tau)d\tau = u(t)$ For y(0)=2 **b)** Find V0(t) in the circuit of Fig.5. Assume V(0) =5 V.  **Fig. 5** **c)**Determine the load impedance that maximizes the average power drawn from the circuit of Fig.6	EE 422.03	Common for All

	 **Fig. 6**		
Unit- IV:(Assignment 4) NETWORK FUNCTION			
1.	**a)** Obtain the Fourier series for the periodic function in Fig.7 [8M]  **Fig. 7** **b)** Obtain the z &*y* parameters for the network shown in Fig 8 [10M]  **Fig.8** **C)**Find the *y* parameters of the two-port in Fig.9 [8M]  **Fig. 9**	EE 422.04	Common for All
Unit- V: (Assignment 5)NETWORK SYNTHESIS			

1.	**a)** Find$I_0(t)$ in the circuit for given Fig. 10  **Fig. 10** **b)** Find in Fig. 11 using mesh analysis  **Fig.11** **C)**Find the Thevenin equivalent of the circuit in Fig. 12 as seen from terminals *a-b*.  **Fig.12**	EE 422.05	Common for All

Sant Gajanan Maharaj College of Engineering, Mahagaon

Site- Chinchewadi, Tal- Gadhinglaj, Dist- Kolhapur

Department of Electronics & Telecommunication Engineering

COURSE PLAN

Course Code	EE 222	**Course Name**	Power Electronics
Prepared by	Mr. P I Kanthi	**Date**	06/12/2018 (AY-2018-19)

Verified by	Mr. M B Patil (HOD EE)	Approved by	Academic Coordinator/ Principal
Objective	Provide an introduction and basic understanding of Semiconductor Devices, Characteristics, Rectifiers, Different types of Converters, Cycloconverters, Design of Different types of Choppers and Inverters		

COURSE OUTCOMES

At the end of this course the students should be able to:

Sr. No.	CO	CO No.
7.	**Relate**[1] basic semiconductor physics to properties of power devices, and **combine**[6] circuit mathematics and characteristics of linear and non-linear devices.	EE222.1
8.	**Discuss**[6] basic operation and **compare**[5] performance of various power semiconductor devices, passive components and switching circuits	EE222.2
9.	**Design**[6] and **Analyze**[4] power converter circuits and learn to **select**[1] suitable power electronic devices by **assessing**[5] the requirements of application fields.	EE222.3
10.	**Design**[6] and **Analyze**[4] power converter circuits and learn to **select**[1] suitable power electronic devices by **assessing** the requirements of application fields.	EE222.4
11.	**Analyze**[4]different types of Cycloconverters and **relate**[1] performance with waveforms	EE222.5
12.	**Formulate**[6] and **analyze**[4] a power electronic design at the system level and **assess**[5] the performance	EE222.6
13.	**Identify**[3] the critical areas in application levels and **derive** typical alternative solutions, **select**[1] suitable power converters to control Electrical Motors and other industry grade apparatus.	EE222.7

EXAMINATION SCHEME

Examination Scheme	Theory	Term Work	#POE	Total
Maximum Marks	100	25	50	175
Contact Hours	3	2	**	5

MAPPING OF COs-Pos

POs / COs	a	b	c	d	e	f	g	h	i	j	k	l
EE222.1	2	1	2	1	#	#	#	#	#	#	#	#
EE222.2	1	1	2	2	#	#	#	#	#	#	#	#
EE222.3	1	2	2	1	1	#	#	1	#	#	#	1

EE222.4	1	2	2	1	1	#	#	1	#	#	#	1
EE222.5	1	2	1	2	#	#	#	#	#	#	#	#
EE222.6	1	1	1	2	1	#	#	1	#	1	#	1
EE222.7	1	1	2	2	#	1	1	#	1	#	1	1

Correlation Levels 1. Low 2. Medium 3. High and "#" if there is no relation

COURSE CONTENTS

Chapter No.	Contents	No. of Hours
I	**Power Semiconductor Devices** Power Diodes – working, characteristics, types, ratings, reverse recovery characteristics, series parallel operation, applications of Power diodes. SCR-basic structure, working, static and switching characteristics, types, ratings, reverse recovery characteristics, Gate characteristic, turn on methods, series-parallel operation, protection, triggering circuits, applications of SCR, GTO, MOSFET, IGBT, Device structure, static characteristic, dynamic characteristic, ratings, applications of GTO, MOSFET and IGBT; TRIAC-structure, static characteristics, different modes of operations, applications of TRIAC.	**6 Hrs.**
II	**Rectifiers** Single phase Half wave with R, RL load, Single phase and Three phase full bridge rectifier with R, RL and RLE load, mathematical expressions, issue of harmonics, applications of diode rectifiers, Numericals expected.	**3 Hrs.**
III	**Single Phase Converter** Single phase fully controlled and half controlled converters - Continuous and discontinuous mode of conduction, analysis with R,RL, RLE load, expressions for average output voltage, RMS, TUF, THD, Ripple factor, Modes of operation in the voltage-current plane, operation as an inverter, Dual converter, Simultaneous and non-simultaneous control, Effect of source inductance, harmonics analysis, Numericals expected.	**4 Hrs.**
IV	**Three Phase Converter** Three phase half wave converter, R, RL, RLE load, expressions for average output voltage, RMS, TUF, THD, Ripple factor, DC magnetization of the input transformer, harmonics analysis Three phase fully controlled and half controlled converters with R, RL, RLE load, expressions for average output voltage, RMS, TUF, THD, Ripple factor, displacement factor, Inverter mode of operation, harmonic analysis, Effect of source inductance, Three phase dual converters, applications of controlled converters and dual converters. Numericals expected.	**5 Hrs.**
V	**Cycloconverters** Single phase to single phase cycloconverter with R and RL load, Three phase to Single phase cycloconverter, Three phase to three phase 3 and 6 pulse converter, circulating and noncirculating mode, applications of cycloconverters.	**5 Hrs.**
VI	**DC to DC Converter** Classification, Principle of working of Step-down Chopper, Step-up Chopper, Analysis,	**5 Hrs.**

	voltagecontrol methods, Morgan Chopper, Jones Chopper, multiphase choppers. Zero voltage switching and Zero current switching.	
VII	**Inverters** Voltage source inverters, Single phase and three-phase- six step (120/180 degree mode ofoperation), thyristorised bridge circuits, output waveforms for R and R-L loads, harmonic analysis, PWM techniques-Single, Multiple and Sinusoidal PWM, applications of VSI, Current Source Inverter, advantages, applications of CSI, Multilevel inverter	**8 Hrs.**

EVALUATION SCHEME

Section	Maximum Marks	Question No.	Chapter No.
I	12-16 Marks	Question-1	Chapter-1
	12-16 Marks	Question-2	Chapter-2
	18-24 Marks	Question-3	Chapter-3
II	18-24 Marks	Question-4	Chapter-4
	12-18 Marks	Question-5	Chapter-5
	16-24 Marks	Question-6	Chapter-6

REFERENCES

Books	
1.	Power Electronics Circuits, Devices, and Application, M.H. Rashid, 2nd Edition, Prentice Hall of India, New Delhi, 1999.
2.	Power Electronics, P.S. Bimbhra, 3rd , Edition, Khanna Pub., New Delhi, 1999.
3.	Power Electronics, M.D. Singh and K.B. Khanchandani, Tata Mc-Graw-Hill, New Delhi, 1998.
4.	SPICE for Power Electronics and Electric Power (Electrical and Computer Engineering):
5.	H. Rashid, Hasan M. Rashid, Second Edition Prentice Hall of India, New Delhi.
6.	Ned Mohan, Robbins,Undeland," Introduction to power electronics" john Willey & Sons.
7.	B.K. Bose," Power electronics and drives" Pearson publication.
Data Manuals	
1.	Power Electronics
E-books/E-Links	
1.	https://nptel.ac.in/downloads/108105066/
2.	https://lecturenotes.in/subject/39/power-electronics-pe
3.	https://www.pdfdrive.net/power-electronics-notes-by-arunkumar-e25241777.html
4.	https://www.vidyarthiplus.com/vp/thread2638.html#.WkMYl9KWa1t

NPTEL /Other Video Links	
1.	https://www.youtube.com/watch?v=1Auay7ja2oY
2.	https://www.youtube.com/watch?v=nhQT2GZUf4Y
3.	https://www.youtube.com/watch?v=yDy7ijrfoPk
4.	https://www.youtube.com/watch?v=K9DkViSeA5Y
5.	http://www.nptelvideos.in/2012/11/power-electronics.html
6.	https://nptel.ac.in/courses/108101038/
7.	http://freevideolectures.com/Course/2351/Power-Electronics
8.	http://www.powerguru.org/power-electronics-videos/
9.	https://www.youtube.com/watch?v=1Auay7ja2oY
10.	https://www.youtube.com/watch?v=nhQT2GZUf4Y

LIST OF EXPERIMENT

Exp. No.	Experiment Title	
B. Practical Exercise		**CO No.**
1.	R Triggering Circuit of SCR	EE222.1
2.	RC Triggering Circuit of SCR	EE222.1
3	UJT Triggering Circuit of SCR	EE222.1
4.	Single Phase Half Controlled Bridge Converter	EE222.3
5.	Single Phase Fully Controlled Bridge Converter	EE222.3
6.	3ϕ phase fully controlled bridge Converter	EE222.4
7.	Single phase speed control of separately excited DC Motor	EE222.4
8.	Speed control of a DC series Motor	EE222.4
C. Beyond Syllabus Activity		
1.	Study and Design of Circuits using MATLAB/PROTEUS	

ASSIGNMENT QUESTIONS/QUESTION BANK

Unit- I (Assignment 1)	Power Semiconductor Devices		12 to 16 Marks
Que. No.	**Question**	**CO No.**	**Remark**
1	Explain V-I Characteristics and Reverse Recovery Characteristics of Diode?	EE 222.1	Common for All
2	Explain Series-Parallel Connection of Diode with Examples.	EE 222.1	
3	Draw the V-I Characteristics of Diode, SCR, MOSFET, IGBT, GTO, TRIAC and DIAC.	EE 222.1	
4	Explain the Static and Dynamic Characteristics of MOSFET, GTO and IGBT.	EE 222.1	
5	Explain the Turn on methods of SCR.	EE 222.1	
6	Explain Reverse Recovery Characteristics and Switching Characteristics of SCR.	EE 222.1	
7	Explain different modes of operation of TRIAC and DIAC	EE 222.1	Additional questions for Fast Learner
8	Applications of Diode, SCR, MOSFET, IGBT, GTO, TRIAC, DIAC, TRANSISTOR and UJT.	EE 222.1	
Unit-II: (Assignment 2)	**Rectifier**		**12 to 16 Marks**
2.	Explain Single Phase Half Wave Rectifier with R, RL and RLE load	EE 222.2	Common for All
3.	Explain Single Phase Full Wave Rectifier with R, RL and RLE load	EE 222.2	
4.	Explain Three Phase Full Wave Rectifier with R, RL and RLE load	EE 222.2	
5.	Write the Mathematical Expressions for Half Wave Rectifier	EE 222.2	
6.	Write the Mathematical Expressions for Full Wave Rectifier	EE 222.2	
7.	Explain harmonics in case of Rectifiers.	EE 222.2	
8.	Write the Applications of Rectifiers	EE 222.2	
9.	Explain 3-Phase Full Bridge Rectifier with R & RLE Load and Derive for Continuous (For Is) and Discontinuous Load Current (For x(Θ))	EE 222.2	
Unit- III:(Assignment 3)	**Single Phase Converter**		**18 to 24 Marks**
Que. No.	**Question**	**CO No.**	**Remark**
2.	Draw the Circuit Diagram and Waveforms for Single Phase half controlled converter and fully controlled converter and Explain Continuous and Discontinuous Conduction Mode of operation	EE 222.3	Common for All
3.	Derive the expressions for RMS, TUF, THD, Ripple Factor for Single phase half controlled and full controlled Converter.	EE 222.3	
4.	Explain 1-Phase Dual Converter with neat Circuit Diagram, Waveforms, Advantages, Limitations and Derive for Ir(max)	EE 222.3	

	Mathematical Expressions.		
5.	Explain modes of operation in the Voltage-Current Plane in case of Single Phase Converter.	EE 222.3	
6.	Explain Effect of Source Inductance on performance of Converter with neat Circuit Diagram, Waveforms and Derive for Vdc	EE 222.3	
7.	Explain Converter operating as an Inverter.	EE 222.3	
8.	Problems	EE 222.3	
Unit- IV:(Assignment 4)	**Three Phase Converter**		**18 to 24 Marks**
2.	Draw the Circuit Diagram and Waveforms for Three Phase half controlled converter and fully controlled converter and Explain Continuous and Discontinuous Conduction Mode of operation	EE 222.4	Common for All
3.	Draw the Circuit Diagram and Waveforms for Three Phase half controlled converter and fully controlled converter for R, RL and RLE load.	EE 222.4	
4.	Derive the expressions for RMS, TUF, THD, Ripple Factor for Three phase half controlled and full controlled Converter.	EE 222.4	
5.	Explain 3-Phase Dual Converter with neat Circuit Diagram, Waveforms, Advantages, Limitations and Derive for Ir(max) Mathematical Expressions.	EE 222.4	
6.	Explain Effect of Source Inductance on performance of 3-Phase Converter with neat Circuit Diagram, Waveforms and Derive for Vdc	EE 222.4	
7.	Explain harmonics Analysis in case of 3-Phase Converters.	EE 222.4	
Unit- V: (Assignment 5)	**Cycloconverters**		**12 to 18 Marks**
2.	Explain Single Phase to Single Phase Converter	EE 222.5	Common for All
3.	Explain Three Phase to Single Phase Converter	EE 222.5	
4.	Explain Three Phase to Single Phase 3 and 6 Pulse Converter	EE 222.5	
5.	Explain Circulating and Non Circulating Mode in Cycloconverter	EE 222.5	
6.	Write an ALP for Reversing an Array and Generation of Prime Numbers.	EE 222.5	
7.	Write the Applications of Cycloconverters.	EE 222.5	
Unit- VI: (Assignment 6)	**DC to DC Converter**		**16 to 24 Marks**
1.	Explain the Classification of Choppers	EE 222.6	Common for All
2.	Explain Working Principle of Step Up and Step Down Chopper with a neat diagram.	EE 222.6	

3.	Draw and Explain Morgan Chopper	EE 222.6	
4.	Draw and Explain Jones Chopper	EE 222.6	
5.	Draw and Explain Multiphase Chopper	EE 222.6	
6.	Draw and Explain Zero Current and Zero Voltage Switching	EE 222.6	
Unit- VII: (Assignment 7)	**Inverters**		**16 to 24 Marks**
1	Explain VSI and CSI with a neat diagram.	EE 222.7	Common for All
2	Single phase and three-phase- six step (120/180 degree mode of operation)	EE 222.7	
3	Explain PWM techniques in Single, Multiple and Sinusoidal PWM	EE 222.7	
4	Explain Thyristorised bridge Circuit and output waveforms for R and R-L loads.	EE 222.7	
5	Explain Multilevel Inverter with a neat diagram	EE 222.7	
6	Give the Advantages and Applications of VSI and CSI	EE 222.7	
7	Problems	EE 222.7	

An ISO 9001-2015 Certified Institute

Sant Gajanan Maharaj College of Engineering, Mahagaon

Site- Chinchewadi, Tal- Gadhinglaj, Dist- Kolhapur

Department of ELEctrical Engineering

COURSE PLAN

Course Code	EE223	**Course Name**	Power System -I
Prepared by	Prof. M. B. Patil	**Date**	25/10/2018 (AY-2018-19)
Verified by	Prof. M. B. Patil (HOD EE)	**Approved by**	Academic Coordinator/ Principal
Objective	To explain the generation of Electric Energy by different sources, basic structure of power system and its components, Distribution system, discuss the overhead transmission line and Underground cables, describe the importance and equipments used to improve the power factor, explain Economic Aspects of Power Generation.		

COURSE OUTCOMES

At the end of this course the students should be able to:

Sr. No.	CO	CO No.
14.	Understand basics of Power System.	EE223.1
15.	Modeling & representation of the system components used in power system.	EE223.2
16.	Understand use of cables in distribution network.	EE223.3
17.	Concept of designing transmission line parameters.	EE223.4
18.	The basic concept of load flow analysis.	EE223.5
19.	Analyze performance of generators & turbines.	EE223.6

EXAMINATION SCHEME

Examination Scheme	Theory	Term Work	#POE	Total
Maximum Marks	100	50	00	150
Contact Hours	4		**	04

MAPPING OF COs-Pos

POs / COs	a	b	c	d	e	f	g	h	i	j	k	l
EE223.1	3	2			2							
EE223.2	3	3		2	2							
EE223.3	3	3			2							
EE223.4	2	1			2							1
EE223.5	3	3		1	2							
EE223.6	2	3			2							1

Degree of Compliance of COs and POs 1: Low 2: Medium 3: High

COURSE CONTENTS

Chapter No.	Contents	No. of Hours

I	**Generation of Electric Energy and Power System Components:** Schematic/ Block diagram of Hydro power plant, Thermal power plant, Nuclear power plant and Diesel power plants and their working. Basic structure of an AC power system, Distribution voltage level, Sub-transmission level, Single line diagram. Brief Description of Power system elements such as Synchronous Machine, Transformer, Bus bar, Circuit Breaker, isolator, CT, PT.	**08 Hrs.**
II	**Distribution Systems:** Classification of Distribution Systems, AC Distribution- Primary and Secondary Distribution systems, Overhead and Underground systems, Connection scheme of distribution system, Radial system, Ring main system, Interconnected systems, feeders and distributors, AC distribution calculations.	**06 Hrs.**
III	**Overhead Transmission Lines and Underground Cables:** Types of conductors- Hard drawn copper, hard drawn aluminum, steel cored aluminum, ACSR, SSC,AAC, Smooth Body ACSR, Expanded ACSR, ACAR, bundled conductor, Resistance, inductance and capacitance for single and double circuit lines, skin effect and proximity effect. Main components of over head lines, conductor materials, line supports, Types of line supports, insulators, types of insulators, potential distribution over suspension insulators, string efficiency, Methods of improving string efficiency. Corona, factors affecting corona, important terms, advantages and disadvantages of corona, methods of reducing corona effect, sag in over head lines and sag calculations. Construction and classification of cables for single and three phase service, Methods of laying Underground cables.	**10 Hrs.**
IV	**Characteristics and Performance of Transmission Line:** Short, medium and long lines, Voltages and currents at sending and receiving end of line, ABCD constants, Sending end and receiving power circle diagrams, universal power circle diagram, voltage and current waves, surge impedance loading of transmission line, Complex Power flow through transmission line, Power transmission capability, Ferranti effect, tuned power lines, methods of voltage control, voltage regulators, tap changing transformers, booster transformers, Synchronous phase modifiers.	**10 Hrs.**
V	**Power Factor Improvement:** Causes and disadvantages of Low power factor, power factor improvement Equipments-using Static capacitors, synchronous condensers, phase advancers, Calculation of Power factor correction; Importance of power factor improvement, Most economical power factor derivation.	**08 Hrs.**

VI	**Economic Aspects of Power Generation:** Load curve, load duration and integrated load duration curves-load, demand, diversity, capacity, Utilization and plant use factors- Numerical Problems. Costs of Generation and their division into Fixed, Semi-fixed and Running Costs. Desirable Characteristics of a Tariff Method.-Tariff Methods: Flat Rate, Block-Rate, two-part, three –part, and power factor tariff methods.	**9 Hrs.**

EVALUATION SCHEME

Section	Maximum Marks	Question No.	Chapter No.
I	16-24 Marks	Question-1	Chapter-1
	16-24 Marks	Question-2	Chapter-2
	16-24 Marks	Question-3	Chapter-3
II	12-18 Marks	Question-4	Chapter-4
	16-24 Marks	Question-5	Chapter-5
	16-24 Marks	Question-6	Chapter-6

REFERENCES

Books	
8.	Modern Power System Analysis by I. J. Nagrath, D. P. Kothari, 3rd Edition, Tata McGraw Hill Publishing Co. Ltd., 2003.
9.	Power System Analysis and Design by J.D.Glover and M.Sarma, 3rd Edition, Brooks/ Cole Publishing, 2002.
10.	Electric Power Systems by Weedy B M, Cory B J,John Wiley Publication, latest edition
11.	Power System Analysis by Grainger John J and W D Stevenson Jr. McGraw Hill, 1994
12.	Power System Analysis by Hadid Sadat, McGraw Hill International, latest edition
13.	M.V. Deshpande , Elements of power station design , Tata Mc Graw Hill
14.	Electrical Power Systems by C.L.Wadhawa New age International (P) Limited, Publishers 1997. D.H.Bacon, Engineering Thermodynamics, London butterworth
15.	P. K. Nag, Power plant Engineering - stream & nuclear, Tata Mc Graw Hill
16.	Mahesh Varma : Power plant Engineering , Metrolitan book Co Pvt Ltd
17.	Fredrick T. Morse. Power plant Engineering , east west press private Ltd
Data Manuals	
2.	National Semiconductor Data Manual
E-books/E-Links	

5.	
6.	
7.	
NPTEL /Other Video Links	
11.	
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	

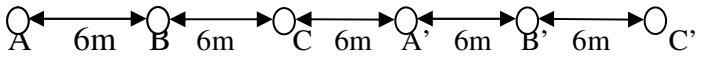
LIST OF EXPERIMENT		
Exp. No.	**Experiment Title**	
C. Practical Exercise		**CO No.**
1.	Introduction of MATLAB	EE223.1

2.	Electrical drawing s	EE223.1
3	Calculation of voltage drop in the given AC distribution system	EE223.1
4.	Calculation of voltage distribution and string efficiency for given string	EE223.1
5.	Calculation of critical distribution voltage and corona loss	EE223.1
6.	Calculation of sag	EE212.2
7.	Calculation of power factor improvement	EE223.2
8.	To study the performance of short transmission line	EE223.3
9.	Calculation for solution of medium transmission line by Nominal T	EE223.3
B. Field Visit		
1.	Filed visit to MSEB Substation Gadhinglaj.	
C. Beyond Syllabus Activity		
1.	Calculate performance of medium transmission on lines by end condenser method	

ASSIGNMENT QUESTIONS/QUESTION BANK

Unit- I (Assignment 1) Generation of Electric Energy and Power System Components 16 to 24 Marks

Que. No.	Question	CO No.	Remark
2.	Draw Neat and labeled Diagram of Hydro power plant.	EE223.1	Common for All
3.	Draw Neat and labeled Diagram of Thermal power plant.	EE223.1	
4.	Draw Neat and labeled Diagram of Nuclear power plant.	EE223.1	
5.	Draw Neat and labeled Diagram of Diesel power plant.	EE223.1	

6.	Write Brief Description of Power system elements Synchronous Machine and Transformer	EE223.1	Additional questions for Fast Learner
7.	Explain the operation of Voltage Tripler circuit.	EE223.1	
Unit-II: (Assignment 2)	**Distribution Systems**	**16 to 24 Marks**	
10.	Classify Distribution Systems.	EE223.2	Common for All
11.	With the neat diagram explain Overhead and Underground systems.	EE223.2	
12.	With the neat diagram explain Radial system.	EE223.2	
13.	With the neat diagram explain Ring main system.	EE223.2	
14.	With the neat diagram explain Interconnected systems	EE223.2	
15.	Evaluate the inductance per phase per nleter of three phase double circuit line having conductor radius 4.5 cm with horizontal arrangement. 	EE223.2	
16.	Compare different overhead line insulators	EE223.2	
17.	Distinguish between thermal power generation and hydro power . generation.	EE223.2	Additional question for Fast Learner
Unit- III:(Assignment 3)	**Overhead Transmission Lines and Underground Cables**		**16 to 24 Marks**
Que. No.	**Question**	**CO No.**	**Remark**
9.	Mention different types of conductors.	EE223.3	Common for All
10.	With the neat diagram explain Hard drawn copper conductor.	EE223.3	
11.	With the neat diagram explain ACSR conductor.	EE223.3	
12.	Explain Skin Effect and proximity effect.	EE223.3	
13.	Mention the methods of improving string efficiency.		
14.	Define Sag. Determine the expression for the calculation of sag		

15.	Define Corona. Mention Factors Affecting Corona.	EE223.3	Additional question for Fast Learner
16.	Mention the methods to reduce Corona Effect	EE223.3	
Unit- IV:(Assignment 4)	**Characteristics and Performance of Transmission Line**		**12 to 16 Marks**
8.	Define Short, medium and long lines.	EE223.4	Common for All
9.	Derive expression of ABCD parameters for Short transmission Line	EE223.4	
10.	Derive expression of ABCD parameters for medium transmission Line	EE223.4	
11.	Derive expression of ABCD parameters for long transmission Line	EE223.4	
12.	Explain Ferranti effect	EE223.4	Additional question for Fast Learner
Unit- V: (Assignment 5)	**Power Factor Improvement**		**16 to 24 Marks**
8.	What are the causes of Low power factor?	EE223.5	Common for All
9.	What are the causes of disadvantages power factor?	EE223.5	
10.	Mention methods to Power Factor Improvement .	EE223.5	
11.	Explain Capacitor method to improve Power factor.	EE223.5	
12.	Explain phase advancers method to improve Power factor.	EE223.5	
13.	Derive expression for Most economical power factor.	EE223.5	
14.	Explain synchronous condensers method to improve Power factor.	EE223.5	Additional question for Fast Learner
Unit- VI: (Assignment 6)	**Economic Aspects of Power Generation**		**16 to 24 Marks**
7.	Define the terms : Load, demand, diversity, capacity, Utilization and plant use factors	EE223.6	Common for All
8.	Explain Load curve, load duration and integrated load duration curves	EE223.6	
9.	Mention Different types of tariff.	EE223.6	
10.	Mention Desirable Characteristics of a Tariff.	EE223.6	
11.	Explain Flat Rate, Block-Rate, two-part, three –part, and power factor tariff methods		

An ISO 9001-2015 Certified Institute

SantGajananMaharaj College of Engineering, Mahagaon

Site- Chinchewadi, Tal- Gadhinglaj, Dist- Kolhapur

Department of Electrical Engineering

COURSE PLAN

Course Code	EE 211	Course Name	DC Machines and Transformer
Prepared by	Prof.Bhalekar R.P.	Date	(AY-2018-19)
Verified by	Mr. M.B PATIL	Approved by	Academic Coordinator/ Principal
Objective	This course requires the knowledge of different types of machines and complete basics of transformers, DC machines,		

COURSE OUTCOMES

At the end of this course the students should be able to:

Sr. No.	CO	CO No.
20.	**Describe**[1]the principle of electromechanical conversion	EE 221.01
21.	**Describe**[1]the constructional details.	EE 221.02
22.	Demonstrate the performance of single phase transformer	EE 221.03
23.	**Explain** the construction & working of three phase transformer	EE 221.04
24.	**Explain**[2]special types of transformer	EE 221.05

EXAMINATION SCHEME

Examination Scheme	Theory	Term Work	POE	Total
Maximum Marks	100	25	50	175
Contact Hours	5	2	**	7

MAPPING OF COs-Pos

POs / COs	a	b	c	d	e	f	g	h	i	j	k	l

EE 221.01	3	1		1						1		
EE 221.02	3	1	2	1	1							
EE 221.03	3	1	2	1	1			1				
EE 221.04	3	1	2	1	1							
EE 221.05	3		1		2							

Degree of Compliance of COs and POs 1:Low 2: Medium 3: High

COURSE CONTENTS

Chapter No.	Contents	No. of Hours
I	**ELECTROMECHANICAL ENERGY CONVERSION PRINCIPLE**: Singly Excited Magnetic System and Doubly Excited Magnetic system. Physical concept of torque production; Electromagnetic torque and Reluctance torque. Concept of General terms pertaining to Rotating Machines: Electrical & Mechanical degree, Pole pitch, Coil, Generated EMF in full pitched coil, Generated EMF in a short pitched coil, EMF polygon, Distribution factor, Pitch factor. MMF produced by Distributed Windings, MMF of a coil, MMF of single phase distributed Winding, MMF waveform of Commutator machines	**06 Hrs.**
II	**DC.MACHINES** : Construction of D.C. machines, commutator and brush arrangement, EMF equation, torque equation, armature winding and its types, armature reaction: Demagnetization and cross magnetization ampere turns, principle of compensation, compensating winding, methods to minimize the effect of armature reaction, Process of commutation, Methods to improve commutation, concept of Motoring, types of motor, Concept of back emf, characteristics of d.c. motors, Method of speed controls, concept of braking of DC separately excited motors (Rheostatic, Regenerative and plugging). Parallel and series operation of motor, starter for shunt and series motor, Design of grading of resistance of starters, testing: Losses and efficiency, Brake load test, Swinburne test, Hopkinson's test, Retardation test, field test. Application of Generator and Motor.	**14 Hrs.**
III	**DC.MACHINES** : Construction of D.C. machines, commutator and brush arrangement, EMF equation, torque equation, armature winding and its types, armature reaction: Demagnetization and cross magnetization ampere turns, principle of compensation, compensating winding, methods to minimize the effect of armature reaction, Process of commutation, Methods to improve commutation, concept of Motoring, types of motor, Concept of back emf, characteristics of d.c. motors, Method of speed controls, concept of braking of DC separately excited motors (Rheostatic, Regenerative and plugging). Parallel and series operation of motor, starter for shunt and series motor, Design of grading of resistance of starters, testing: Losses and efficiency, Brake load test, Swinburne test, Hopkinson's test, Retardation test, field test. Application of Generator and Motor.	**10 Hrs.**

IV	**3-PHASE TRANSFORMER**: Determination of polarity and connections (star/star, star/delta, delta/star, star/zigzag, delta/zigzag, open delta), Phasor group's performance of transformers: heat run test, sumpners test, Equivalent delta. Effect of unbalanced loading, Production of Harmonics in Transformer and its suppression, 3 phase to 2 phase transformation, Scott connection 3 phase to 6 phase connections, Double star and Double delta, 3 winding transformer: Parameter estimation, application, Parallel operation of Transformers, Introduction to Tap changing transformer and its function.	**08 Hrs.**
V	**SPECIAL TRANSFORMERS:** Potential transformer, Current transformer, Pulse transformer, Audio frequency transformer, Grounding transformer, Pulse transformer.	**02 Hrs.**

EVALUATION SCHEME

Section	Maximum Marks	Question No.	Chapter No.
I	16	Question-1	Chapter-1
	20	Question-2	Chapter-2
II	18	Question-4	Chapter-3
	24	Question-5	Chapter-4
	18	Question-6	Chapter-5

REFERENCES

Books

Sr.No.	Title of the Book	Author	Publisher/Edition
1.	*Electric Machinery*	Bimbhra P.S	Khanna Publisher
2.	*Generalized Machine Theory*	Bimbhra P.S	Khanna Publisher
3.	*Electric Machines*	Kothari D.P, Nagrath I.J.	TMH Publishcations
4.	*Electric Machinery*	A.E. Fitzgerald, Kingsly, Stephen	Tata McGraw Hill
5.	*Electric Machines*	Ashfaq Husain	DhanpatRai and co. publications

E-books/E-Links

8.	http://www.academia.edu/34040906/P_s_bimbhra_electrical_machines_pdf

NPTEL /Other Video Links

22.	https://www.youtube.com/watch?v=AECBgmkWvo0&list=PLUqpLMfRKiGs1slCYx1egjb-Ore_lq6BG
23.	https://www.youtube.com/watch?v=TpuhGCzlndQ&list=PLZC14dV5ckpGRBilglpDJuKQP0v75KWga
24.	https://www.youtube.com/watch?v=n2JUG8a7kyk&list=PLgzsL8klq6DIf8p4PSbfUzHV6EaLhiNHl

25.	https://www.youtube.com/watch?v=NkRk_xaRwjg&list=PLLQiBbMXygz5QqZ12mEAss8Vn5WKZoirq
26.	https://www.youtube.com/watch?v=f4G5nZUl6sA&list=PLfDaOYdi9aZyBNYxN8IxdnSAPg2_AlpTM

LIST OF ASSIGNMENTS

Asst. No.	Assignment Title	
D. Assignment Exercise		**CO No.**
1.	Electromechanical Energy Conversion Principle	EE 221.01
2.	DC Machines	EE 221.02
3	Transformer – Single Phase	EE 221.03
4.	3-Phase Transformer	EE 221.04
5.	Special Transformers	EE 221.05

LIST OF LAB EXPERIMENTS

SL.NO	EXPERIMENT TITLE
1.	To perform speed control of DC shunt motor
2.	.To study the efficiency of motor by using break load test
3	To obtain open circuit characteristics of self-excited dc shunt generator and to find it's critical
4.	Determination of efficiency of DC motor by Swinburn test
5.	Perform O.C. & S.C. test On single phase transformer and determine equivalent circuit parameter and efficiency
6.	To recognize the load sharing in two similar transformer operation in parallel.
7.	To determine the efficiency and voltage regulation of single phase transformer by direct loading.
8.	To perform polarity test and phasing out test for a 3-phase and 1-phase transformer.
B. Beyond Syllabus Activity	
1.	Industrial visit.

ASSIGNMENT QUESTIONS/QUESTION BANK

Que. No.	Question	CO No.	Remark
Unit- I (Assignment 1) ELECTROMECHANICAL ENERGY CONVERSION PRINCIPLE			
8.	Explain double excited magnetic system in details	EE 221.01	Common for All
9.	Define physical concept of torque production. Also explain electromagnetic torque and reluctance torque	EE 221.01	
10.	With the help of neat diagram explain how torque is produced in DC motor. State the factor on which torque depends.	EE 221.01	Additional questions for Fast Learner
11.	Explain full pitched coil and fractional pitched coil. Also explain commutator pitch and pole pitch.	EE 221.01	
Unit-II: (Assignment 2) DC MACHINES			
18.	Explain following characteristics of DC series. DC shunt and DC compound motor. 1] T-la 2] N-la 3] N-T	EE 221.02	Common for All
19.	Derive condition for maximum efficiency in DC machine .	EE 221.02	
Unit- III:(Assignment 3) TRANSFORMER – SINGLE PHASE			
Que. No.	**Question**	**CO No.**	**Remark**
17.	What is sumpner's test of single phase transformer? How it is carried out on transformer? Draw the neat connection of diagram.	EE 221.03	Common for All
18.	Define voltage regulation of transformer derive condition for 1] Zero voltage regulation 2] Maximum voltage regulation.	EE 221.03	
Unit- IV:(Assignment 4) 3-Phase Transformer			
13.	Draw the Scott connection of transformer and mark the terminal and turn ratio .Also explain vector diagram and it's working.	EE 221.04	Common for All
14.	State varies phasor groups of three phase transformer with their phase displacement. State the application of each group	EE 221.04	
15.	Draw the physical connection and phasor diagram of one 1]YD11 2]DY1 connected three phase transformer	EE 221.04	
Unit- V: (Assignment 5)Special Transformers			
15.	Explain 1) Current transformer	EE 221.05	Common for

	2) Audio Frequency transformer 3) Isolation transformer and its application 4) Grounding transformer	EE 221.05 EE 221.05	All

An ISO 9001-2015 Certified Institute

SantGajananMaharaj College of Engineering, Mahagaon

Site- Chinchewadi, Tal- Gadhinglaj, Dist- Kolhapur

Department of Electrical Engineering

COURSE PLAN

Course Code		**Course Name**	Control Systems-I
Prepared by	Ms. Shevale P.B.	**Date**	
Verified by	Mr. Patil M.B.(HOD ELECTRICAL)	**Approved by**	Academic Coordinator/ Principal
Objective	This course requires the knowledge of Engineering mathematics and its applications. Concept of Transfer Function for different physical system, stability of system in time domain and laplace domain. Designing of root locus and frequency response techiniques.controllability and observability of system.		

COURSE OUTCOMES

At the end of this course the students should be able to:

Sr. No.	CO	CO No.
25.	**Illustrate**[2] the transfer functions of different physical systems.	EE215.1
26.	**Demonstrate**[2] the system stability and system response.	EE215.2
27.	**Illustrate**[2] the servo component.	EE215.3
28.	**Examine**[4] behavior of systems using Root locus and Routh-Hurwitz criteria	EE215.4
29.	**Detect** behavior of systems using Bode plot.	EE215.5
30.	**Develop**[3] the state model of system and its analysis.	EE215.6

EXAMINATION SCHEME

Examination Scheme	Theory	Term Work	OE	Total
Maximum Marks	100	50	--	150
Contact Hours	04	02	**	06

MAPPING OF COs-Pos

POs / COs	a	b	c	d	e	f	g	h	i	j	k	l
EE215.1	2				1							
EE215.2	2	2	1									
EE215.3	2											
EE215.4	2		2									
EE215.5	2	2	1									
EE215.6	2	2			1			2				

Degree of Compliance of COs and POs 1:Low 2: Medium 3: High

COURSE CONTENTS

Chapter No.	Contents	No. of Hours
I	**MODELING AND REPRESENTATION OF CONTROL SYSTEM AND TRANSFER FUNCTION.** History of control system, Laplace transform review, Transfer function of electrical, mechanical, thermal, hydraulic system, Electrical circuits analogs, Block dia. Representation and reduction, types of feedback systems, signal flow graph, Mason's gain rule, SFG.	**09 Hrs.**
II	**TIME DOMAIN ANALYSIS AND STABILITY CONCEPT** Response of first and second order system, general second order system, response with additional pole and zeros, steady state error for unity feedback system , static error constants and systems type, steady state error specifications, Routh criteria for stability.	**10 Hrs.**
III	**SERVO COMPONENETS** Error detectors ,Potentiometer, synchros, optical rotary encoders, DC and AC Servomotors, stepper motor, gear trains, A C and DC tacho-generators, Transfer function and applications of these.	**08 Hrs.**

IV	**ROOT LOCUS** Definition of root locus, Rules for plotting root loci, Root contour, stability analysis using root locus, effect of addition of pole and zero.	**06 Hrs.**
V	**FREQUENCY RESPONSE TECHNIQUE** Bode plot, Nyquist criterion, stability, gain margin, phase margin by Nyquist diagram and bode plot, Determination of transfer function from bode plot.	**08 Hrs.**
VI	**STATE SPACE CONCEPT**. State space representation, phase variable form, converting transfer function to state space and vice versa, Canonical form, companion form, Jordan Canonical form, Solution of state equations. Concept of controllability and observability, eigen values and stability.	**07 Hrs.**

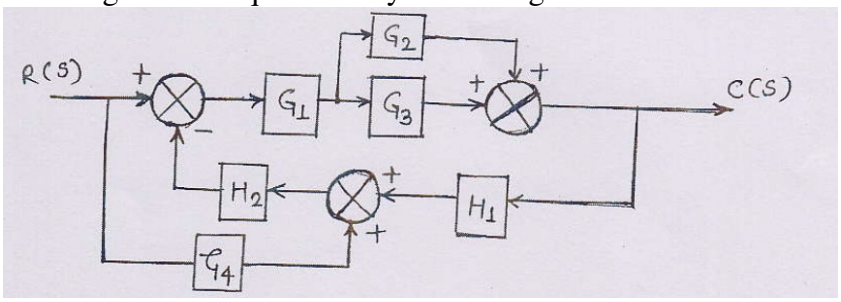
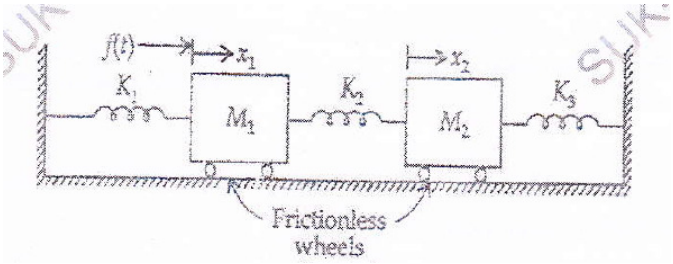
EVALUATION SCHEME

Section	Maximum Marks	Question No.	Chapter No.
I	16Marks	Question-1	Chapter-1
	18 Marks	Question-2	Chapter-2
	16 Marks	Question-3	Chapter-3
II	18 Marks	Question-4	Chapter-4
	16 Marks	Question-5	Chapter-5
	16 Marks	Question-6	Chapter-6

REFERENCES

Books	
18.	"Control system principles and design", M. Gopal, Tata McGraw-Hill Publishing 4thedition.
19.	"Modern Control Engineering", K. Ogata,Eastern Economy 5th Edition.
20.	"Automatic Control System", B.C. Kuo, Wiley 8th edition
21.	"Control System Engineering", Norman S. Nise, John Wiley 4th edition..
22.	"Digital Control and State Variable Analysis", M.Gopal , Tata McGraw-Hill Publishing 4th edition.
E-books/E-Links	
9.	"Control System", M. Gopal, 4th Edition.
NPTEL /Other Video Links	
27.	Control System M. Gopal NPTEL Video

ASSIGNMENT QUESTIONS/QUESTION BANK

Que. No.	Question	CO No.	Remark
Unit- I (Assignment 1) Modeling and Representation of Control System and Transfer Function. 16 to 24 Marks			
12.	Define i) Control systems ii) Input iii) Output iv) Control v) Control Actionvi) Disturbance vii) Feedback	EE215.1	Common for All
13.	Give classification of Control System with examples	EE215.1	
14.	Find single block equivalent by block diagram reduction 	EE215.1	
15.	Draw mechanical equivalent network and write the system equation. 	EE215.1	
16.	Give the comparison between block diagram reduction and signal flow graph method	EE215.1	
Unit-II: (Assignment 2) Control System Design and Analysis by Root Locus Method 16 to 24 Marks			
20.	What is Time response? Explain their types	EE215.2	Common for All
21.	Derive expression of Steady State Error	EE215.2	
22.	Explain analysis of first order system and second order syatem.	EE215.2	
23.	Explain Transient response specifications	EE215.2	
24.	Feedback control system described by $G(s) = \frac{K}{s^2(s+20)(s+30)}$; H(s)=1 Determine steady state error coefficient and also determine value of K to limit steady state error to 10 units due to input $r(t) = 1 + 10t + 20t^2$	EE215.2	

25.	What is Routh's Stability Criterion, Give advantages and disadvantages	EE215.2	
26.	Determine Stability of the system $s^5 + s^4 + 2s^3 + 2s^2 + 3s + 5$	EE215.2	
27.	A unity feedback system has $G = \frac{K}{(s+4)(s+6)(s+10)}$ find range of K so that system will be stable.	EE215.2	
28.	Derive generalized equation for second order system in under damped condition and draw step response	EE215.2	
29.	For the feedback system $G(s) = \frac{36}{s(s+0.27)}$ Find characteristic equation, damping ratio, peak time, settling time peak overshoot	EE215.2	
Unit- III:(Assignment 3) Servo Components 16 to 24Marks			
Que. No.	**Question**	**CO No.**	**Remark**
19.	Explain Error Detector	EE215.3	Common for All
20.	Explain Potentiometer.	EE215.3	
21.	Write short note on Synchros	EE215.3	
22.	Explain DC and AC servomotors	EE215.3	
23.	Write a short note on stepper motor	EE215.3	
24.	Explain DC- AC tacho-generator	EE215.3	
25.	Derive and explain Gear Trains	EE215.3	
Unit- IV:(Assignment 4) Root Locus 12 to16Marks			
16.	What is root locus write steps for solving root locus.	EE215.4	Common for All
17.	Explain effect of addition of poles and zeros on root locus .	EE215.4	
18.	Obtain root locus plot for the unity feedback system with transfer function $G(s) = \frac{K}{s(s+2)}$	EE215.4	
19.	A unity feedback control system has an open loop transfer function $G(s) = \frac{K}{s(s^2 + 4s + 13)}$	EE215.4	

	Determine : i)Centroid, number and angle of asymptotes ii)Breakaway points if any		
20.	**S**ketch the root locus of a unity feedback control system with $G(s) = \frac{k}{s(s+1)(s+3)}$ And determine the value of k for marginal stability	EE215.4	
21.	The open loop transfer function of a system is $G(s) = \frac{k}{s(s+2+2j)(s+2-2j)}$ Determine the complete root locus and comment on the stability of the closed loop system.	EE215.4	
22.	Sketch the root locus diagram of a control system having $G(s) = \frac{k(s+4)}{s(s^2+6s+13)}$ and H(s)=1 Also find the value of k for a system having damping ratio 0.707	EE215.4	
Unit- V: (Assignment 5) Frequency Response Technique 16 to 24Marks			
16.	Write steps for solving Bode plot	EE215.5	Common for All
17.	Explain Nyquist stability criteria in detail	EE215.5	
18.	What is the correlation between Time Response and Frequency Response?	EE215.5	
19.	Sketch the Bode plot for the transfer function given by, $G(s)H(s) = \frac{K}{[s(s+2)(s+3)]}$	EE215.5	
20.	The open loop transfer function of a unity feedback system is given by, $G(s)H(s) = \frac{5}{[s(s+1)(s+2)]}$ Draw the Nyquist plot and find whether the system is stable or not	EE215.5	
21.	Explain in detail the effect of poles on stability with suitable example.	EE215.5	
22.	Determine the closed loop stability of a control system whose open loop transfer function is $G(s)H(s) = \frac{10}{(s+1)(s+3)(s+7)}$	EE215.5	

	using nyquist criteria.		
23.	Sketch the bode Bode plot for the open loop transfer function $$G(s)H(s) = \frac{1000}{s(1+0.1s)(1+0.001s)}$$ Determine the GM,PM,ω_{gc} and ω_{pc}. Also comment on stability.	EE215.5	
24.	Draw the trajectory when ξ=0.5,ω_n=1rad/sec. For unit step input.	EE215.5	
Unit- VI:(Assignment 6) State Space Concept 16 to 24Marks			
12.	State and explain state space representation using phase variable form	EE215.6	Common for All
13.	Explain Jordan Canonical Form	EE215.6	
14.	Give advantages of state space representation over transfer function.	EE215.6	
15.	State and explain Controllability and Observability	EE215.6	
16.	Obtain state transition matrix using Cayley Hamilton method (Solve by manually and using MATLAB) $$A = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix}$$	EE215.6	
17.	Find out the solution of state equation, state transition matrix and output of system having state model $$x = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$ $$y = [1 \quad 1]x$$ $$x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$ u=unit step signal	EE215.6	
18.	Define controllability and observability and check for the system $$x = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$ $$y = [1 \quad 0 \quad 0]x$$	EE215.6	
19.	Find the space model of the following T.F. using MATLAB and manually $$\frac{Y(s)}{U(s)} = \frac{3s^2 + 2s + 7}{(s^3 + 5s^2 + 12s + 5)}$$ Also obtain the phase variable form.	EE215.6	