INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

Department of Electrical and Electronics Engineering

COURSE DESCRIPTION FORMS

Course Title	**POWESYSTEM OPERATION AND CONTROL**			
Course Code	**A70230**			
Regulation	**R13**			
Course Structure	**Lectures**	**Tutorials**	**Practical's**	**Credits**
	4	**1**	**-**	**4**
Course Coordinator	**Mr. A Sathish Kumar, Assistant Professor, EEE**			
Team of Instructors	**Mr. A Sathish Kumar, Assistant Professor, EEE**			

I. COURSE OVERVIEW:

This electrical distribution course introduces the components of the distribution system and the way in which the system delivers power to end-use customers. Included in the course are descriptions of key system components including single and three phase lines as well as we and delta lines. The course also addresses the ways in which distribution systems are designed to serve various types of customer loads

II. PREREQUISITES:

Level	Credits	Periods	Prerequisite
UG	4	4	Power System-I, Computer Methods in Power Systems.

III. COURSE ASSESSMENT METHODS:

a) Marks distribution:

Session Marks	University End Exam Marks	Total Marks
There shall be two mid tem examinations. Each id term exam consists of subjective type and objective type test. The subjective test is for 10 marks, with duration of 1 hour. Subjective test of each semester shall contain four questions; the student has to answer two out of them. Each carrying 5 marks The objective test paper Is prepared by JNTUH, which consists of 20 questions each carrying 0.5 marks and total of 10 marks. The student is assessed by giving two assignments, one, after completion of 1to 4 units and the second, after the completion of 4 to 8 units each carrying 5 marks. On the total the internal marks are 25. The average of two internal tests is the final internal marks. The external question paper is set by JNTUH consisting of 8 questions each carrying 15 marks out of which 5 questions are to be answered their by external examination is of total 75 mark	75	100

IV. EVALUATION SCHEME:

S. No	Component	Duration	Marks
1	I Mid Examination	90 minutes	20
2	I Assignment	--	05
3	II Mid Examination	90 minutes	20
4	II Assignment	--	05
5	External Examination	3 hours	75

V. COURSE OBJECTIVE:

The course should enable the students to:

i. Illustrate the Economic operation of power systems and optimal loading.
ii. Demonstrate the modeling of turbines and automatic controllers.
iii. Understand the single area and two area load frequency control.
iv. Understand the reactive power control and compensating equipments.

VI. COURSE OUTCOMES:

Students, who complete the course, will have demonstrated the ability to do the following:

1. Design an optimal operation setup of power system which minimizes operation costs and meet desired needs
2. Compute energy generation, power system behavior and economics of generating costs.
3. Understand optimal operation setup design problem and constraints that include most of the following: economic, environmental, operability and security
4. Understand thermal and hydro generator characteristics and their economic operation.
5. Understand the optimum operation and scheduling of thermal and hydel plants
6. Solve the unit Commitment problem with various constraints using conventional optimization techniques.
7. Develop the modeling of speed-governor systems for steam and hydraulic turbines
8. Design the single area and two area thermal power system.
9. Solve economic dispatch, unit commitment, load frequency control and automatic voltage generation using conventional method
10. Understand the significance of reactive power control in power systems to maintain quality of power
11. Design appropriate control scheme to compensate reactive power
12. Understand the concept of power systems and operation and control to solve real time world applications
13. Explore the knowledge and skills of employability to succeed in national and international level competitive examinations

VII. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program outcomes		Level	Proficiency Assessed By
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	H	Exercise and Discussion
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.	S	Exercise and Discussion
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.	S	Discussion and Seminar
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis	N	------

	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 modeling to complex engineering activities with an understanding of the limitations.	N	------
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.	N	------
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.	N	------
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	N	------
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	N	------
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.	N	------
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.	N	------
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.	N	------

N= None **S=Supportive** **H=highly related**

VIII. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency Assessed By
PSO1	**Professional Skills:** Able to utilize the knowledge of high voltage engineering in collaboration with power systems in innovative, dynamic and challenging environment, for the research based team work.	H	Lectures, Assignments
PSO2	**Problem-Solving Skills:** Can explore the scientific theories, ideas, methodologies and the new cutting edge technologies in renewable energy engineering, and use this erudition in their professional development and gain sufficient competence to solve the current and future energy problems universally.	N	------
PSO3	**Successful Career and Entrepreneurship:** The understanding of technologies like PLC, PMC, process controllers, transducers and HMI one can analyze, design electrical and electronics principles to install, test , maintain power system and applications.	N	------

N - None **S - Supportive** **H - Highly Related**

IX. SYLLABUS:

UNIT I:

Economic Operation of Power Systems: Optimal operation of Generators in Thermal Power Stations, heat rate Curve ,Cost Curve, Incremental fuel and Production costs, input-output characteristics, Optimum generation allocation with line losses neglected. Optimum generation allocation including the effect of transmission line losses – Loss Coefficients, General transmission line loss formula.

UNIT II:

Hydrothermal Scheduling: Optimal scheduling of Hydrothermal System: Hydroelectric power plant models, scheduling problems- Short term hydrothermal scheduling problem.

UNIT III:

Modeling of Turbine, Generator and Automatic Controllers Modeling of Turbine: First order Turbine model, Block Diagram representation of Steam Turbines and Approximate Linear Models.

Modeling of Generator (Steady State and Transient Models): Description of Simplified Network Model of a Synchronous Machine (Classical Model), Description of Swing Equation (No Derivation) and State-Space II-Order Mathematical Model of Synchronous Machine.

Modeling of Governor: Mathematical Modeling of Speed Governing System – Derivation of small signal transfer function.

Modeling of Excitation System: Fundamental Characteristics of an Excitation system, Transfer function, Block Diagram Representation of IEEE Type-1 Model.

UNIT IV:

Single Area & Two-area Load Frequency Control: Necessity of keeping frequency constant. Definitions of Control area – Single area control – Block diagram representation of an isolated power system – Steady state analysis – Dynamic response – Uncontrolled case.

Load Frequency Control Load frequency control of 2-area system: uncontrolled case and controlled case, tie-line bias control.

Load Frequency Controllers: Proportional plus Integral control of single area and its block diagram representation, steady state response – Load Frequency Control and Economic dispatch control.

UNIT V:

Reactive Power control: Overview of Reactive Power Control - Reactive Power compensation in transmission systems – advantages and disadvantages of different types of compensating equipment for transmission systems; load compensation – Specifications of load compensator, Uncompensated and compensated transmission lines: shunt and Series Compensation (Quantitative treatment)

X. COURSE PLAN:

At the end of the course, the students are able to achieve the following course learning outcomes:

Lecture No.	Learning Objectives	Topic To Be Covered	Reference
1	To understand optimal System	Introduction to optimal system operation	T_1:5
2	To understand economy of operation	Economic operation and economic dispatch	T_1:6-7
3	To derive optimum allocations	Optimum generation allocations without line losses	T_1:8-9
4	Exercise	Solving problems	T_1,T_3
5	To understand the constraints in the operation of thermal power plant	Constraints in the operation of thermal power plant	T_1:25-26
6	To understand the optimal scheduling	Optimal scheduling of thermal generators,	T_1:26-28

		input/output and incremental fuel cost curves	
7	To understand the optimum generation allocation	Optimum generation allocation including the effect of transmission line losses	T_1:26-28
8-9	Exercise	Solving problems	T_1
10	To derive line loss formula	General transmission line loss formula	T_1:12
11-12	Exercise	Solving Problems	T_1, T_3
13	To design the modeling of turbine	Modeling of turbine	T_3:285-286
14	To remember turbine models	Automatic controllers modeling of turbine	T_3:285-287
15	To remember turbine models	First order turbine model,	T_3:286
16	To understand the steam turbines	Block diagram representation of steam turbines	T_3:289
17	To understand linear model	Approximate linear models	T_3:292
18	To remember generator modeling	Modeling of generator	T_3:272
19	To understand the model of synchronous machine	Description of simplified network model of a synchronous machine	T_3:285
20-21	Exercise	Solving Problems	T_1, T_3
22	To derive the swing expression	Description of swing equation	T_3:312
23	To understand the mathematical model	State space second order mathematical model of synchronous machine	T_3:318
24	To understand the speed governing system	Mathematical modeling of speed governing system	T_3:322-326
25	To derive signal transfer function	Derivation of small signal transfer function	T_3:327
26	To understand the modeling of excitation system	Modeling of excitation system	T_3:412
27-28	Exercise	Solving Problems	T_1, T_3
29	To understand the excitation systems	Fundamental characteristics of an excitation system	T_3:319
30	To remember transfer function	Transfer function, block diagram	T_3:320
31	To remember IEEE Model	Representation of IEEE Type-1 Model	T_1:85
32	Exercise	Solving Problems	T_1
33	To understand Hydrothermal Scheduling	Hydrothermal scheduling	T_1:29-32
34	To understand the single control area and two control area	Control area, mechanism of individual generators	T_1:31-33
35	To understand speed variations	Speed regulations	T_1:31-38
36	To remember the generator loading	Single and two generators systems	T_1:56-58
37	To understand the control strategies	Generator controllers	T_1:59
38	To understand how to control the output of generator	Load frequency control of single area	T_1:65
39	To understand load frequency control	Study state analysis of load frequency control system	T_1:67-68
40	To remember PI control	Dynamic response and PI Controller	T_1:69
41- 42	Exercise	Solving Problems	T_1
43	To understand two control area	Two control area	T_1:285
44	To remember dynamic response	CI control and dynamic response	T_1:290
45	To understand two control area	Load frequency control of two area system	T_1:286
46- 47	Exercise	Solving problems	T_1
48	To understand controlled devices	Uncontrolled case and controlled case	T_1:291-94

49	To understand control reactive power	Overview of reactive power control	T_1:295
50	To remember compensation in transmission system	Reactive power compensation in transmission systems	T_1:296
51	To understand compressions	Advantages and disadvantages of different types of compensating methods	T_1:297-298
52	To remember compensate reactive power at load side	Load compensation	T_1:312-313
53	To remember specifications load compensator	Specifications of load compensator	T_1:315
54	To understand performance of uncompensated system	Uncompensated transmission lines	T_1:316-318
55	To remember performance of compensated system	Compensated transmission	T_3:318-321
56	To understand different compensation methods	Shunt and series compensation	T_1:330-345
57,58	Exercise	Solving Problems	T_1, T_3

XI. TEXT BOOKS:

1. S Sivanagarju "Power system operation and control " Pearson Education India, 2009
2. C.L.Wadhwa "Electrical power systems " New age international publishers,6th edition
3. I.J. Nagarath and D.P Kothari "Modern Power Systems Analysis" Tata Mc grawhill publication,4th edition

XII. REFERENCES:

1. Power system Analysis and Design by Duncan Glover and M.S Sarma
2. Electrical Energy systems Theory by O.I. Elgerd

XIII. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I		S	S										H		
II	H		H	S									H		
III	S			H											
IV		H		S									H		

S – Supportive **H - Highly Related**

XIV. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF THE PROGRAM OUTCOME

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	S		S										H		
2	S	S	S												
3			S										S		
4	S	H											H		
5	H	H											H		

6			H										S			
7	S		S													
8	H	H														
9		H											H			
10			H										H			
11	S		S													
12		H	S										S			
13	H		S										H			

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Prepared by: Mr. A Sathish Kumar, Assistant Professor, EEE

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