INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

Department of Electrical and Electronics Engineering

COURSE DESCRIPTION FORM

Course Title	**POWER SYSTEMS-II**			
Course Code	**A50221**			
Regulation	**R13**			
Course Structure	**Lectures**	**Tutorials**	**Practical**	**Credits**
	4	**1**	**-**	**4**
Course Coordinator	Mr **K.Raju** , Assistant Professor			
Team of Instructors	Mr **K.Raju** , Assistant Professor			

I. COURSE OVERVIEW:

This course deals with basic theory of transmission lines modelling and their performance analysis. Also this course gives emphasis on mechanical design of transmission lines, cables and insulators. The main objective of the course is to introduce students to Transmission system concepts. In particular, concepts like Transmission line parameters, Cables, Performance of Transmission lines, Transients, Sag & tension calculations & Underground cables concepts are emphasized.

II. PREREQUISITE(S):

Level	Credits	Periods / Week	Prerequisites
UG	4	4	Basic concepts of Power System Generation

III. MARKS DISTRIBUTION:

Session Marks	University End Exam Marks	Total Marks
There shall be 2 midterm examinations. Each midterm examination consists of subjective test. The subjective test is for 20 marks, with duration of 2 hours. Subjective test of each semester shall contain 5 one mark compulsory questions in part-A and part-B contains 5 questions, the student has to answer 3 questions, each carrying 5 marks. First midterm examination shall be conducted for the first two and half units of syllabus and second midterm examination shall be conducted for the remaining portion. Five marks are earmarked for assignments. There shall be two assignments in every theory course. Marks shall be awarded considering the average of two assignments in each course.	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 OBJECTIVES:

At the end of the course, the students will be able to

i. gain knowledge on the basic transmission line parameters.
ii. gain knowledge on the performance of short, medium & long transmission lines.
iii. analysis of power system transients.
iv. gain knowledge on various factors governing the performance of transmission line.
v. gain knowledge on the overhead line parameters.
vi. analysis of transmission line sag and tension.
vii. gain knowledge on underground cables.

VI. COURSE OUTCOMES:

After completing this course the student must demonstrate the knowledge and ability to:

1. Have an **Understanding** on the basic Transmission line parameters.
2. Have gained **Knowledge** on Performance of short, medium & long transmission lines.
3. **Analyses** the power system transients.
4. Have an **Understanding** on various factors governing the performance of transmission line.
5. Have an **Understanding** on Overhead Line parameters.
6. **Analyses** the transmission line sag and tension.
7. Have an **Understanding** on underground cables.
8. Demonstrate **knowledge** of professional and ethical responsibilities.
9. **Able** to communicate effectively in both verbal and written form.
10. **Understanding** of impact of engineering solutions on the society and also will be aware of contemporary issues.
11. Develop confidence for self-education and **ability** for life-long learning.
12. Can able to participate and succeed in competitive examinations like GATE, IES.

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	Lectures
PO2	**Problem Analysis**: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	H	Assignments
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	Project Work
PO4	**Conduct Investigations of Complex Problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	S	Project Work
PO5	**Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	H	Project Work
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	S	Presentations

	practice.		
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.	S	-
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	S	-
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader indiverse teams, and in multidisciplinary settings.	S	Project Work
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.	S	Seminars
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.	H	Project Work
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.	H	Lectures

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	Seminars
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.	S	Assignments
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.	S	Project Work

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

IX. SYLLABUS:

UNIT – I

Transmission Line Parameters: Types of Conductors-calculation of resistance for solid conductors-Calculation of inductance for single phase and three phase, single and double circuits lines, concept of GMR and GMD, symmetrical and asymmetrical conductor configuration with and without transposition, Numerical Problems. Calculation of Capacitance for 2 wire and 3 wire systems, effect of ground on capacitance, capacitance calculations for symmetrical and asymmetrical single and three phase, single and double circuit lines, Numerical Problems.

UNIT – II

Performance of Short, Medium and Long Length Transmission Lines : Classification of Transmission Lines- Short, medium and Long line and their model representations- Nominal-T, Nominal- Pie and A,B,C,D Constants for symmetrical and Asymmetrical Networks, Numerical Problems. Mathematical Solutions to estimate regulation and efficiency of all types of lines-Numerical Problems.

Long Transmission Line-Rigorous Solution, equivalent of A,B,C,D constants, Interpretation of Long Line Equations, Incident, Reflected and Refracted Waves- Surge Impedance and SIL of Long Lines, Wave Length and Velocity of Propagation of Waves- Representation of Long Lines- Equivalent Pie network models(numerical problems)

UNIT – III

Power System Transients & Factors Governing The Performance of Transmission Lines: Types of System Transients- Travelling or Propagation of Surges- Attenuation, Distortion, Reflection and Refraction Coefficients- Termination of Lines with different types of conditions- Open Circuited line, short Circuited Line, T-Junction, lumped Reactive Junctions (Numerical Problems). Beweley's Lattice Diagrams (for all the cases mentioned with numerical examples).

Skin and Proximity effects-Description and effect on Resistance of Solid Conductors- Ferranti effect- Charging Current- Effect on Regulation of the Transmission Line. Corona- Description of the phenomenon, factors affecting corona, critical voltages and power loss, Radio Interference.

UNIT – IV

Overhead Line Insulators & Sag Tension Calculations: Types of Insulator, String efficiency and Methods for improvement, Numerical Problems- Voltage distribution, calculation of string efficiency, Capacitance grading and static Shielding.

Sag and Tension Calculations with equal and unequal heights of towers, Effect of Wind and Ice on weight of Conductor, Numerical Problems – Stringing chart and Sag template and its applications.

UNIT – V

Underground Cables : Types of Cables, Construction, Types of Insulating materials, Calculations of Insulation resistance and stress in Insulation, Numerical Problems, Capacitance of Single and 3-Core belted cables, Numerical Problems, grading of Cables- Capacitance- Capacitance grading, Numerical Problems, Description of Inter-sheath grading, HV cables.

X. LIST OF TEXT BOOKS / REFERENCES / WEBSITES / JOURNALS / OTHERS

Text Books:

1. C.L. Wadhwa "Electrical power systems" New Age International (P) Limited, Publishers, 1998.
2. M.L. Soni, P.V.Gupta, U.S. Bhathnagar, A. Chakrabarthy "A Text Book on Power System Engineering" Dhanpat Rai & Co Pvt. Ltd.

References:

1. I.J. Nagaraj and D.P. Kothari "Modern Power System Analysis", Tata McGraw Hill, 2nd Edition.
2. John J Grainger William D Stevenson "Power system Analysis" TMC Companies, 4th edition.

XI. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No.	Learning Objectives	Topics to be covered	Reference
1	Transmission Line Parameters: Different Types of Conductors	To Understand Basic Electrical Parameters	T1:1.1-1.4
2	Concept of GMD, GMR, Symmetrical and asymmetrical conductor configuration	To Understand the Configuration Of Transmission Lines	T1:2.11-2.12

3	Calculation of Resistance for Solid Conductors	To Know the use of Solid Conductors in Transmission Lines	T1:
4	Calculation of Inductance for Single Phase Transmission Line	Know about the Effect of Inductance on Transmission Lines	T1:2.1-2.4
5	Inductance Calculation for Three Phase Transmission Line	Understand effect of Inductance on Three Phase Transmission Lines	T1:2.5-2.6
6	Calculation of inductance for single and double circuit lines	Know about the effect of inductance on transmission lines	T1:2.7-2.10
7	Calculation of capacitance for 2 wire systems	Understand the effect of capacitance in transmission lines	T1:3.1-3.4
8	Calculation of capacitance for 3 wire systems	Analyse the capacitance for 3 wire systems	T1:3.5
9	Effect of ground on capacitance.	To Know the effect of ground on capacitance	T1:3.6-3.7
10	Capacitance calculation for symmetrical transmission lines	To know Importance of capacitance calculation in transmission line system	T1:3.6
11	Capacitance calculation for asymmetrical transmission lines.	To know the method to calculate the capacitance in a symmetrical circuit lines	T1:3.5-3.6
12	Capacitance calculation for symmetrical and asymmetrical single phase and 3 phase, single and double circuit lines. Problems on same.	Methods to calculate the capacitance in symmetrical three phase lines	T1:3.5
13	Problems on capacitance calculation for symmetrical and asymmetrical single phase and 3 phase, single and double circuit lines	To understand the importance of capacitance calculation	T1:3.1-3.7
14	Performance Of Short, Medium And Long Length Transmission Lines. Classification of transmission lines- short, medium and long line	To know the importance of voltage regulation in transmission lines	T1:4.1
15	model representations of short, medium and long line	Know the modelling importance in transmission line	T2:4.1-4.4
16	Model representations- Nominal-T, Nominal-pi	To Understand the concept of line constants	T2:4.1-4.4
17	Nominal-T, Nominal-pi and ABCD constants for symmetrical and Asymmetrical networks	To understand the importance of transmission line modelling	T2:4.1-4.4
18	Mathematical Solutions to estimate regulation and efficiency of all types of lines-numerical problems	Understand the regulation and efficiency of transmission lines	T2:4.1-4.4
19	Estimating efficiency of all types of lines-numerical problems	Understand the efficiency of transmission lines	T2:4.1-4.4
20	Interpretation of long line equations	To understand Concepts of wave properties	T2:4.4
21	Surge impedance and SIL of long lines,	To understand the concept of surge impedance loading	T2:4.4
22	incident and reflected waves	To know the properties of waves	T2:13.1-13.10
23	Surge impedance and SIL of long lines, Wave length and velocity of propagation of waves.	To know the importance of surge impedance loading in transmission lines	T2:13.1-13.10
24	Representation of long lines- Equivalent-T and Equivalent pie network models	Understand the different models of networks	T2:13.1-13.10
25	problems on Equivalent-T and Equivalent pie network models	Understand the importance of Z, Y parameters	T2:13.1-13.10

26	Power System Transients & Factors governing the performance of Transmission lines- Types of System transients	To understand the concepts of Transients	T2:13.1-13.10
27	Travelling or Propagation of Surges-Attenuation, Distortion, Reflection and Refraction Coefficients-	To Understand the Propagation of Waves	T2:13.1-13.10
28	Termination of Lines with different types of conditions- Open Circuited line, short Circuited Line	Understand termination of open and circuited line	T2:13.1-13.10
29	T-Junction, lumped Reactive Junctions(Numerical Problems)	Analyse T-Junction	T2:13.1-13.10
30-31	Beweley's Lattice Diagrams (for all the cases mentioned with numerical examples)	Understand and Analysis the Beweley's Lattice Diagrams	T2:13.1-13.10
32	Skin and Proximity effects	To understand The skin and Proximity effects on a transmission line	T1:2.13
33	Description and effect on Resistance of Solid Conductors	Analyse the resistance of a solid conductors	T1:4.6
34-35	Ferranti effect- Charging Current- Effect on Regulation of the Transmission Line	To understand ferranti effect on Transmission line and Analysing	T1:4.6
36	Corona- Description of the phenomenon	Knows about the concept of corona	T1:6.1
37-39	factors affecting corona, critical voltages and power loss, Radio Interference	To understand the factors affecting the corona	T1:6.2-6.6
40	Sag And Tension Calculations Sag and tension calculation with equal heights of towers	To understand the mechanical concepts of transmission lines	T1:7.1-7.2
41	Sag and tension calculation with unequal heights of towers	To understand the importance of Sag in transmission lines	T1:7.3
42	Problems on Sag and tension calculation with equal and unequal heights of towers	To find the SAG importance in designing transmission lines	T1:7.3
43	Effect of wind and ice on weight of conductor	Understand the environmental conditions on transmission lines	T1:7.4
44	Problems on wind and ice Effect on weight of conductor	Understand the effect of ice on transmission line	T1:7.3
45	Stringing chart	Know about stringing chart	T1:7.4
46	Stringing chart applications	To know Importance of stringing chart in transmission lines	T1:7.4
47	Sag template and its applications	Know the use of both stringing chart and sag template in transmission lines design	T1:7.5
48	Overhead Line Insulators Type of insulators	To know about types of insulators	T2:5.1-5.3
49	Type of Insulators Based on their Operating Voltage	To Understand the Different Types Of Insulators Based on Their Operating Voltages	T2:5.3
50	String efficiency	To Know about String Efficiency Concepts	T2:5.4
51	Methods for Improvement, Numerical Problems	Understand the Effect of String Efficiency	T2:5.5
52	Voltage Distribution in Suspension Type Insulators	To Understand the Concept of Voltage Distribution Through Insulator	T2:5.4
53	capacitance grading and static shielding	To Understand the Importance of Capacitance Grading	T2:9.1

54-55	Underground cables Types of Cables, Construction Types of insulating materials	To understand the uses of Underground Cables	T2:9.1-9.2
56	Calculations of Insulation Resistance	To understand the importance of insulation resistance	T2:9.5
57	Stress In Insulation	Understand the Concept of Stress In Underground Cables	T2:9.6
58-59	numerical Problems on Stress And Insulation Resistance In Underground Cables	Importance of Insulation Resistance and Potential Distribution In Underground Cables	T2:9.6
60-61	Capacitance of single core and 3 core cable	Understand the concept of single core cables	T2:9.3
62	Grading of Cables-Capacitance Grading	Understand the Concept Of 3-Core Belted Cables	T2:9.9
63	Description of inter-sheath Grading, Comparison Between Cables And Overhead Lines	Importance of Inter Sheathing In Capacitance Grading	T2:9.7-9.8
64-65	Numerical Problems on Grading of Cables-Capacitance Grading, Description Of Inter-Sheath Grading	To Know The Effect of Electrical Stress In Cable	T2:9.9

XII. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF THE PROGRAM 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	H		S							S	S	H	S	S
II	S	S	H	S	S				S		S	S	S	S	H
III	S	S	S	S	S				S		S	S	H	S	H
IV	S	S	S	H	S		S	S		S		S	H	H	S
V		S	S	S	S	S		S				S		S	S
VI	S	S	S	S		S		S				S		S	S
VII		S	S	S	S	S		S	S		S	S	S	S	S

S = Supportive **H = Highly Related**

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

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

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

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Prepared By: K. Raju, Assistant Professor

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