INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE DESCRIPTOR

Course Title	**MODERN POWER SYSTEM ANALYSIS**					
Course Code	**BPSB01**					
Programme	M.Tech					
Semester	I	Electrical Power Systems				
Course Type	Core					
Regulation	IARE - R18					
Course Structure	**Theory**			**Practical**		
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**	
	3	0	3	4	2	
Chief Coordinator	Dr. M. Pala Prasad Reddy, Associate Professor					
Course Faculty	Dr. M. Pala Prasad Reddy, Associate Professor					

I. COURSE OVERVIEW:

Power system analysisdeals formation impedance and admittance matrices for power system network, finding different electrical parameters for various buses in power system, study fault analysis and represent power system using per unit system, understand steady state and transient stability of power system

II. COURSE PRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AEE011	V	Transmission And Distribution System	4
UG	AEE012	VI	Power system analysis	4

III. MARKSDISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Modern Power System Analysis	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✘	MOOCs
✔	LCD / PPT	✔	Seminars	✘	Mini Project	✔	Videos
✔	Open Ended Experiments						

V. EVALUATION METHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two session examinations.

Semester End Examination (SEE): The SEE shall be conducted for 70 marks of 3 hours duration. The syllabus for the theory courses shall be divided into FIVE UNITs and each UNIT carries equal weight age in terms of marks distribution. The question paper pattern shall be as defined below. Two full questions with „either" „or" choice will be drawn from each UNIT. Each question carries 14 marks. There could be a maximum of three sub divisions in a question.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept
30 %	To test the analytical skill of the concept
20 %	To test the application skill of the concept

Continuous Internal Assessment (CIA):
The CIA shall be conducted by the faculty/teacher handling the course as given in Table 1. CIA is conducted for a total of 30 marks, with 25 marks for Continuous Internal Examination (CIE) and 05 marks for Technical Seminar and Term Paper.

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total marks**
Type of Assessment	CIE Exam	Technical Seminar and Term paper	
CIA marks	25	05	30

Continuous Internal Examination (CIE):
Two CIE exams shall be conducted at the end of the 9th and 17th week of the semester respectively. The CIE exam is conducted for 25 marks of 2 hours duration, consisting of 5 one mark compulsory questions in part-A and 4 questions in part-B. The student has to answer any 4 questions out of five questions, each carrying 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Technical Seminar and Term Paper:
Two seminar presentations are conducted during I year I semester and II semester. For seminar, a student under the supervision of a concerned faculty member, shall identify a topic in each course and prepare the term paper with overview of topic. The evaluation of Technical seminar and term paper is for maximum of 5 marks. Marks are awarded by taking average of marks scored in two Seminar Evaluations.

VI. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (POs)		Strength	Proficiency assessed by
PO 1	Identify, formulate and solve power system related problems using advanced level computing techniques.	2	Discussion and Seminars
PO 2	Explore ideas to carry out research / investigation independently to solve practical problems through continuing education	2	Seminars
PO 3	Demonstrate knowledge and execute projects on contemporary issues in multidisciplinary environment.	2	Seminars
PO 4	Ability to write and present a substantial technical report / document	2	Seminars
PO 5	Inculcate ethics, professionalism, multidisciplinary approach, entrepreneurial thinking and effective communication skills**.**	1	Discussion and Seminars
PO 6	Function effectively as an individual or a leader in a team to propagate ideas and promote teamwork.	2	Laboratory practice
PO 7	Develop confidence for self-study and to engage in lifelong learning.	2	Laboratory practice

3 = High; 2 = Medium; 1 = Low

VII. COURSE OBJECTIVES (COs):

The course should enable the students to:

I	Explain the basic components and restructuring of power systems.
II	Understand power flow analysis using various methods.
III	Describe fault analysis for balanced and unbalanced faults.
IV	Describe power system security concepts and study the methods to rank the contingencies.
V	Explain the need of state estimation and study simple algorithms for state estimation.

VIII. COURSE OUTCOMES

COs	Course Outcomes	CLO's	Course Learning Outcomes
CO1	Describe the basic components, restructuring and formulation of bus matrices for power system networks.	CLO 1	Describe the basic components of power system and its restructuring.
		CLO 2	Understand the single line diagram, per unit and per phase calculations of power system network.
		CLO 3	Understand the representation of power system components.
		CLO 4	Determine the bus impedance and admittance matrices for power system.
CO2	Solve power flow analysis problems using various methods.	CLO 5	Understand the importance of power flow analysis in planning and operation of power systems.
		CLO 6	Describe the power flow models in complex variable and polar forms.
		CLO 7	Use different numerical methods to determine unknown parameters at various buses and to draw relevant algorithms.
		CLO 8	Describe the optimal power flow solution using FACTS devices.

CO3	Discuss various methods for short circuit analysis of balanced and unbalanced networks.	CLO 9	Use Thevenin's theorem and Z-bus building algorithm for balance short circuit fault analysis using Z-bus computations.
		CLO 10	Calculate the electrical parameters under symmetrical fault conditions and understand symmetrical component theory.
		CLO 11	Use Thevenin's theorem and Z-bus matrix for fault analysis of sequence networks.
CO4	Describe the operating states of power system and its contingency analysis.	CLO 12	Discuss the operating states and security monitoring of power systems.
		CLO 13	Describe the various techniques for contingency evaluation and analysis.
		CLO 14	Calculation of new bus voltages using contingency analysis by adding/removal of lines.
CO5	Implement the various algorithms for state estimation.	CLO 15	Understand the requirements of state estimation methods for power systems.
		CLO 16	Use various methods for state estimation of power system networks.
		CLO 17	Explain network observability pseudo measurements.

IX. COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
BPSB01.01	CLO 1	Describe the basic components of power system and its restructuring.	PO1	2
BPSB01.02	CLO 2	Understand the single line diagram, per unit and per phase calculations of power system network.	PO1	2
BPSB01.03	CLO 3	Understand the representation of power system components.	PO1,PO2	2
BPSB01.04	CLO 4	Determine the bus impedance and admittance matrices for power system.	PO1	2
BPSB01.05	CLO 5	Understand the importance of power flow analysis in planning and operation of power systems.	PO1,PO2,PO4	2
BPSB01.06	CLO 6	Describe the power flow models in complex variable and polar forms.	PO1,PO2	2
BPSB01.07	CLO 7	Use different numerical methods to determine unknown parameters at various buses and to draw relevant algorithms.	PO1,PO2,PO3, PO6,PO7	2
BPSB01.08	CLO 8	Describe the optimal power flow solution using FACTS devices.	PO1,PO3	2
BPSB01.09	CLO 9	Use Thevenin's theorem and Z-bus building algorithm for balance short circuit fault analysis using Z-bus computations.	PO1,PO3	2
BPSB01.10	CLO 10	Calculate the electrical parameters under symmetrical fault conditions and understand symmetrical component theory.	PO1,PO3	2
BPSB01.11	CLO 11	Use Thevenin's theorem and Z-bus matrix for fault analysis of sequence networks.	PO1,PO3	2

BPSB01.12	CLO 12	Discuss the operating states and security monitoring of power systems.	PO1,PO4,PO5	2,2,1
BPSB01.13	CLO 13	Describe the various techniques for contingency evaluation and analysis.	PO1,PO2,PO5,PO7	2,2,1,2
BPSB01.14	CLO 14	Calculation of new bus voltages using contingency analysis by adding/removal of lines.	PO1,PO2,PO4,PO5 PO6,PO7	2,2,2,1,2,2
BPSB01.15	CLO 15	Understand the requirements of state estimation methods for power systems.	PO1,PO2,PO3	2
BPSB01.16	CLO 16	Use various methods for state estimation of power system networks.	PO1,PO2,PO5,PO7	2,2,1,2
BPSB01.17	CLO 17	Explain network observability pseudo measurements.	PO1,PO2,PO4	2

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X. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes (CLOs)	Program Outcomes (POs)						
	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CLO 1	2						
CLO 2	2						
CLO 3	2	2					
CLO 4	2						
CLO 5	2	2		2			
CLO 6	2	2					
CLO 7	2	2	2				2
CLO 8	2		2				
CLO 9	2		2				
CLO 10	2		2				
CLO 11	2		2				
CLO 12	2			2	1		
CLO 13	2	2			1		2
CLO 14	2	2		2	1	2	2
CLO 15	2	2	2				
CLO 16	2	2					2
CLO 17	2	2		2	1		

3 = High; 2 = Medium; 1 = Low

XI. ASSESSMENT METHODOLOGIES–DIRECT

CIE Exams	PO1, PO2, PO3, PO5, PSO2,PSO3	SEE Exams	PO1, PO2, PO3, PO5, PSO2,PSO3	Assignments	PO2, PO3, PO5	Seminars	PO2, PO5
Laboratory Practices	PO3, PSO3	Student Viva	PO2, PO3, PSO3	Mini Project	-	Certification	-
Term Paper	-						

XII. ASSESSMENT METHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✘	Assessment of Mini Projects by Experts		

XIII. SYLLABUS

UNIT-I	**PLANNING AND OPERATIONAL STUDIES OF POWER SYSTEMS**
Need for system planning and operational studies, basic components of a power system, introduction to restructuring, single line diagram, per phase and per UNIT analysis, generator, transformer, transmission line and load representation for different power system studies, primitive network, construction of Y-bus using inspection and singular transformation methods, Z-bus.	
UNIT-II	**POWER FLOW ANALYSIS**
Importance of power flow analysis in planning and operation of power systems, statement of power flow problem, classification of buses, development of power flow model in complex variables form, iterative solution using Gauss-Seidel method, Q-limit check for voltage controlled buses, power flow model in polar form, iterative solution using Newton-Raphson method, decoupled and fast decoupled power flow solutions, DC power flow solution, power flow solution using FACTS devices, optimal power flow solution	
UNIT-III	**SHORTCIRCUITANALYSIS**
Balanced faults: Importance of short circuit analysis, assumptions in fault analysis, analysis using Thevenin"s theorem, Z-bus building algorithm, fault analysis using Z-bus, computations of short circuit capacity, post fault voltage and currents. Unbalanced faults: Introduction to symmetrical components, sequence impedances, sequence circuits of synchronous machine, transformer and transmission lines, sequence networks analysis of single line to ground, line to line and double line to ground faults using Thevenin"s theorem and Z-bus matrix.	
UNIT-IV	**CONTINGENCY ANALYSIS**
Contingency Evaluation: Operating states of a power system, concept of security monitoring, techniques for contingency evaluation, Importance of contingency analysis, addition / removal of one line, construction of a column of bus impedance matrix from the bus admittance matrix, calculation of new bus voltages due to addition / removal of one line, calculation of new bus voltages due to addition / removal of two lines	
UNIT-V	**STATE ESTIMATION**
Power system state estimation, maximum likelihood weighted least squares estimation, matrix formulation, state estimation of AC network, state estimation by orthogonal decomposition, detection and identification of bad measurements, estimation of quantities not being measured, network observability and pseudo measurements	

Text Books:
1. J J Grainger, W D Stevenson, "Power system analysis", McGraw Hill, 1st Edition, 2003. 2. A R Bergen & Vijay Vittal, "Power System Analysis", Pearson, 2nd Edition,2000.
Reference Books:
1. K Umarao, "Computer Techniques and Models in Power Systems", I K International Pvt. Ltd. 2. HadiSaadat, "Power System Analysis", TMH, 2nd Edition, 2003. 3. Grainger and Stevenson, "Power System Analysis", Tata McGraw-Hill, 3rd Edition, 2011. 4. J Duncan Glover and M S Sarma., THOMPSON, "Power System Analysis and Design", 3rd Edition 2006.

XIV. COURSE PLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	CLOs	Reference
1	Need for system planning and operational studies	CLO1	T1:1.1
2	Basic components of a power system	CLO1	T1:2,3,4
3	Introduction to power system restructuring.	CLO1	T4:9.4.3
4	Single line diagram of power system network.	CLO2	T1:1.13 R4:3.4
5	Per phase and per UNIT analysis	CLO2	T1:1.10-1.11
6,7	Generator, transformer, transmission line and load representation for different power system studies	CLO3	T1:2.3,3.1 R4:3.1-3.2
8	Primitive network	CLO3	T4:9.4
9,10	Construction of Y-bus using inspection and singular transformation methods	CLO4	T1:7.1-7.10
11	Construction of Z-bus	CLO4	T1: 8.1-8.7
12	Importance of power flow analysis in planning and operation of power	CLO5	T1: 9.1 R4:6.1,6.4
13	Classification of buses	CLO5	T1:8.1 R4:6.1
14	Development of power flow model in complex variables form	CLO6	T1:9.1 R4:6.1
15	Iterative solution using Gauss-Seidel method	CLO7	T1:9.2 R4:6.2
16	Q-limit check for voltage controlled buses, power flow	CLO6 CLO7	T4:9.1
17	Iterative solution using Newton-Raphson method	CLO7	T1:9.3-9.4 R4:6.3
18	Decoupled and fast decoupled power flow solutions	CLO7	T1:9.7 R4:6.9
19	DC power flow solution	CLO7	T4:9.7 R4:6.10
20	Power flow solution using FACTS devices	CLO8	T4:9.4.12
21	Optimal power flow solution	CLO8	T4:10.3
22	Importance of short circuit analysis, assumptions in fault analysis	CLO9	T1:10.1-10.2
23	Analysis using Thevenin"s theorem	CLO9	T1:8.2 R1:6.1-6.3
24	Z-bus building algorithm, fault analysis using Z-bus	CLO9	T1:8.3

Lecture No	Topics to be covered	CLOs	Reference
25,26	Computations of short circuit capacity, post fault voltage and currents.	CLO9	T4:10.5
27	Introduction to symmetrical components, sequence impedances	CLO10	T1:11.1-11.2
28	Sequence circuits of synchronous machine	CLO10	T1:11.7
29	Transformer and transmission lines	CLO10	T1:11.6
30,31	Sequence networks analysis of single line to ground, line to line and double line to ground faults using Thevenin"s theorem and Z-bus matrix.	CLO11	T1:12.3-12.4 R2:10.5-
32	Operating states of a power system, concept of security monitoring	CLO12	T1:15.1
33	Techniques for contingency evaluation, Importance of contingency analysis,	CLO13	T1:14.1
34,35	Addition / removal of one line, construction of a column of bus impedance matrix from the bus admittance matrix	CLO14	T1:14.2
36,37	Calculation of new bus voltages due to addition / removal of one line	CLO14	T1:14.3
38	Calculation of new bus voltages due to addition / removal of two lines	CLO14	T1:14.4
39	Power system state estimation, maximum likelihood weighted least squares estimation	CLO15 CLO16	T1:15.1
40	Matrix formulation, state estimation of AC network	CLO16	T1:15.2
41,42	State estimation by orthogonal decomposition	CLO16	T1:15.4
43	Detection and identification of bad measurements	CLO16	T1:15.3
44	Estimation of quantities not being measured	CLO16	T1:15.4
45	Network observability and pseudo measurements	CLO17	T1:15.5

XV. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSION REQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Introduction to Human Machine Interface (HMI) and its interfacing with PLC	Seminars, Open ended experiments	PSO 2, PO5	PSO 3
2	Controlling of Variable frequency Drive (VFD) through PLC	Seminars, Open ended experiments	PSO 2, PO5	PSO 3

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