Master in Power System Engineering

Sample Question Papers for Entrance

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SECTION A: POWER SYSTEM LINES (30 MARKS)

Answer all questions (1 mark each)

1. In a per-unit system, if the base power is doubled while keeping the base voltage constant, the per- unit impedance value will:
   [a] Double
   [b] Halve
   [c] Remain unchanged
   [d] Quadruple

2. The primary purpose of using a single-line diagram in power system representation is to:
   [a] Show exact physical layout of conductors
   [b] Simplify three-phase system analysis by representing all three phases with one line
   [c] Display harmonic content in the system
   [d] Illustrate grounding arrangements only

3. For a lossless transmission line, the characteristic impedance is purely:
   [a] Resistive
   [b] Inductive
   [c] Capacitive
   [d] Complex with equal R and X components

4. Voltage regulation of a transmission line is defined as:
   [a] $(V_s - V_r)/V_s \times 100\%$ at no-load
   [b] $(V_{nl} - V_{fl})/V_{fl} \times 100\%$ at full load
   [c] $(V_{fl} - V_{nl})/V_{nl} \times 100\%$ at full load
   [d] $(P_{loss}/P_s) \times 100\%$

5. Corona discharge in EHV transmission lines primarily causes:
   [a] Increased inductance
   [b] Reduced capacitance
   [c] Power loss and radio interference
   [d] Decreased surge impedance

6. For a short transmission line model (length < 80 km), which parameter is typically neglected?
   [a] Resistance
   [b] Inductance
   [c] Capacitance
   [d] Conductance

7. The surge impedance loading (SIL) of a transmission line is given by:
   [a] V^2/Z_0
   [b] V/Z_0
   [c] Z_0/V
   [d] $V^2 \times Z_0$

8. In the nominal-π model of a medium transmission line, the total shunt admittance is:
   [a] Concentrated at the sending end
   [b] Concentrated at the receiving end
   [c] Split equally between sending and receiving ends
   [d] Distributed uniformly along the line

9. The ABCD parameters of a transmission line satisfy the condition:
   [a] AD - BC = 0
   [b] AD - BC = 1
   [c] AB - CD = 1
   [d] A + D = B + C

10. Skin effect in transmission line conductors results in:
    [a] Uniform current distribution across conductor cross-section
    [b] Increased effective resistance at higher frequencies
    [c] Reduced inductance at power frequency
    [d] Decreased corona inception voltage

11. Bundled conductors in EHV lines are primarily employed to:
    [a] Reduce tower height requirements
    [b] Minimize corona losses and reduce reactance
    [c] Increase thermal loading capacity only
    [d] Simplify insulator string design

12. The Ferranti effect is predominantly observed in:
    [a] Short lines under heavy load
    [b] Long lightly loaded or open-circuited lines
    [c] Distribution feeders with high R/X ratio
    [d] Generator step-up transformers

13. For a 3-phase transmission line with symmetrical spacing, the geometric mean distance (GMD) equals:
    [a] Actual physical spacing between conductors
    [b] Geometric mean radius of the conductor
    [c] Cube root of product of all three mutual distances
    [d] Arithmetic mean of phase spacings

14. The charging current in a transmission line is primarily determined by:
    [a] Series resistance
    [b] Series inductance
    [c] Shunt capacitance
    [d] Shunt conductance

15. A power factor of 0.8 lagging for an industrial load implies that:
    [a] Active power is 80% of apparent power
    [b] Reactive power is 80% of apparent power
    [c] Active power leads reactive power by 36.87°
    [d] The load is predominantly capacitive

16. In per-unit system conversion from one base to another, the per-unit impedance transforms as:
    [a] $Z_{pu2} = Z_{pu1} \times (kV_1/kV_2)^2 \times (MVA_2/MVA_1)$
    [b] $Z_{pu2} = Z_{pu1} \times (kV_2/kV_1)^2 \times (MVA_1/MVA_2)$
    [c] $Z_{pu2} = Z_{pu1} \times (kV_1/kV_2) \times (MVA_2/MVA_1)$
    [d] $Z_{pu2} = Z_{pu1} \times (kV_2/kV_1) \times (MVA_1/MVA_2)$

17. The primary advantage of per-unit representation in power system analysis is:
    [a] Elimination of transformers from equivalent circuits
    [b] Normalization of quantities enabling easier comparison across voltage levels
    [c] Direct measurement of fault currents
    [d] Simplification of load flow Jacobian matrix

18. For a long transmission line (>240 km), the most accurate model employs:
    [a] Nominal-T representation
    [b] Nominal-π representation
    [c] Distributed parameter model using hyperbolic function
    [d] Short line approximation with lumped R and L

19. The efficiency of a transmission line is defined as:
    [a] $(P_r/P_s) \times 100\%$
    [b] $(P_s/P_r) \times 100\%$
    [c] $(P_{loss}/P_s) \times 100\%$
    [d] $(P_r/(P_r + P_{loss})) \times 100\%$

20. Transposition of transmission line conductors is performed to:
    [a] Reduce corona effects
    [b] Equalize inductance and capacitance of all three phases
    [c] Minimize tower loading
    [d] Facilitate maintenance operations

21. The conductance parameter (G) in transmission line modeling primarily accounts for:
    [a] Conductor resistance losses
    [b] Dielectric losses in insulators and corona
    [c] Hysteresis losses in nearby steel structures
    [d] Eddy current losses in ground wires

22. For a lossless line, the propagation constant γ equals:
    [a] $j\omega\sqrt{(LC)}$
    [b] $\sqrt{(RG)}$
    [c] $R + j\omega L$
    [d] $G + j\omega C$

23. The wavelength of a 50 Hz power wave on a lossless transmission line with velocity factor 0.95 is approximately:
    [a] 5700 km
    [b] 6000 km
    [c] 5000 km
    [d] 4800 km

24. A transmission line operating at its surge impedance loading (SIL) will have:
    [a] Zero voltage regulation
    [b] Maximum power transfer
    [c] Unity power factor at both ends
    [d] All of the above

25. The primary factor influencing corona inception voltage is:
    [a] Conductor surface gradient
    [b] Line length
    [c] System frequency
    [d] Load power factor

26. In a 3-phase system, the relationship between line-to-line voltage (V_{ll}) and line-to-neutral voltage (V_{ln}) for a balanced system is:
    [a] $V_{ll} = V_{ln}$
    [b] $V_{ll} = \sqrt{3}\ V_{ln}$
    [c] $V_{ll} = 3\ V_{ln}$
    [d] $V_{ll} = V_{ln}/\sqrt{3}$

27. The geometric mean radius (GMR) of a stranded conductor is:
    [a] Equal to its physical radius
    [b] Greater than its physical radius
    [c] Less than its physical radius
    [d] Independent of strand arrangement

28. For a short transmission line with impedance Z = R + jX delivering power P at receiving end voltage V_r, the approximate voltage regulation is:
    [a] $(PR + QX)/V_r^2$
    [b] $(PX - QR)/V_r^2$
    [c] $(PR - QX)/V_r^2$
    [d] $(PX + QR)/V_r^2$

29. The primary purpose of series capacitors in transmission lines is to:
    [a] Compensate for lagging power factor loads
    b] Reduce line inductive reactance and improve stability
    [c] Limit fault currents
    [d] Suppress harmonics

30. In a per-unit system with 100 MVA and 220 kV bases, a 50 Ω physical impedance has a per-unit value of:
    [a] 0.103
    [b] 0.206
    [c] 0.413
    [d] 0.826

SECTION B: POWER FLOW ANALYSIS (30 MARKS)

31. In load flow studies, a slack bus is required primarily to:
    [a] Supply reactive power only
    [b] Balance real power losses in the system
    [c] Maintain constant voltage magnitude
    [d] Represent infinite bus with fixed voltage and angle

32. For a PV bus in load flow analysis, the specified quantities are:
    [a] Real power injection and voltage magnitude
    [b] Real power injection and reactive power injection
    [c] Voltage magnitude and voltage angle
    [d] Real power injection and voltage angle

33. The Gauss-Seidel method for load flow solution has the advantage of:
    [a] Faster convergence than Newton-Raphson
    [b] Lower memory requirements
    [c] Quadratic convergence characteristics
    [d] Insensitivity to initial guess

34. The primary limitation of the Gauss-Seidel method is:
   [a] High computational complexity per iteration
   [b] Slow convergence for large systems
   [c] Requirement of Jacobian matrix inversion
   [d] Inability to handle PV buses

35. In the Newton-Raphson load flow method, the Jacobian matrix contains partial derivatives of:
   [a] Real and reactive power injections with respect to voltage magnitudes and angles
   [b] Voltage magnitudes with respect to real power injections only
   [c] Line flows with respect to tap changer positions
   [d] Losses with respect to generator outputs

36. For a system with N buses including one slack bus, the dimension of the Jacobian matrix in polar form Newton-Raphson is approximately:
   [a] $(N-1) \times (N-1)$
   [b] $2(N-1) \times 2(N-1)$
   [c] $(2N-2) \times (2N-2)$
   [d] $N \times N$

37. Symmetrical components transformation is used in fault analysis because:
   [a] It simplifies unbalanced three-phase systems into three independent sequence networks
   [b] It eliminates the need for complex numbers
   [c] It reduces computational time for load flow
   [d] It accounts for harmonic distortions

38. The zero-sequence network for a Y-connected generator with grounded neutral contains:
   [a] No impedance path
   [b] $3Z_n$ in series with generator impedance
   [c] Only generator subtransient reactance
   [d] Infinite impedance

39. For a single line-to-ground (LG) fault at bus k, the fault current is given by:
   [a] $3V_k/(Z_1 + Z_2 + Z_0)$
   [b] $V_k/(Z_1 + Z_2)$
   [c] V_k/Z_1
   [d] $3V_k/Z_1$

40. During a three-phase bolted fault, the sequence networks are connected:
   [a] In series
   [b] In parallel
   [c] Only positive sequence network is used
   [d] Positive and negative in parallel, zero open

41. The operator 'a' in symmetrical components is defined as:
   [a] $1\angle 0°$
   [b] $1\angle 90°$
   [c] $1\angle 120°$
   [d] $1\angle 240°$

42. For a line-to-line (LL) fault between phases b and c, the boundary conditions are:
   [a] $I_a = 0, V_\beta = V_c$
   [b] $I_\beta = -I_c, V_a = 0$
   [c] $I_a = 0, I_\beta = -I_c, V_\beta = V_c$
   [d] $I_a = I_\beta = I_c, V_a = V_\beta = V_c$

43. In load flow formulation, the mismatch equation for real power at bus i is:
[a] $\Delta P_i = P_i^{spec} - P_i^{calc}$
[b] $\Delta P_i = P_i^{calc} - P_i^{spec}$
[c] $\Delta P_i = P_{loss}/2$
[d] $\Delta P_i = V_i \Sigma Y_{ij} V_j \cos(\theta_{ij} - \delta_i + \delta_j)$

44. The acceleration factor in Gauss-Seidel method is used to:
[a] Improve convergence rate
[b] Reduce memory requirements
[c] Handle inequality constraints
[d] Account for transformer tap changes

45. During a double line-to-ground (LLG) fault, the sequence networks are connected:
[a] All three in series
[b] Positive and negative in parallel, then in series with zero
[c] Positive and zero in parallel, then in series with negative
[d] All three in parallel

46. The subtransient reactance (X") of a synchronous machine is used for fault analysis because:
[a] It represents steady-state behavior
[b] It determines initial fault current magnitude
[c] It accounts for damper winding effects during transient period
[d] It is larger than transient reactance

47. In a power system with predominantly inductive loads, the receiving end voltage of a long transmission line under light load conditions will be:
[a] Lower than sending end voltage
[b] Equal to sending end voltage
[c] Higher than sending end voltage
[d] Independent of load

48. For a PQ bus, the unknown state variables in load flow are:
[a] Voltage magnitude and angle
[b] Real and reactive power injections
[c] Only voltage angle
[d] Only voltage magnitude

49. The primary reason Newton-Raphson converges faster than Gauss-Seidel is:
[a] It uses constant Jacobian throughout iterations
[b] It has quadratic convergence near the solution
[c] It requires fewer buses to be classified
[d] It ignores reactive power constraints

50. During fault analysis, the prefault load current is typically neglected because:
[a] It is always zero
[b] Its contribution to fault current is negligible compared to fault component
[c] It complicates symmetrical component analysis
[d] Load current is capacitive while fault current is inductive

51. For a balanced three-phase system, the zero-sequence current is:
[a] Equal to phase current
[b] Three times phase current
[c] Zero
[d) √3 times phase current

52. The bus admittance matrix (Y-bus) is generally:
   [a] Dense and asymmetric
   [b] Sparse and symmetric
   [c] Diagonal only
   [d] Upper triangular

53. In Newton-Raphson method, flat start initialization assumes:
   [a] All voltage magnitudes = 1.0 p.u., all angles = 0° except slack
   [b] All voltage magnitudes = rated values, angles from previous solution
   [c] All voltages equal to slack bus voltage
   [d] Voltage magnitudes proportional to load levels

54. For a line-to-line fault, the zero-sequence network:
   [a] Carries fault current
   [b] Is not involved in the fault
   [c] Determines fault current magnitude
   [d] Must be grounded for fault to occur

55. The primary advantage of fast decoupled load flow over full Newton-Raphson is:
   [a] Better accuracy
   [b] Reduced memory requirement due to constant approximate Jacobian
   [c] Ability to handle voltage collapse
   [d] No need for PV bus classification

56. During a single line-to-ground fault, the voltage at the faulted phase becomes:
   [a] Equal to prefault voltage
   [b] $\sqrt{3}$ times prefault voltage
   [c] Zero (for bolted fault)
   [d] 1.5 times prefault voltage

57. The sequence impedances of a fully transposed transmission line satisfy:
   [a] $Z_0 = Z_1 = Z_2$
   [b] $Z_1 = Z_2 \neq Z_0$
   [c] $Z_0 = Z_2 \neq Z_1$
   [d] $Z_0 = 2Z_1 = 2Z_2$

58. In load flow studies, voltage-controlled buses (PV buses) typically represent:
   [a] Load buses
   [b] Generator buses with AVR control
   [c] Tie-line interconnections
   [d] Distribution transformers

59. The convergence criterion in iterative load flow methods is typically based on:
   [a] Maximum number of iterations
   [b] Maximum power mismatch below tolerance
   [c] Constant voltage magnitudes
   [d] Zero reactive power injection

60. For a three-phase fault, the fault current magnitude is generally:
   [a] Highest among all fault types
   [b] Lowest among all fault types
   [c] Equal to single line-to-ground fault current
   [d] Dependent on system grounding

SECTION C: POWER SYSTEM PROTECTION (30 MARKS)

61. Current transformers (CTs) used for protection must have:
    [a] High accuracy at rated current only
    [b] Ability to reproduce primary current accurately during fault conditions
    [c] Low burden rating
    [d] Air core construction

62. The primary purpose of instrument transformer grounding is to:
    [a] Improve measurement accuracy
    [b] Provide safety against high voltage hazards
    [c] Reduce magnetizing current
    [d] Minimize phase angle error

63. Overcurrent relays are typically classified as:
    [a] Unit protection schemes
    [b] Non-unit protection schemes
    [c] Differential protection schemes
    [d] Distance protection schemes

64. In a differential protection scheme for a transformer, the restraining coil is used to:
    [a] Increase sensitivity during internal faults
    [b] Prevent operation during external faults and magnetizing inrush
    [c] Compensate for CT ratio errors
    [d] Provide time delay coordination

65. The reach of a distance relay zone 1 is typically set to protect:
    [a] 100% of the protected line
    [b] 80-90% of the protected line
    [c] 120% of the protected line
    [d] Only the first 50% of the line

66. Magnetizing inrush current in transformers contains significant:
    [a] Fundamental frequency
    [b] Second harmonic component
    [c] Third harmonic component
    [d] Fifth harmonic component

67. For feeder protection, the coordination between upstream and downstream overcurrent relays requires:
    (a) Same time dial settings
    [b] Time grading (discrimination) to ensure selectivity
    [c] Identical current settings
    [d] Inverse definite minimum time (IDMT) characteristics only

68. Buchholz relay is used for protection of:
    [a] Overhead transmission lines
    [b] Oil-immersed power transformers against internal faults
    [c] Generator stator windings
    [d] Busbars

69. The primary advantage of numerical (digital) relays over electromechanical relays is:
   [a] Lower cost
   [b] Multi-functionality and communication capabilities
   [c] Higher burden on CTs/VTs
   [d] Simpler testing procedures

70. In a three-phase differential protection scheme for generators, the CTs must be connected in:
   [a] Wye on both sides regardless of transformer connection
   [b] Delta on generator side, wye on neutral side
   [c] Configuration that compensates for phase shift due to transformer connection
   [d] Only on-line side, not neutral side

71. The burden of a CT refers to:
   [a] Maximum primary current it can carry
   [b] Impedance connected across its secondary terminals
   [c] Ratio of primary to secondary current
   [d] Accuracy class under fault conditions

72. For distance protection, the impedance seen by the relay during a fault is proportional to:
   [a] Fault current magnitude
   [b] Distance from relay location to fault
   [c] System voltage level
   [d] Type of fault

73. A reverse power relay is primarily used to protect generators against:
   [a] Overexcitation
   [b] Motoring action when prime mover fails
   [c] Loss of excitation
   [d] Stator earth faults

74. The standard accuracy class for protection CTs as per IEC 61869 is:
   [a] 0.1, 0.2, 0.5
   [b] 5P, 10P
   [c] Class 1.0
   [d] 0.1S, 0.2S

75. In a percentage differential relay, the operating characteristic is defined by:
   [a] Fixed current threshold
   [b] Ratio of differential current to restraining current
   [c] Time delay proportional to fault current
   [d] Voltage magnitude at relay location

76. For transmission line protection, pilot wire schemes are generally limited to lines shorter than: [a] 500 km
   [b] 200 km
   [c] 50 km
   [d] 10 km

77. Loss of excitation protection for synchronous generators typically uses:
   [a] Overcurrent elements
   [b] Impedance (mho) characteristics in the underexcited region
   [c] Negative sequence current detection
   [d] Differential current measurement

78. The primary function of a circuit breaker in a power system is to:
   [a] Regulate voltage
   [b] Interrupt fault current and isolate faulty section
   [c] Compensate reactive power
   [d] Step up voltage levels

79. Zone 3 of a distance relay provides:
   [a] Instantaneous protection for entire line
   [b] Backup protection for adjacent lines
   [c] Protection against transformer faults
   [d] Protection against high impedance faults only

80. For transformer protection against earth faults on delta-connected windings, which scheme is most effective?
   [a] Overcurrent relays on line side only
   [b] Restricted earth fault (REF) protection
   [c] Differential protection with harmonic restraint
   [d] Distance relays set for zero-sequence impedance

81. The term "CT saturation" during high fault currents leads to:
   [a] Increased secondary current accuracy
   [b] Distorted secondary current waveform and reduced magnitude
   [c] Improved relay operation speed
   [d] Lower burden requirement

82. In a solid-state relay, the primary sensing element is typically:
   [a] Induction disc
   [b] Electromagnet
   [c] Operational amplifier or microprocessor
   [d] Bimetallic strip

83. For generator protection, 100% stator earth fault protection typically employs:
   [a] Third harmonic voltage monitoring
   [b] Overcurrent relays on neutral connection
   [c] Differential protection only
   [d] Distance relays with low impedance setting

84. The purpose of a "dead time" in auto-reclosing schemes is to allow:
   [a] Fault arc deionization
   [b] Relay reset time
   [c] Operator intervention
   [d] Generator resynchronization

85. In directional overcurrent relays, the directional element responds to:
   [a] Magnitude of current only
   [b] Phase angle between current and voltage
   [c] Rate of change of current
   [d] Harmonic content of current

86. For busbar protection, the preferred scheme in modern substations is:
    [a] Overcurrent backup protection
    [b] High impedance differential protection
    [c] Distance protection with zone extension
    [d] Voltage restrained overcurrent

87. The standard time grading between two coordinated overcurrent relays is typically: [a) 0.1 seconds
    [b] 0.3 to 0.4 seconds
    [c] 1.0 second
    [d] 3.0 seconds

88. Negative sequence current protection for generators is primarily used to detect:
    [a] Balanced three-phase faults
    [b] Unbalanced loading and phase faults
    [c] Overvoltage conditions
    [d] Loss of synchronism

89. In distance relay characteristics, the mho relay has a:
    [a] Straight line characterstics
    [b] Eliptical characterstics
    [c] Circular characteristic passing through origin [d) Quadrilateral characteristic

90. The primary challenge in protecting series capacitor compensated lines is:
    [a] Voltage regulation issues
    [b] Dual impedance loci causing relay misoperation
    [c] Increased fault current levels
    [d] Harmonic resonance

SECTION D: HIGH VOLTAGE ENGINEERING (10 MARKS)

91. Switching overvoltages in EHV systems are primarily caused by:
    [a] Lightning strikes on towers
    [b] Energization/de-energization of lines and transformers
    [c] Corona discharges
    [d] Load rejection only

92. The primary purpose of insulation coordination is to:
    [a] Minimize cost of insulation system while maintaining reliability
    [b] Eliminate all overvoltages
    [c] Increase system voltage levels
    [d] Reduce corona losses

93. The standard lightning impulse voltage waveform used in testing is:
    [a] 1.2/50 μs (rise time/tail time)
    [b] 8/20 μs
    [c] 250/2500 μs
    [d] 10/350 μs

94. The protective margin in insulation coordination is defined as the difference between:
  [a] BIL of equipment and protective level of surge arrester
  [b] System voltage and equipment rating
  [c] Switching surge magnitude and lightning surge magnitude
  [d] Dry and wet withstand voltages

95. Dielectric breakdown in gases at power frequency is primarily explained by:
  [a] Thermal theory
  [b] Townsend's avalanche mechanism
  [c] Electrochemical theory
  [d] Bubble theory

96. For EHV transmission (>400 kV), the dominant factor in determining insulation requirements is:
  [a] Power frequency withstand voltage
  [b] Switching surge withstand voltage
  [c] Lightning impulse withstand voltage
  [d] Radio interference voltage

97. Surge arresters protect equipment by:
  [a] Blocking all transient voltages
  [b] Limiting voltage by diverting surge current to ground when voltage exceeds threshold
  [c] Increasing system impedance during transients
  [d] Absorbing energy through resistive elements only

98. The concept of "statistical approach" in insulation coordination recognizes that:
  [a] All overvoltages have identical magnitude
  [b] Overvoltages and withstand strengths have probabilistic distributions
  [c] Insulation failure is deterministic
  [d] Only worst-case scenarios need consideration

99. The primary advantage of SF_6 gas as an insulating medium is its:
  [a] Low cost
  [b] High dielectric strength and arc-quenching capability
  [c] Environmental friendliness
  [d] Low liquefaction temperature

100. In high voltage testing, the purpose of partial discharge measurement is to:
  [a] Determine power frequency withstand capability
  [b] Detect incipient insulation defects before complete failure
  [c] Measure dielectric loss tangent
  [d] Verify voltage distribution along insulator strings

Thank You