Department of Electrical and Electronics Engineering

COURSE MODULES OF THE SUBJECT TAUGHT FOR THE SESSION SEP–DEC 2024-25

Course Syllabi with CO's

Faculty Name: Shreeshayana R			**Academic Year: 2024-25**				
Department: Electrical and Electronics Engineering							
Course Code	Course Title	Core/ Elective	Prerequisite	Contact Hours			Total Hrs/ Sessions
				L	T	P	
21EE72	Power System Operation and Control	CORE	Power System Analysis-I, SCADA Fundamentals	4	-	-	50
Objectives	**After going through the course, the students should be able to:** • To describe various levels of controls in power systems and the vulnerability of the system. • To explain components, architecture and configuration of SCADA. • To explain basic generator control loops, functions of Automatic generation control, speed governors and mathematical models of Automatic Load Frequency Control • To explain automatic generation control, voltage and reactive power control in an interconnected power system. • To explain reliability and contingency analysis, state estimation and related issues.						
Topics Covered as per Syllabus							
Module-1: **Introduction:** Operating States of Power System, Objectives of Control, Key Concepts of Reliable Operation, Preventive and Emergency Controls, Energy Management Centers. **Supervisory Control and Data acquisition (SCADA):** Introduction, components, application in Power System, basic functions and advantages. Building blocks of SCADA system, components of RTU, communication subsystem, IED functional block diagram. **Classification of SCADA system:** Single master–single remote; Single master–multiple RTU; Multiple master–multiple RTUs; and Single master, multiple submaster, multiple remote. **[10 Hours]**							
Bloom's Taxonomy Level	L1 – Remembering, L2 – Understanding						
Module-2: **Automatic Generation Control (AGC):** Introduction, Schematic diagram of load frequency and excitation voltage regulators of turbo generators, Load frequency control (Single area case), Turbine speed governing system, Model of speed governing system, Turbine model, Generator load model, Complete block diagram of representation of load frequency control of an isolated power system, Steady state analysis, Control area concept, Proportional plus Integral Controller. **[10 Hours]**							
Bloom's Taxonomy Level	L1 – Remembering, L2 – Understanding, L3 – Applying, L4-Analyzing						
Module-3: **Automatic Generation Control in Interconnected Power system:** Two area load frequency control, Optimal (Two area) load frequency control by state variable, Automatic voltage control, Load frequency control with generation rate constraints (GRCs), Speed governor dead band and its effect on AGC, Digital LF Controllers, Decentralized control. **[10 Hours]**							
Bloom's Taxonomy Level	L1 – Remembering, L2 – Understanding, L3 – Applying, L4-Analyzing						
Module-4: **Control of Voltage and Reactive Power:** Introduction, Generation and absorption of reactive power, Relation between voltage, power and reactive power at a node, Methods of voltage control: i. Injection of reactive power, Shunt capacitors and reactors, Series capacitors, Synchronous compensators, Series injection. ii Tap changing transformers. Combined use of tap changing transformers and reactive power injection, Booster transformers, Phase shift transformers, Voltage collapse. **[10 Hours]**							
Bloom's Taxonomy Level	L1 – Remembering, L2 – Understanding, L3 – Applying, L4-Analyzing						

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Module-5:
Power System Security: Introduction, Factors affecting power system security, Contingency Analysis, Linear Sensitivity Factors, AC power flow methods, Contingency Selection and Ranking.
State estimation of Power Systems: Introduction, Linear Least Square Estimation. **[10 Hours]**

Bloom's Taxonomy Level	L1 – Remembering, L2 – Understanding, L3 – Applying

List of Text Books

1. Power System Operation and Control, K. Uma Rao, Wiley, 1st Edition, 2012.
2. Modern Power System Analysis, D. P. Kothari, McGraw Hill, 4th Edition, 2011.
3. Power Generation Operation and Control, Allen J Wood et al, Wiley, 2nd Edition, 2003.
4. Electric Power Systems, B M Weedy, B J Cory, Wiley. 4th Edition, 2012.

List of Reference Books

1. Computer-Aided Power System Analysis, G. L. Kusic, CRC Press, 2nd Edition.2010.
2. Power System SCADA and Smart Grid, Mini S Thom and John D. McDonald, CRC Press 2015.
3. Power System Stability and Control, Kundur, McGraw Hill, 8th Reprint, 2009.

List of URLs, Text Books, Notes, Multimedia Content, etc

https://archive.nptel.ac.in/courses/108/104/108104052/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning
Activity Based Learning, Quizzes, Seminars.

Course Outcomes	**At the end of the course the student will be able to:** CO-1: **Describe** various levels of controls in power systems, architecture and configuration of SCADA **[L2]** CO-2: Develop and **analyze** mathematical models of Automatic Load Frequency Control **[L4]** CO-3: **Develop** mathematical model of Automatic Generation Control in Interconnected Power system **[L4]** CO-4: **Discuss** the Control of Voltage, Reactive Power and Voltage collapse **[L4]** CO-4: Explain security, contingency analysis, and state estimation of power systems **[L3]**

Assessment Details (both CIE and SEE)
The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than **35% (18 Marks out of 50)** in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.
Continuous Internal Evaluation:
Three Unit Tests each of **20 Marks (duration 01 hour**)
1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester
Two assignments each of **10 Marks**
4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester
Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks** (**duration 01 hours**)
6. At the end of the 13th week of the semester
The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**
(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.
Semester End Examination: Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)** • The question paper will have ten questions. Each question is set for 20 marks. • There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module. The students have to answer 5 full questions, selecting one full question from each module.

The Correlation of Course Outcomes (CO's) and Program Outcomes (PO's)

Course Code:	**21EE72**	**TITLE: Power System Operation and Control**						**Faculty Name:**		**Mr.Shreeshayana R**	
List of Course Outcomes	**Program Outcomes**										
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO-1	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO-2	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO-3	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO-4	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**
CO-5	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

Note: 3 = Strong Contribution 2 = Average Contribution 1 = Weak Contribution "-" = No Contribution

The Correlation of Course Outcomes (CO's) and Program Specific Outcomes (PSO's)

Course Code: 21EE72	**TITLE: Power System Operation and Control**	**Faculty Name:** Mr.Shreeshayana R
List of Course Outcomes	**Program Specific Outcome**	
	PSO1	**PSO2**
CO-1	-	3
CO-2	-	3
CO-3	-	3
CO-4	-	3
CO-5	-	3

Note: 3 = Strong Contribution 2 = Average Contribution 1 = Weak Contribution "-"= No Contribution