POWER SYSTEMS-II

Subject Code : EE502PC
Regulations : R16 - JNTUH
Class : III Year B.Tech EEE I Semester

Department of Electrical and Electronics and Engineering

BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY

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POWER SYSTEMS- II (EE502PC)

COURSE PLANNER

COURSE OVERVIEW

This course is an extension of power systems-I course. It deals with basic theory of transmission lines modeling and their performance analysis. Also this course gives emphasis on mechanical design of transmission lines, cables and insulators.

PRE REQUISITES:

The knowledge of following subjects is essential to understand the subject:

1. Power Systems –I and
2. Electromagnetic field theory.

COURSE OBJECTIVE:

1	To compute inductance and capacitance of different transmission lines.
2	To understand performance of short, medium and long transmission lines.
3	To examine the traveling wave performance and sag of transmission lines.
4	To understand the type of insulators for over head lines and understand the type of cables for power transmission.

COURSE OUTCOMES:

At the end of the course the student will be in a position to

S.no	Description	Bloom's Taxonomy Level
1	Able to compute inductance and capacitance for different configurations of transmission lines.	Remembering, Analyze (Level1, Level 4)
2	Able to analyze the performance of transmission lines.	Understand,(Level-2), Analyze (Level – 4)
3	Can understand transient's phenomenon of transmission lines.	Understand (Level-2)
4	Able to calculate corona, sag and tension calculations.	Understand, Analyze (Level-1,Level-4**)**
5	Will be able to understand overhead line insulators and underground cables	Understand (Level-2)

HOW PROGRAM OUTCOMES ARE ASSESSED

Program Outcomes		Level	Proficiency assed by
PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Assignments, Mock tests
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.	1	Assignments, Mock tests
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.	2	Assignments, Mock tests
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.	-	Assignments, Mock tests
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex	1	Assignments, Mock tests

	engineering activities with an understanding of the limitations.		
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.	1	Assignments, Mock tests
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.	-	
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	-	
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	-	
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.	-	
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.	1	seminars
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.	2	Industrial visits

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency assed by
PSO 1	Talented to analyze, design and implement electrical & electronics systems and deal with the rapid pace of industrial innovations and developments	1	Assignments, Mock tests, Miniprojects
PSO 2	Skillful to use application and control techniques for research and advanced studies in Electrical and Electronics engineering domain	1	Assignments, Mock tests,Projects

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

COURSE CONTENT:

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 circuit lines, concept of GMR &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 and Medium 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 & Asymmetrical Networks, Numerical Problems. Mathematical Solutions to estimate regulation and efficiency of all types of lines - Numerical Problems.

Performance of Long Transmission Lines: Long Transmission Line-Rigorous Solution, evaluation of A,B,C,D Constants, Interpretation of the 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-T and Equivalent Pie network models (numerical problems).

Unit-III:

Power System Transients : 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). Bewley's Lattice Diagrams (for all the cases mentioned with numerical examples).

Factors Governing the Performance of Transmission lines: Skin and Proximity effects - Description and effect on Resistance of Solid Conductors - Ferranti effect - Charging Current - Effect on Regulation of the Transmission Line, Shunt Compensation.

Corona - Description of the phenomenon, factors affecting corona, critical voltages and power loss, Radio Interference.

Unit-IV:

Overhead Line Insulators: Types of Insulators, String efficiency and Methods for improvement, Numerical Problems - voltage distribution, calculation of string efficiency, Capacitance grading and Static Shielding.

Sag and Tension Calculations: 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 grading, Numerical Problems, Description of Inter-sheath grading, HV cables.

GATE SYLLABUS:

AC transmission concepts, Models and performance of transmission lines and cables, Electric field distribution and insulators.

IES SYLLABUS:

Transmission line models and performance, cable performance, insulation, corona and radio interference.

LESSON PLAN- COURSE SCHEDULE

Lectur	Week	Topic	Course learning	Reference

e No.	No.		outcome	
Unit-I				
1.	1	Types of conductors-calculation of resistance for solid conductors	Classify the conductors	Text Book:1,2
2.		calculation of inductance for single phase and three phase	Evaluate the inductance	
3.		Single and double circuit lines	Evaluate the inductance	
4.		concept of GMR &GMD	Evaluate the inductance & capacitance	
5.	2	Symmetrical and asymmetrical conductor configuration with and without transposition	Understand the concept of interference	
6.		Symmetrical and asymmetrical conductor configuration with and without transposition	Understand the concept of interference	
7.		Numerical problems	Analyse and evaluate the problems	
8.		Numerical problems	Analyse and evaluate the problems	
9.	3	Calculation of capacitance for 2 wire and 3 wire systems	Evaluate the capacitance	Text book:1,2
10.		Effect of ground on capacitance	Understand the effect of ground capacitance	
11.		Capacitance calculations for symmetrical and asymmetrical single and three phase	Analyse and evaluate the problems	
12.		Capacitance calculations for symmetrical and asymmetrical single and three phase	Analyse and evaluate the problems	
13.	4	Single and double circuit lines	Analyse and evaluate the problems	
14.		Numerical problems	Analyse and evaluate the problems	Text book:1,2
		Mock Test-1		
Unit-II				
15.	5	Classification of Transmission Lines - Short, medium and long line and their model representations	Classify and discuss about lines	
16.		Nominal- T, Nominal-Pie and A, B, C, D Constants for symmetrical & Asymmetrical Networks	Classify and discuss about lines	
17.		Nominal- T, Nominal-Pie and A, B, C, D Constants for symmetrical & Asymmetrical Networks	Classify and to discuss about lines	
18.		Nominal- T, Nominal-Pie and A, B, C, D Constants for symmetrical & Asymmetrical Networks	Classify and to discuss about lines	
19.		Numerical Problems	Analyse and to evaluate the problems	
20.		Numerical Problems	To analyse and to evaluate the problems	

		Bridge Class-1		
21.	6	Mathematical Solutions to estimate regulation and efficiency of all types of lines - Numerical Problems.	Analyse and evaluate the problems	
22.		Mathematical Solutions to estimate regulation and efficiency of all types of lines - Numerical Problems.	Analyse and evaluate the problems	
23.				
24.		Long Transmission Line-Rigorous Solution, evaluation of A,B,C,D Constants	Analyse and evaluate the problems	
		Bridge Class-2		
25.	7	Interpretation of the Long Line Equations, Incident, Reflected and Refracted Waves	Interpret and evaluate the long lines	Text book:1,2
26.		Surge Impedance and SIL of Long Lines, Wave Length and Velocity of Propagation of Waves	Interpret and evaluate the long lines	
27.		Representation of Long Lines - Equivalent-T and Equivalent Pie network models (numerical problems)	Analyse and to determine the model	
28.		Representation of Long Lines - Equivalent-T and Equivalent Pie network models (numerical problems)	Analyse and to determine the model	
		Bridge Class-3		
Unit-III				
29.	8	Types of System Transients - Travelling or Propagation of Surges	Analyse the transients on wave propagation	
30.		Attenuation, Distortion, Reflection and Refraction Coefficients	Analyse the transients on wave propagation	
31.		Termination of lines with different types of conditions - Open Circuited Line, Short circuited Line	Analyse the transients on wave propagation	
32.		T-Junction, Lumped Reactive Junctions (Numerical Problems) & Bewley's Lattice Diagrams	Analyse the transients on wave propagation and to evaluate the problems	
		Bridge Class-4		
Mid- 1 Examinations(week 9)				
33.	10	Skin and Proximity effects - Description and effect on Resistance of Solid Conductors	To define the effects occur on ac & dc transmission line	
34.		Ferranti effect - Charging Current - Effect on Regulation of the Transmission Line,	To define the effects occur on ac & dc transmission line	
35.		Shunt Compensation	To compensate the effect on transmission line by shunt elements	
36.		Problems	To analyse and to evaluate the problems	
		Bridge Class-5		
37.	11	Corona - Description of the phenomenon, factors affecting corona	Understand the concept of corona	

38.		factors affecting corona	To understand the concept of corona	
39.		critical voltages and power loss,	Determine the values of power loss	
40.		Radio Interference	Understand the concept of corona	
		Bridge Class-6		
Unit-IV				
41.	12	Types of Insulators	Classify the types of insulators	Text Book:1,2
42.		String efficiency and Methods for improvement	Determine the methods of string efficiency	
43.		Numerical Problems - voltage distribution,	Analyse and to evaluate the problems	
44.		calculation of string efficiency,	Analyse and to evaluate the problems	
		Bridge Class-7		
45.	13	Numerical Problems - Capacitance grading and Static Shielding	Analyse and to evaluate the problems	
46.		Sag and Tension Calculations with equal and unequal heights of towers	Find the sag and tension calculations of towers	
47.		Sag and Tension Calculations with equal and unequal heights of towers	Find the sag and tension calculations of towers	
48.		***Mock Test-2***		
		Bridge Class-8		
49.	14	Effect of Wind and Ice on weight of Conductor	Know about the effect of wind and ice on conductor weight	
50.		Effect of Wind and Ice on weight of Conductor	Know about the effect of wind and ice on conductor weight	
51.		Numerical Problems	Analyse and to evaluate the problems	
52.		Stringing chart and sag template and its applications.	Compare the string chart and template	Text Book:1,2
		Bridge Class-9		
Unit-V				
53.	15	Types of Cables, Construction, Types of Insulating materials	Classify the types of cables and insulating materials	
54.		Calculations of Insulation resistance and stress in insulation	Analyse and evaluate the insulation resistance	
55.		Numerical Problems	Analyse and to evaluate the problems	
56.		Numerical Problems	Analyse and to evaluate the problems	
		Bridge Class-10		

57.	16	Capacitance of Single and 3-Core belted cables	Know about capacitance type cables	
58.		Numerical Problems	Analyse and to evaluate the problems	
59.		Grading of Cables - Capacitance grading	Know about the grading of cables	
60.		Numerical Problems	Analyse and to evaluate the problems	
		Bridge Class-11		
61.	17	Description of Inter-sheath grading	Know about inter sheath grading	
62.		HV cables	Know about types of HV cables	
63.		Revision		
64.		Revision		
		Bridge Class-12		
		Mid-2 Examinations(week 18)		

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

Course Outcomes	Program Outcomes (PO)												Program Specific Outcomes (PSO)	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	-	-	-	-	-	-	-	-	-	-	2	1
CO2	2	2	1	-	-	-	-	-	-	-	-	-	2	1
CO3	3	1	1	-	-	-	-	-	-	-	-	-	1	2
CO4	2	3	2	-	-	-	-	-	-	-	-	-	2	1
CO5	2	3	-	-	-	-	-	-	-	-	-	-	1	2
Avg	1.1	2.4	0.8	-	-	-	-	-	-	-	-	-	1.6	1.4

SUGGESTED BOOKS:

Text Books

1. 1.A Text Book on Power system Engineering by M.L Soni P.V
2. Electrical Power Systems by C.L Wadhwa New Age International(p) Limited,Publishers

Reference Books

3. Power Systems Engineering by I.J Nagrath& D.P Kothari, TMH 2/e, 2010.
4. Power Systems Analysis, Operation and control by Abhijit Chakrapabarti, Sunitha Halder, PHI, 3/e, 2010.
5. Power Systems Analysis & Design by B.R Gupta, Wheeler Publishing.

QUESTION BANK

DESCRIPTIVE QUESTIONS

UNIT-I

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Define GMD and GMR?	Knowledge	1
2	Explain about skin effect?	Understand	1
3	Explain about proximity effect?	Understand	1
4	What are different types of transmission conductors?	Knowledge	1
5	Why we prefer double circuit lines in transmission?	Knowledge	1

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	A 3-Phase, 50 Hz, 66 KV, 100 Km overhead line conductors are placed in a horizontal plane with diameter of 1.25 cm. Calculate the capacitance & charging current per phase assuming complete transposition of the line.	Evaluate	1
2	Explain the effect of earth on capacitance calculations mathematically	Understand	1
3	Derive an expression for 3 phase capacitance in symmetrical& asymmetrical configuration	Analyze	1
4	Derive an expression for 3 phase inductance in asymmetrical configuration	Analyze	1
5	Derive an expression for inductance of a single phase two wire line.	Analyze	1

UNIT II

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Explain the difference between symmetrical and un-symmetrical spacing?	Knowledge	2
2	Determine A, B, C, D constants for Nominal T network?	Knowledge	2
3	Determine A, B, C, D constants by using Rigorous solution?	Knowledge	2
4	Define Ferranti effect?	Knowledge	2
5	What are the different types of transmission lines?	Knowledge	2

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Explain the concept of travelling waves in long transmission lines	Knowledge	2
2	Give the various loading and voltage level factors that influence the design and Operation of primary feeder?	Knowledge	2
3	Explain Nominal-π method of Medium transmission lines with a phasor diagram	Understand	2
4	Find the following for a single circuit transmission line delivering a load of 50 MVA at 110 Kv & 0.8 p.f. lagging. Find Sending end voltage, sending end current, sending end power & efficiency of transmission. Given A=D=0.98	Analyze	2

	<3, B=110<75Ω, C=0.0005<80 siemen		
5	Give a brief note of Rigorous method with a phasor diagram		2
6	Describe Nominal-T method of medium transmission lines with a phasor diagram	Knowledge	
7	Derive A,B,C,D constants of an End condenser method with a phasor diagram	Analyze	2
8	A 3-Phase, 50 Hz overhead transmission line 100 Km has Resistance/Km/Phase=0.1Ω,Inductive reactance/km/phase=0.2Ω,capacitive susceptance/km/phase=$0.04*10^{-4}$ siemen. Determine i) Sending end current ii) Sending end voltage iii) Sending end power factor iv) Transmission efficiency when supplying a balanced load of 10,000kw at 66kv,p.f of 0.8 lagging. Use Nominal-T method	Analyze	2
9	Explain the performance of single phase short transmission line with a phasor diagram	Understand	2
10	A 3-Phase, 50 Hz overhead transmission line 200 Km has Resistance/Km/Phase=0.16Ω,Inductive reactance/km/phase=0.25Ω, capacitive susceptance/km/phase=$1.5*10^{-6}$ siemen. Calculate by Rigorous method the sending end voltage and current when the line is delivering a load of 20Mw at 0.8 p.f. lagging. The receiving end voltage is kept constant at 110Kv.	Analyze	2
11	Explain Surge impedance, Surge impedance loading, Wave length and velocity of propagation	Understand	2

UNIT III

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Explain the concept of corona?	Evaluate	3
2	Explain the concept Radio Interference?	Analyze	3
3	What are the different factors affecting the corona?	Knowledge	3
4	What are the different system transients?	Knowledge	3
5	Define Attenuation, Distortion?	Knowledge	3

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	**1.** Define Attenuation, Distortion, Reflection and Refraction	knowledge	3
2	Explain about the Termination of a line with Open circuit	Understand	3
3	Derive Reflection & Refraction coefficients for T-Junction	Understand	3
4	Explain the concept of Skin effect, Ferranti effect & Proximity effect with phasor diagram	Knowledge	3
5	What is Corona? What are the factors affecting it and methods to reduce corona	Understand	3

6	Give a brief note of: i) Charging current ii) Radio interference	Understand	3
7	A 1-phase feeder circuit has total impedance (1+j3) ohms, receiving end voltage is 11 kV and current is 50L-30 deg A. Determine: (a) p.f. of load? (b) Load p.f. for which the drop is maximum. (c) Load p.f. for which impedance angle is maximum and derive the formula used?	Analyze	3
8	A 3-Phase, 220KV, 50 Hz transmission line consists of 1.5Cm radius conductor spaced 2m apart in equilateral triangular formation. If the temperature in degrees is 40 & atmospheric pressure is 76cm. Calculate the corona loss per km of the line taken m`=0.85.	Analyse	3
9	Explain about the Termination of a line with Short circuit and what is transient and what are the types of transients.	Understand	3

UNIT IV

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	What are the different sag template applications?	Knowledge	4
2	Define sag and tension?	Understand	4
3	What are the different types of insulators?	Knowledge	4
4	What are the different methods to improve string efficiency?	Knowledge	4
5	Explain about capacitance grading?	Understand	4

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	What is String efficiency and what are the methods to improve it	Knowledge	4
2	Each line of a 3-Phase system is suspended by a string of 3 similar insulators. If the voltage across the line unit is 17.5 KV, calculate the line to neutral voltage. Assume that the shunt capacitance between each insulator and earth is 1/5 of the capacitance of the insulator itself. Also find the string efficiency	Knowledge	4
3	Explain about Pin type & Suspension type insulators with neat diagrams?	Understand	4
4	Explain the effect of wind & ice loading on Unequal height towers	Knowledge	4
5	An overhead line has a span of 150m between level supports. The conductor has a cross sectional area of 2 Sq.cm, Ultimate strength=5000kg/sq.cm, safety factor=5, specific gravity=8.9gm/cc, wind pressure=1.5kg/m. Calculate the height of the conductor above the ground level at which it should be supported if a minimum clearance of 7m is to be left between the ground & conductor.	Evaluate	4

6	Give a brief note of Stringing chart& sag template along with its applications	Knowledge	4
7	Give a brief note of strain & shackle insulators with neat diagrams?	Understand	4
8	Derive an expression of SAG for Unequal height towers.	Knowledge	4
9	Derive a mathematical expression for string efficiency of 4 suspension type insulators	Knowledge	4
10	What is SAG? Derive an expression of SAG for equal height supports	understand	4

UNIT V

Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Explain the different types of cables?	Understand	5
2	Derive the expression for capacitance of a Single core cable?	Evaluate	5
3	Compare overhead lines and underground cables?	Knowledge	5
4	What are the different types of Insulating materials?	Understand	5
5	Explain about Inter-sheath grading?	Understand	5

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Derive an expression for capacitance of a single core cable.	Knowledge	5
2	Give a brief note of Capacitance grading mathematically.	Understand	5
3	Calculate the capacitance & charging current of a single core cable used on a 3-ph, 66 KV system. The cable is 1 km long having a core diameter of 10cm & an insulation thickness of 7cm. Relative permittivity of insulation is 4 at 50Hz.	Knowledge	5
4	What is an Underground cable & explain its construction with a neat diagram.	Knowledge	5
5	Explain about the types of cables based on operating voltage	Evaluate	5

OBJECTIVE QUESTIONS

UNIT-I

1. A 3-Ph, 4-Wire system is commonly used for
   a) Primary Distribution b) Secondary Distribution
   c) Primary Transmission d) Secondary Transmission
2. The Conductor connecting Consumer terminals to the distributor is called
   a) Feeder b) Distributor
   c) Service mains d) none
3. The volume of the copper required for an AC transmission line is inversely proportional to
   a) Current b) Voltage
   c) Power factor d) both voltage, power factor
4. The relation of magnetic field direction to the current direction can be easily measured by

a) Flemings Left hand rule b) Flemings Right hand rule
c) Faradays rule d) Lenz's rule

5. Internal Flux linkage in independent of
   a) Radius of the conductor b) Current in the conductor
   c) Permeability d) Size of the conductor
6. Skin depth is the distance from the conductor surface where the field strength has fallen to
   a) Increase its strength at the surface b) e of its strength at the surface
   c) (1/e) of its strength at the surface d) (1/ e) of its strength at the surface
7. A generating station has a maximum demand of 50 Mw, a load factor of 60%, a plant capacity factor of 45% and if the plant while running as per schedule were fully loaded. The daily energy produced will be
   a) 400 MW b) 720 MW c) 500 MW d) 600 MW
8. A single phase transmission line of impedance j 0.8 ohm supplies a resistive load of 500 A at 300 V. The sending end power factor is
   a) Unity **b**) 0.8 lagging c) 0.8 leading d) 0.6 lagging

UNIT II

1. Transposition of lines is done mainly to
   a) Reduce corona b) Reduce Charging Currents
   c) Reduce Radio interference d) Reduce Over Voltages
2. Corona Losses are reduced by
   a) Larger Spacing between conductors b) Smaller Resistance in the line
   c) Larger diameter of the conductor d) none
3. Effect of earth is negligible if
   a) Conductors are high above the earth than distance between them
   b) Distance between them is higher compared to height
   c) Height from earth and distance between them are equal
   d) Conductors are transposed
4. Voltage regulation depends on
   a) Source power factor b) Load Power factor
   c) Losses of the line d) none of the above
5. Surge impedance of a line
   a) Increase with length of a line b) Increase with radius of a conductor
   c) Decrease with increase in length & radius d) Is independent of length

UNIT III

1. Advantage of DC transmission over AC
   a) Maintenance of substations is easy b) Switches & breakers have no limits
   c) No commutation problems d) Reduced corona loss & interference
2. The best material to avoid radio interference is
   a) Aluminum b) Galvanized steel
   c) Bundled Conductors d) Aluminum& bundled conductors
3. Distortion is found in
   a) Lower frequencies b) Audible frequencies
   c) Medium frequencies d) Radio frequencies
4. Zero sequence currents are found in
   a) 1-ph system b) 3-ph system
   c) DC system d) both 1-ph, 3-ph
5. Characteristics of a loss less line are
   a) Naturally loading with low power factor at sending end
   b) Naturally loading with unity power factor at both ends
   c) Naturally loading with zero power factor at both ends
   d) Naturally loading with zero power factor at receiving end

UNIT IV

1. The technique of coordinating power and telephone lines is

a) Radio interference b) Transposition
c) Geometrical mean distance d) Asymmetry

2. Disadvantage of constant voltage transmission
   a) Short circuit current increased b) power factor decreased
   c) Losses increased d) none
3. ACSR Conductors have
   a) All conductors made of aluminium b) Outer conductors made of aluminium
   c) Inner conductors made of aluminium d) no conductors made of aluminium
4. Which of the following materials is not used for transmission & distribution?
   a) Tungsten b) copper
   c) Aluminum d) cadmium copper
5. Capacitance in equivalent circuit of a transmission line is due to
   a) Current in the line b) Difference in potential of a line
   c) Leakage current d) Presence of magnetic flux

UNIT V

1. Surge impedance of a overhead line is
   a) Above 700 ohms b) (40-60) ohms
   c) (400-600) ohms d) below 40 ohms
2. Inductance of a line is minimum when
   a) GMD is high b) GMR is high
   c) Both GMD & GMR high d) GMD low & GMR high
3. Increase in frequency of a transmission line causes
   a) no change in line resistance b) Increase in line resistance
   c) Decrease in line resistance d) Decrease in line series reactance
4. Transients in a system are caused due to
   a) Resistance b) Inductance
   c) Capacitance d) both b) & c)
5. When transmission line is terminated through a resistance equal to surge impedance
   a) There is reflection b) There is reflection & refraction
   c) There is neither reflection nor refraction d) there is refraction
6. Voltage& current waves get attenuated
   a) Linearly b) parabolic ally
   c) Inversely d) Exponentially
7. If terminating resistance greater than natural impedance of the line
   a) There is a reflection b) There is a reflection with positive sign
   c) There is no reflection d) There is a reflection with negative sign
8. The accurate technique for analyzing transient circuits
   a) Differential equations b) Fourier series
   c) Fourier transforms d) Laplace transforms
9. Harmonic voltages are due to
   a) Natural frequency voltages b) Fundamental voltages
   c) Unbalanced currents d) Balanced reactance's

GATE:

1) For equilateral spacing of conductors of an untrasposed 3-phase line, we have
   a) balanced receiving end voltage and no communication interference
   b) unbalanced receiving end voltage and no communication interference
   c) balanced receiving end voltage and communication interference
   d) unbalanced receiving end voltage and communication interference.
2) A 100 km transmission line is designed for a nominal voltage of 132 kV and consists of one conductor per phase. The line reactance is 0.726 ohm/km. The static transmission capacity of the line, in Megawatts, would be
   a) 132 b) 240 c) 416 d) 720

3) A 100 km long transmission line is loaded at 110 kV.if the loss of line is 5 MW and the load is 150 MVA, the resistance of the line is
   a) ohms per phase b) 0.806 ohms per phase c) 0.0806 ohms per phase d)80.6 ohms per phase
4) Which one of the following statement. is not correct for the use of bundled conductors in transmission lines?
   a) Control of voltage gradient b) Reduction in corona 1088 c) Reduction in radio interference (D)Increase in interference with communication lines.
5) For a 500 Hz frequency excitation, a 500 km long power line will be modeled as
   a) short line b)medium line c) long line d) data insufficient for decision
6) The depth of penetration of a wave in a dielectric loss increases with increasing
   a) conductivity b)permeability c) wavelength d) permittivity
7) It is possible to destroy the super conductivity of a material by applying
   a) a strong magnetic field b) a temperature much below the transition temperature c) a strong electric field d) a pressure below that of the atmosphere
8) If a high frequency AC signal, whose r.m.s. value is √2V, is applied to a PMMC instrument, then the reading of the instrument will be
   a) 2 V b) √2 V c) 1 V d)zero

IES:

1. Skin depth is the distance from conductor surface where the field strength has fallen to
   a) Increase its strength at the surface b) e of its strength at the surface
   c) (1/e) of its strength at the surface d) (1/ e) of its strength at the surface
2. The electric field in the vicinity of two oppositely charged parallel conductors is
   (a) Radial uniformly (b) In parallel lines between the two imaginary parallel planes passing through the centers of the two conductors
   (c) Not uniform and its direction changes from point to point
   (d) In parallel circular paths between the two conductors, with the centre of the circles located at the mid-point of a line joining the two centres of the two conductors
3. Two charges are placed at a distance apart. Now, if a glass slab is inserted between them, then the force between the charges will
   (a) Reduce to zero (b) increase (c) decrease (d) not change
4. The presence of one of the following materials, in iron or steel for use as a magnetic material, tends to reduce the hysteresis loss
   (a) Carbon (b) Sulphur (c) Phosphorus (d) Silicon
5. As a result of reflections from a plane conducting wall, electromagnetic waves acquire an apparent velocity greater than the velocity of light in space. This is called
   (a) Velocity propagation (b) normal velocity (c) group velocity (d) phase velocity
6. A 75 Ω transmission line is first short-terminated and the minima locations are noted. When the short is replaced by a resistive load RL, the minima locations are not altered and the VSWR is measured to be 3. The value of RL is
   (a) 25 Ω (b) 50Ω (c) 225Ω (d) 250Ω
7. Match List-I with List-II and select the correct answer using the code given below the

List-I	**List-II**
A. Carbon (Diamond)	1. Conducting
B. Silicon	2. Semi-conducting
C. Tin (Grey)	3. Insulating

D. Lead

WEBSITES:

1. http://www.ee.uidaho.edu/ee/power/ee
2. http://www.kpsec.freeuk.com/symbol.htm
3. http://nptelonlinecourses.iitm.ac.in/

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JOURNALS:

1. IEEE Transaction on Power systems

LIST OF TOPICS FOR STUDENT'S SEMINARS:

1. Corona & formation
2. Nominal methods
3. Rigorous method of long lines
4. Skin & proximity effects
5. Ferranti effect
6. Proximity effect
7. Types of insulators
8. Methods of improving string efficiency
9. Sag and tension
10. Underground cables

CASE STUDIES / SMALL PROJECTS:

1. Power factor improvement on transmission lines by condensers.
2. Insulator design's