MOHAMMED SATHAK A J COLLEGE OF ENGINEERING

Siruseri IT park, OMR, Chennai - 603103

LESSON PLAN

Department of Electrical and Electronics Engineering

Name of the Subject	POWER SYSTEM OPERATION AND CONTROL	Name of the handling Faculty	Mrs.R. ABIRAMI
Subject Code	EE8702	Year / Sem	IV/VIII
Acad Year	2022-2023	Batch	2019-2023

Course Objective

To impart knowledge on the following topics

• Significance of power system operation and control.

• Real power-frequency interaction and design of power-frequency controller.

• Reactive power-voltage interaction and the control actions to be implemented for maintaining the voltage profile against varying system load.

• Economic operation of power system.

• SCADA and its application for real time operation and control of power systems

Course Outcome

CO1 Analyze the various load characteristics with load curve and load duration curve by applying the Engineering knowledge

CO2 Develop the static and dynamic modelling of simple single area and two area power systems for frequency control

CO3 Develop the static and dynamic modelling of simple single area and two area power systems for voltage control

CO4 Solve economic dispatch problems and unit commitments problems in power Systems

CO5 Explain the need of computer controls to energy management using SCADA

Lesson Plan

Sl. No.	Topic(s)	T / R* Book	Periods Required	Mode of Teaching (BB / PPT / NPTEL / MOOC / etc)	Blooms Level (L1-L6)	CO	PO
UNIT I PRELIMINARIES ON POWER SYSTEM OPERATION AND CONTROL							
1	Power scenario in Indian grid	T2	1	BB, PPT	L1	CO1	PO1-PO2
2	National and Regional load dispatching centers	T2	1	BB, PPT	L1	CO1	PO1-PO2
3	Requirements of good power system	T2	1	BB, PPT	L1	CO1	PO1-PO2
4	Necessity of voltage and frequency regulation	T2	1	BB, PPT	L3	CO1	PO1-PO3
5	Real power vs frequency and reactive power vs voltage control loops	T2	1	BB, PPT	L3	CO1	PO1-PO3
6	System load variation, loadcurves	T2	1	BB, PPT	L3	CO1	PO1-PO3
7	Basic concepts of load dispatching, load forecasting	T2	1	BB, PPT	L1	CO1	PO1-PO3
8	Basics of speed governing mechanisms and modeling - speed load characteristics	T2	1	BB, PPT	L3	CO1	PO1-PO3
9	Regulation of two generators in parallel.	T2	1	BB, PPT	L1	CO1	PO1-PO2

Suggested Activity: Assignment / Case Studies / Tuorials/ Quiz / Mini Projects / Model Developed/others Planned if any : Assignment on speed governing mechanism

Evaluation method Conducting Quiz on Preliminaries on power system operation and control

UNIT II REAL POWER - FREQUENCY CONTROL							
10	Load Frequency Control (LFC) of single area system-static	R3	1	BB, PPT	L1	CO2	PO1-PO3
11	Dynamic analysis of uncontrolled and controlled cases	R3	1	BB, PPT	L2	CO2	PO1-PO3
12	LFC of two area system	R3	1	BB, PPT	L2	CO2	PO1-PO3
13	Tie line modeling	R3	1	BB, PPT	L3	CO2	PO1-PO3
14	Block diagram representation of two area system	T2	1	BB, PPT	L3	CO2	PO1-PO3
15	Static and dynamic analysis	R3	1	BB, PPT	L1	CO2	PO1-PO3
16	Tie line with frequency bias control	R3	1	BB, PPT	L3	CO2	PO1-PO3
17	State variability model	R3	1	BB, PPT	L3	CO2	PO1-PO3
18	Integration of economic dispatch control with LFC.	R3	1	BB, PPT	L2	CO2	PO1-PO3

Suggested Activity: Asssignment / Case Studies / Tuorials/ Quiz / Mini Projects / Model Developed/others Planned if any : HV test on power as well as control and protective circuits

Evaluation method paper based
evaluation on the given topic

UNIT III REACTIVE POWER – VOLTAGE CONTROL							
19	Generation and absorption of reactive power - basics of reactive power control	R3	1	BB, PPT	L1	CO3	PO1-PO3
20	Automatic Voltage Regulator (AVR) – brushless AC excitation system	R3	1	BB, PPT	L2	CO3	PO1-PO3
21	Block diagram representation of AVR loop	R3	1	BB, PPT	L2	CO3	PO1-PO3
22	Static and dynamic analysis	R3	1	BB, PPT	L3	CO3	PO1-PO3
23	Stability compensation – voltage drop in transmission line	R3	1	BB, PPT	L1	CO3	PO1-PO3
24	Methods of reactive power injection	R3	1	BB, PPT	L1	CO3	PO1-PO3
25	Tap changing transformer	R3	1	BB, PPT	L1	CO3	PO1-PO3
26	SVC (TCR + TSC)	R3	1	BB, PPT	L1	CO3	PO1-PO3
27	STATCOM for voltage control.	R3,R5	1	BB, PPT	L1	CO3	PO1-PO3

Suggested Activity: Assignment / Case Studies / Tuorials/ Quiz / Mini Projects / Model Developed/others Planned if any Assignments on New trends on reactive power injection

Evaluation method Quiz on
reactive power voltage control

UNIT IV ECONOMIC OPERATION OF POWER SYSTEM							
28	Statement of economic dispatch problem	R3	1	BB, PPT	L4	CO4	PO1-PO5
29	Input and output characteristics of thermal plant	R3	1	BB, PPT	L1	CO4	PO1-PO3
30	Incremental cost curve	R3	1	BB, PPT	L3	CO4	PO1-PO3
31	Optimal operation of thermal units without and with transmission losses (no derivation of transmission loss coefficients)	R3	1	BB, PPT	L3	CO4	PO1-PO3
32	Base point and participation factors method	R3	1	BB, PPT	L3	CO4	PO1-PO3
33	Statement of unit commitment (UC) problem	R3	1	BB, PPT	L4	CO4	PO1-PO5,PO12
34	constraints on UC problem	R3,R5	1	BB, PPT	L3	CO4	PO1-PO3
35	Solution of UC problem using priority list	R3	1	BB, PPT	L4	CO4	PO1-PO5
36	Special aspects of short term and long term hydrothermal problems.	R3	1	BB, PPT	L3	CO4	PO1-PO3,PO7

Suggested Activity: Assignment / Case Studies / Tuorials/ Quiz / Mini Projects / Model Developed/others Planned if any Assignment problems on unit commitment and Economic Dispatch problem

Evaluation method : paper based

evaluation method on the given assignment topic

UNIT V COMPUTER CONTROL OF POWER SYSTEMS

37	Need of computer control of power systems	R3	1	BB, PPT	L1	CO5	PO1-PO2
38	concept of energy control centers and functions	R3	1	BB, PPT	L1	CO5	PO1-PO2
39	PMU - system monitoring	R3	1	BB, PPT	L1	CO5	PO1-PO2
40	Data acquisition and controls	R3	1	BB, PPT	L1	CO5	PO1-PO2
41	System hardware configurations- SCADA and EMS functions	R3	1	BB, PPT	L1	CO5	PO1-PO2
42	state estimation problem	R3	1	BB, PPT	L3	CO5	PO1-PO3
43	measurements and errors , weighted least square estimation	R3	1	BB, PPT	L2	CO5	PO1-PO2
44	various operating states	R3	1	BB, PPT	L1	CO5	PO1-PO2
45	state transition diagram.	R3	1	BB, PPT	L1	CO5	PO1-PO2

Suggested Activity: Assignment / Case Studies / Tuorials/ Quiz / Mini Projects / Model Developed/others Planned if any : Assignment on advanced power system control methods

Evaluation method : quiz conduction on power system control methods

Content Beyond the Syllabus Planned

1	Fundamentals of Evolutionary algorithms
2	Solution of Economic Dispatch problem using Optimization Techniques (EA)

Text Books

1	Olle.I.Elgerd, 'Electric Energy Systems theory - An introduction', McGraw Hill Education Pvt. Ltd., New Delhi, 34th reprint, 2010.
2	Allen. J. Wood and Bruce F. Wollen berg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 2016.
3	Abhijit Chakrabarti and Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.

Reference Books

1	Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, Second Edition, 2008.
2	Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi,21st reprint, 2010.
3	Kundur P., 'Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.

Website / URL References

1	https://nptel.ac.in/courses/108/104/108104052/
2	https://nptel.ac.in/courses/108/105/108105104/
3	https://nptel.ac.in/courses/108/101/108101040/

Blooms Level

Level 1 (L1) : Remembering **Level 2 (L2) : Understanding** **Level 3 (L3) : Applying**	Lower Order Thinking	Fixed Hour Exams	**Level 4 (L4) : Analysing** **Level 5 (L5) : Evaluating** **Level 6 (L6) : Creating**		Higher Order Thinking	Projects / Mini Projects

Mapping syllabus with Bloom's Taxonomy LOT and HOT

Unit No	Unit Name	L1	L2	L3	L4	L5	L6	LOT	HOT	Total
Unit 1	Preliminaries On Power System Operation And Control	5	0	4	0	0	0	9	0	9
Unit 2	Real Power - Frequency Control	2	3	4	0	0	0	9	0	9
Unit 3	Reactive Power – Voltage Control	6	2	1	0	0	0	9	0	9
Unit 4	Economic Operation Of Power System	1	0	5	3	0	0	6	3	9
Unit 5	Computer Control Of Power Systems	7	1	1	0	0	0	9	0	9
Total		21	6	15	3	0	0	42	3	45
Total Percentage		46.67	13.33	33.33	6.67	0	0	93.33	6.67	100

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2										1	
CO2	3	3	3										2	
CO3	3	3	3										2	
CO4	3	2	2	1	1		1					1	1	
CO5	3	3	1		1								2	
Avg	3	2.8	2.2	0.2	0.4		0.2					0.2	1.6	

Justification for CO-PO mapping

CO1	High correlation for PO1&PO2 and medium correlation for PO3 it is having application in Conventional Non Conventional energy.
CO2	High correlation for PO1,PO2 &PO3 , its having medium correlations with PSO 1 having the societal environmental benefits
CO3	High correlation for PO1,PO2 & PO3 , it is used for reactive power calculation.
CO4	High correlation for PO1,Medium level correlation for PO2 & PO3 & Low level Correlation for PO4, PO5 & PO7 it is related with PSO1 in Conventional Non Conventional energy.
CO5	High correlation for PO1&PO2, Low level Correlation for PO3, correlation for PSO1 can be able to design a modelling of an computer control system

3	**High level**	**2**	**Moderate level**	**1**	Low level

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Name & Sign of Subject Expert : Dr.J.Jeha

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