

Adda247

UPSC

**Sikkim
PSC**

**Previous Year Paper
Under Secretary Mains
Electrical Engineering 2017**



Paper - ELECTRICAL ENGINEERING

PART - I : OBJECTIVE / MCQ

Each question carries 2 marks:

(75X2= 150 Marks)

1. In a travelling electromagnetic wave, E and H vector fields are
 - (A) perpendicular in space .
 - (B) parallel in space.
 - (C) E is in the direction of wave travel.
 - (D) H is in the direction of wave travel.
2. The polarization of a dielectric material is given by
 - (A) $\vec{P} = \epsilon_r \vec{E}$
 - (B) $\vec{P} = (\epsilon_r - 1) \vec{E}$
 - (C) $\vec{P} = \epsilon_0 (\epsilon_r - 1) \vec{E}$
 - (D) $\vec{P} = \epsilon_0 (\epsilon_r - 1)$
3. The ratio of conduction current density to the displacement current density is
 - (A) $\frac{\sigma}{j\omega\epsilon}$
 - (B) $\frac{j\sigma}{\omega\epsilon}$
 - (C) $\frac{\omega\sigma}{j\epsilon}$
 - (D) $\frac{\sigma}{\omega\epsilon}$

where symbols have their usual meaning.

4. Electric field intensity due to line charge of infinite length is
 - (A) $\frac{\rho_L}{2\pi\epsilon R}$
 - (B) $\frac{\rho_L}{4\pi\epsilon R}$
 - (C) $\frac{\rho_L}{2\pi\epsilon R^2}$
 - (D) $\frac{\rho_L}{2\pi\epsilon R^3}$

5. A loop is rotating about y-axis in a magnetic field $B = B_0 \sin \omega t \vec{a}_x$. The voltage induced in the loop is due to
- (A) Motional emf
 - (B) Transformer emf
 - (C) A combination of motional & transformer emf
 - (D) None of the above
6. Which of the following materials is used for making permanent magnet.
- (A) Platinum cobalt
 - (B) Alnico
 - (C) Carbon Steel
 - (D) all the three
7. The number of atoms present in the unit cell of HCP structure is
- (A) 2.
 - (B) 4.
 - (C) 6.
 - (D) 7.
8. The Fermi level in an n-type semiconductor at 0°K lies
- (A) below the donor level.
 - (B) Half way between the bottom of conduction band and donor level.
 - (C) Exactly in the middle of band gap.
 - (D) Half way between the top of valence band and the acceptor level.
9. Hard magnetic material is characterized by
- (A) High coercive force and low residual magnetic induction..
 - (B) Low coercive force and high residual magnetic induction..
 - (C) Only low coercive force.
 - (D) High coercive force and high residual magnetic induction..
10. Polarization in a dielectric on application of electric field is
- (A) Displacement/separation of opposite charge centres.
 - (B) Passing of current through dielectric.
 - (C) Breaking of insulation.
 - (D) Excitation of electrons to higher energy level.

11. Superposition theorem is applicable only to networks that are:
- (A) linear.
 - (B) nonlinear.
 - (C) time-invariant.
 - (D) passive.
12. In the solution of network differential equations, the constants in the complementary function have to be evaluated from the initial conditions, and then the particular integral is to be added. This procedure is
- (A) correct.
 - (B) incorrect.
 - (C) the one to be followed for finding the natural response.
 - (D) the one to be followed for finding the natural and forced responses.
13. Two inductors of values L_1 and L_2 are coupled by a mutual inductance M . By inter connection of the two elements, one can obtain a maximum inductance of
- (A) $L_1 + L_2 - M$
 - (B) $L_1 + L_2$
 - (C) $L_1 + L_2 + M$
 - (D) $L_1 + L_2 + 2M$
14. A system is described by the transfer function
- $$H(s) = \frac{1}{s-1}$$
- The value of its step response at very large time will be close to
- (A) -1
 - (B) 0
 - (C) 1
 - (D) ∞
15. A unit impulse voltage is applied to one port network having two linear components. If the current through the network is 0 for $t < 0$ and decays exponentially for $t > 0$ then the network consists of
- (A) R and L in series
 - (B) R and L in parallel
 - (C) R and C in parallel
 - (D) R and C in series

16. The major advantage of electromagnet type meter over a permanent magnet meter is
- (A) The electromagnet meter costs much less
 - (B) The permanent magnet meter has a more sluggish coil
 - (C) The electromagnet meter need not be aligned with the earth's magnetic field
 - (D) The electromagnet meter is more rugged
17. The major advantage of an electrostatic meter is
- (A) It can handle large currents
 - (B) It measures very small currents
 - (C) It can detect and indicate ac voltages as well as dc voltages
 - (D) It draws a large current from a power supply.
18. Ammeter shunts are useful because
- (A) They prevent overheating of the meter movement
 - (B) They make a meter more physically rugged
 - (C) They allow for measurement of large currents
 - (D) They increase meter sensitivity
19. The major advantage of FETVM over a conventional voltmeter is that FETVM
- (A) Can withstand higher voltages safely
 - (B) Draws less current from the circuit under test
 - (C) Can measure lower voltages
 - (D) Is sensitive to ac voltage as well as to dc voltage
20. An oscilloscope cannot be used to indicate
- (A) Frequency
 - (B) Peak signal voltage
 - (C) Energy
 - (D) Wave shape
21. In two watt meter method of power measurement, if one of the watt meter shows zero reading, then it can be concluded that
- (A) Power factor is unity
 - (B) Power factor is zero
 - (C) Power factor is 0.5 lagging
 - (D) Power factor is 0.5 leading

22. The steady-state error of a feedback control system with an acceleration input becomes finite in a

- (A) type 0 system.
- (B) type 1 system.
- (C) type 2 system.
- (D) type 3 system.

23. The Laplace transform of $e^{-2t} \sin 2\omega t$ is _____.

- (A) $\frac{2S}{(S+2)^2 + 2\omega^2}$
- (B) $\frac{2S}{(S+2)^2 + 4\omega^2}$
- (C) $\frac{2\omega}{(S+2)^2 + 4\omega^2}$
- (D) $\frac{S}{(S+2)^2 + 2\omega^2}$

24. If for a control system, the Laplace transform of error $e(t)$ is given as $\frac{8(S+3)}{S(S+10)}$ then the steady state value of the error works out as _____.

- (A) 3.6
- (B) 1.8
- (C) 3.2
- (D) 2.4

25. The equation $2S^4 + S^3 + 3S^2 + 5S + 10$ has

- (A) one
- (B) two
- (C) three
- (D) four

roots in the left half of s-plane.

26. The state-variable description of a linear autonomous system is $\dot{X} = AX$ where $A = \begin{bmatrix} 0 & 2 \\ 2 & 0 \end{bmatrix}$

The poles of the system are located at

- (A) -2 and +2
- (B) -2j and +2j

- (C) -2 and -2
- (D) +2 and +2

27. A system with gain margin close to unity or a phase margin close to zero is

- (A) highly stable.
- (B) oscillatory.
- (C) relatively stable.
- (D) unstable.

28. The overshoot in the response of the system having the transfer function

$$F(s) = \frac{16K}{s(s^2 + 2s + 6)} \text{ for a unit-step input is}$$

- (A) 60%.
- (B) 40%.
- (C) 20%.
- (D) 10%.

29. The damping ratio of a system having the characteristic equation $S^2 + 2S + 8 = 0$ is

- (A) 0.353
- (B) 0.330.
- (C) 0.300
- (D) 0.250.

30. The input to a controller is

- (A) sensed signal.
- (B) desired variable value.
- (C) error signal.
- (D) servo-signal.

31. A salient pole synchronous motor is running at no load. Its field current is switched off. The motor will

- (A) come to stop.
- (B) continue to run at synchronous speed.
- (C) continue to run at a speed slightly more than the synchronous speed.
- (D) continue to run at a speed slightly less than the synchronous speed.

32. The emf induced in the primary of a transformer
- (A) is in phase with the flux.
 - (B) lags behind the flux by 90 degree.
 - (C) leads the flux by 90 degree.
 - (D) is in phase opposition to that of flux.
33. The frequency of the rotor current in a 3 phase 50 Hz, 4 pole induction motor at full load speed is about
- (A) 50 Hz.
 - (B) 20 Hz.
 - (C) 2 Hz.
 - (D) Zero.
34. The d.c. series motor should always be started with load because
- (A) at no load, it will rotate at dangerously high speed.
 - (B) it will fail to start.
 - (C) it will not develop high starting torque.
 - (D) all are true.
35. Out of the following methods of heating the one which is independent of supply frequency is
- (A) electric arc heating
 - (B) induction heating
 - (C) electric resistance heating
 - (D) dielectric heating
36. The generation voltage is usually
- (A) between 11 KV and 33 KV.
 - (B) between 132 KV and 400 KV.
 - (C) between 400 KV and 700 KV.
 - (D) None of the above.
37. When a synchronous motor is running at synchronous speed, the damper winding produces
- (A) damping torque.
 - (B) eddy current torque.
 - (C) torque aiding the developed torque.
 - (D) no torque.

38. If a transformer primary is energized from a square wave voltage source, its output voltage will be
- (A) A square wave.
 - (B) A sine wave.
 - (C) A triangular wave.
 - (D) A pulse wave.
39. The power factor of a squirrel cage induction motor is
- (A) low at light load only.
 - (B) low at heavy load only.
 - (C) low at light and heavy load both.
 - (D) low at rated load only.
40. In a d.c. machine, the armature mmf is
- (A) stationary w.r.t. armature.
 - (B) rotating w.r.t. field.
 - (C) stationary w.r.t. field.
 - (D) rotating w.r.t. brushes.
41. In a transformer the voltage regulation will be zero when it operates at
- (A) unity p.f.
 - (B) leading p.f.
 - (C) lagging p.f.
 - (D) zero p.f. leading.
42. A motor which can conveniently be operated at lagging as well as leading power factors is the
- (A) squirrel cage induction motor.
 - (B) wound rotor induction motor.
 - (C) synchronous motor.
 - (D) DC shunt motor.
43. The most suitable servomotor for low power applications is
- (A) a dc series motor.
 - (B) a dc shunt motor.
 - (C) an ac two-phase induction motor.
 - (D) an ac series motor.

44. The size of a conductor used in power cables depends on the
- (A) operating voltage.
 - (B) power factor.
 - (C) current to be carried.
 - (D) type of insulation used.
45. The size of the feeder is determined primarily by
- (A) the current it is required to carry.
 - (B) the percent variation of voltage in the feeder.
 - (C) the voltage across the feeder.
 - (D) the distance of transmission.
46. For enhancing the power transmission in a long EHV transmission line, the most preferred method is to connect a
- (A) series inductive compensator in the line
 - (B) shunt inductive compensator at the receiving end
 - (C) series capacitive compensator in the line
 - (D) shunt capacitive compensator at the sending end
47. A 500MW, 21kV, 50Hz, 3-phase, 2-pole synchronous generator having a rated p.f. =0.9, has a moment of inertia of $27.5 \times 10^3 \text{ kg-m}^2$. The inertia constant (H) will be
- a. 2.44 s
 - b. 2.71s
 - c. 4.88s
 - d. 5.42s
48. For a fixed value of complex power flow in a transmission line having a sending end voltage V, the real power loss will be proportional to
- (A) V
 - (B) V^2
 - (C) $1/V^2$
 - (D) $1/V$
49. How many 200W/220V incandescent lamps connected in series would consume the same total power as a single 100W/220V incandescent lamps?
- (A) Not possible

- (B) 4
- (C) 3
- (D) 2

50. As the voltage of transmission increases, the volume of conductor

- (A) increases.
- (B) does not change.
- (C) decreases.
- (D) increases proportionately.

51. The boundary of the protective zone is determined by the

- (A) Location of CT
- (B) sensitivity of relay used
- (C) Location of PT
- (D) None of these

52. In a three phase transformer, if the primary side is connected in star and secondary side is connected in delta, what is the angle difference between phase voltage in the two cases.

- (A) delta side lags by -30°
- (B) star side lags by -30°
- (C) delta side leads by 30°
- (D) star side leads by -30°

53. To achieve low PT error, the burden value should be _____.

- (A) low
- (B) high
- (C) medium
- (D) none of the above

54. Inverse definite minimum time lag relay is also called _____

- (A) pilot relay.
- (B) differential relay.
- (C) over current relay.
- (D) directional overcurrent relay.

55. If the phase angle of the voltage coil of a directional relay is 50° , the maximum torque angle of the relay is

- (A) 130°
- (B) 100°
- (C) 50°
- (D) 25°

56. The voltage at the two ends of a transmission line are 132 KV and its reactance is 40 ohm. The Capacity of the line is

- (A) 435.6 MW
- (B) 217.8 MW
- (C) 251.5 MW
- (D) 500 MW

57. Low head plants generally use

- (A) Pelton Turbines
- (B) Francis Turbine
- (C) Pelton or Francis Turbine
- (D) Kaplan Turbines

58. The charging reactance of 50 Km length of line is 1500Ω . The charging reactance for 100Km length of line will be

- (A) 1500Ω
- (B) 3000Ω
- (C) 750Ω
- (D) 600Ω

59. How many two input AND gates and two input OR gates are required to realize

$$Y = BD + CE + AB$$

- (A) 1, 1
- (B) 4, 2
- (C) 3, 2
- (D) 2, 3

60. How many select lines will a 32:1 multiplexer will have

- (A) 5.
- (B) 8.

- (C) 9.
- (D) 11.

61. How many address bits are required to represent 4K memory

- (A) 5 bits.
- (B) 12 bits.
- (C) 8 bits.
- (D) 10 bits.

62. Which of following are known as universal gates

- (A) NAND & NOR.
- (B) AND & OR.
- (C) XOR & OR.
- (D) None.

63. Which of the following memories stores the most number of bits

- (A) 64K × 8 memory.
- (B) 1M × 8 memory.
- (C) 32M × 8 memory.
- (D) 64 × 6 memory.

64. The decimal equivalent of hex number 1A53 is

- (A) 6793
- (B) 6739
- (C) 6973
- (D) 6379

65. The number of control lines for a 8 – to – 1 multiplexer is

- (A) 2
- (B) 3
- (C) 4
- (D) 5

66. How many Flip-Flops are required for mod-16 counter?

- (A) 5
- (B) 6

(C) 3

(D) 4

67. The speed of conversion is maximum in

(A) Successive-approximation A/D converter.

(B) Parallel-comparative A/D converter.

(C) Counter ramp A/D converter.

(D) Dual-slope A/D converter.

68. When simplified with Boolean Algebra $(x + y)(x + z)$ simplifies to

(A) x

(B) $x + x(y + z)$

(C) $x(1 + yz)$

(D) $x + yz$

69. If the crystal oscillator is operating at 15 MHz, the PCLK output of 8284 is

(A) 2.5 MHz.

(B) 5 MHz.

(C) 7.5 MHz.

(D) 10 MHz.

70. Number of the times the instruction sequence below will loop before coming out of loop is

MOV AL, 00h

A1: INC AL

JNZ A1

(A) 00

(B) 01

(C) 255

(D) 256

71. What will be the contents of register AL after the following has been executed

MOV BL, 8C

MOV AL, 7E

ADD AL, BL

(A) 0A and carry flag is set

(B) 0A and carry flag is reset

(C) 6A and carry flag is set

(D) 6A and carry flag is reset

72. Which of the following statements are true about VI characteristic of SCR?
- (A) Holding current is more than Latching current
 - (B) SCR will trigger if the applied voltage exceeds forward break over voltage
 - (C) SCR can be triggered without gate current
 - (D) When the SCR is in reverse biased, small leakage current will flow

Options:

- a. A, B and C
 - b. All are true
 - c. B, C, D
 - d. C, D
73. Which of the following statements are true about BJT?
- (i) It has more power handling capability than MOSFET
 - (ii) Has higher switching speed than IGBT and MOSFET
 - (iii) Has low on state conduction resistance
 - (iv) Has second breakdown voltage problem

Options:

- (A) All are true
- (B) (i), (ii), (iii) and (iv)
- (C) (i), (iii) and (iv)
- (D) (ii), (iii) and (iv)

74. For a JFET, when V_{DS} is increased beyond the pinch off voltage, the drain current

- (A) Increases
- (B) Decreases
- (C) Remains constant
- (D) First decreases and then increases

75. The MOSFET has

- (i) Higher Power handling capability than BJT
- (ii) Faster switching speed than BJT
- (iii) High on state resistance
- (iv) Secondary breakdown voltage problem

which of the above statements are incorrect?

Options:

- (A) (i), (iii) and (iv)
- (B) (ii) and (iii)
- (C) All of the above
- (D) (ii), (iii) and (iv)

PART – II

Subjective / conventional : Marks: 150

This paper consists of: A - 10 question of 5 marks each.....50 Marks
B - 5 question of 10 marks each.....50 Marks
C - 2 question of 25 marks each.....50 Marks

A. Attempt only 10 questions, each question carries 5 marks.

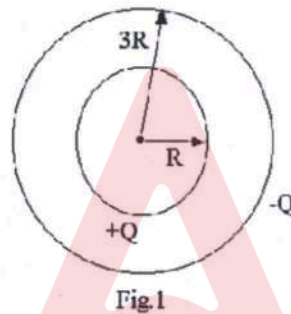
1. A wave is incident normally on a good conductor. If the frequency of a plane electromagnetic wave increases four times, how the skin depth will be changed?
2. Calculate the magnetic field intensity (in A/m) at the centre of a circular coil of diameter 1 metre and carrying current of 2 A.
3. Calculate the mutual inductance M associated with the two coupled inductances L1 and L2 and the coefficient of coupling is K.
4. If the transfer function of a first-order system is
$$G(s) = \frac{10}{(2S + 1)}$$
then find the time constant of the system.
5. The unit-impulse response of a system starting from rest is given by
$$C(t) = 1 - e^{-2t} \text{ for } t \geq 0$$
Find the the transfer function of the system.
6. How are the no load current and it's power factor of an induction motor affected with an increase in the length of the air gap?
7. What is the nature of armature reaction if an alternator is connected to a purely inductive load?

8. What is Buchholz Relay ? Which type of fault of transformer is protected by a Buchholz Relay?
9. A single-phase bridge inverter delivers power to a series connected RLC load with $R=2\Omega$, $\omega L = 8\Omega$. What would be the value of capacitor's reactance for which load commutation is possible for this inverter load combination?
10. In single phase modulation of PWM inverters, pulse width is 120° . For an input voltage of 220V DC, what would be the rms value of output voltage?
11. Consider the program:
- ```
MVI A,32H
RRC
RRC
```
- What would be the content of A after execution of this program?
12. In a 4 bit full adder, how many half adders and OR gates are required?
13. For a D/A converter, the maximum full scaled output is 16V, then what would be the resolution after doubling the step?
14. An industrial consumer has a daily load pattern of 2000kW, 0.8lag for 12hour and 1000kW for 12 hours. What is the value of load factor?

B. Answer any 5 Questions of the following.

5x10=50

1. Two concentric spherical shells carry equal and opposite uniformly distributed charges over their surfaces as shown in Fig.1. calculate the Electric field on the surface of inner shell.

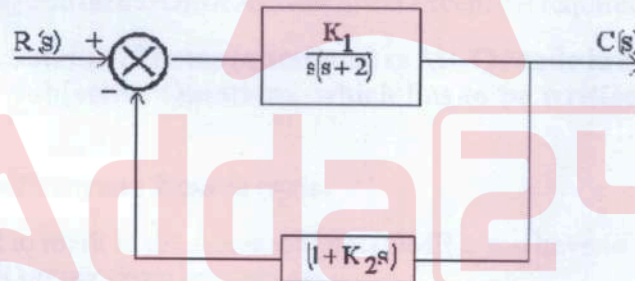


2. For a two port network, show that  $AD-BC=1$ . A,B,C,D are the transmission parameters of the network.
3. Draw a minimum circuit for a Passive Low pass filter. Derive its transfer function.
4. Which coil, current coil or pressure coil, of a electro-dynamometer type instrument does use a thicker wire and why?
5. Calculate the voltage regulation of a transformer in which ohmic drop is 2% and the reactance drop in 5% of the voltage at 0.8 lagging power factor.
6. Calculate the line transformation ratio of a Yd11 transformer if phase transformation ratio is "a".
7. A 800kV transmission line has a maximum power transfer capacity of P. If it is operated at 400kV with the series reactance unchanged, find the new minimum power transfer capability.
8. At an industrial sub-station with a 4MW load, a capacitor of 2MVA|R is installed to maintain the load power factor at 0.97 lag. If the capacitance goes out of service what would be the load power factor?

C. Answer any TWO Questions of the following.

25x2=50

1. A spherical volume of radius  $R$  has a volume charge density given by  $\rho = kr$ , where  $r$  is the radial distance and  $K$  is a constant. Develop expressions for  $\vec{E}$  and  $V$  and sketch their variation with respect to  $r$  ( $0 \leq r \leq \infty$ ).
2. For the system shown in the block diagram of Fig. shown below determine the values of gain  $K_1$  and velocity feedback constant  $K_2$  so that the maximum overshoot with a unit step input is 0.25 and the time to reach the first peak is 0.8 sec. Thus obtain the rise time and settling time for 5% tolerance band.



3. A 230 V d.c. shunt motor with constant field drives a load whose torque is proportional to the speed. When running at 750 rpm it takes 30 A. Find the speed at which it will run if a 10 ohm resistance is connected in series with the armature. The armature resistance may be neglected.
4. A single phase ac voltage controller has a resistive load of  $R=5\Omega$  and the input voltage 120V, 50Hz. The delay angle of thyristor  $=\pi/2$ . Determine
  - a. RMS value of output voltage
  - b. Input power factor