1. Consider the shaded triangle region P shown in the figure what is \(\iint_P xy \, dx \, dy\)?

- (a) \(\frac{1}{6}\)
- (b) \(\frac{2}{9}\)
- (c) \(\frac{7}{16}\)
- (d) 1

2. Distance between origin and the point nearest to it on the surface \(z^2 = 1 + xy\) is

- (a) \(\frac{\sqrt{3}}{2}\)
- (b) 1
- (c) \(\sqrt{3}\)
- (d) 2

3. At \(x = 0\), the function \(f(x) = |x|\) has

- (a) A maximum
- (b) A point of inflection
- (c) A minimum
- (d) Neither maximum nor minimum

4. General solution of differential equation \(\frac{dy}{dx} = \cos(x + y)\) is

- (a) \(\tan\left(\frac{x + y}{2}\right) = y + c\)
- (b) \(\sin\left(\frac{x + y}{2}\right) = y + c\)
- (c) \(\cos\left(\frac{x + y}{2}\right) = x + c\)
- (d) \(\tan\left(\frac{x + y}{2}\right) = x + c\)
5. Minimum number of wattmeter required to measure 3 phase, 3 wire balanced or unbalanced power?
   (a) 1  (b) 2  
   (c) 3  (d) 4

6. An electric motor with constant output power will have Torque Speed characteristics in the form of
   (a) Straight line through origin
   (b) Straight line parallel to speed axis
   (c) Circle about origin
   (d) Rectangular hyperbola

7. A current impulse $5\delta(t)$ is forced through a capacitor $C$. The voltage across capacitor $V_C(t)$ is given by?
   (a) $5t$  (b) $5u(t) - C$  
   (c) $\frac{5}{C}t$  (d) $\frac{5}{C}u(t)$

8. Total instantaneous power supplied by Three phase AC supply to a balanced R-L Load is?
   (a) Zero  (b) Constant
   (c) Pulsating with zero average  (d) Pulsating with non-zero average

9. RMS value of Voltage $v(t) = 8 + 6\cos(3t)$?
   (a) $10V$  (b) $\sqrt{82}V$
   (c) $2\sqrt{2} + \sqrt{6}V$  (d) $\frac{6}{\sqrt{2}}V$

10. If $\vec{E}$ is electric field intensity then $\nabla \cdot (\nabla \times \vec{E})$ is?
    (a) $\vec{E}$  (b) $|\vec{E}|$
    (c) Null vector  (d) Zero

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11. Plant Use Factor is
   (a) Maximum demand
       Connected load
   (b) Number of units generated
       Plant capacity × number of hours plant operated
   (c) Average demand
       Plant capacity
   (d) Average load
       Maximum load

12. Two identical synchronous machines A and B running at same speed are connected to each other through an inductor. Machine A is supplying an active power to Machine B and Machine B is supplying reactive power to Machine A, then which among the following is correct?
   (a) $|V_a| > |V_b|$
   (b) $|V_a| < |V_b|$
   (c) $|V_a| = |V_b|$
   (d) None of the above

13. A 90 MW, 11 kV generator has an inertia constant $H = 3s$. The stored energy in the rotor at synchronous speed is
   (a) 30 kJ
   (b) 270 kJ
   (c) 270 MJ
   (d) 30 MJ

14. MHO relays are used for protection of
   (a) Long transmission lines
   (b) Power transformer
   (c) Busbars
   (d) Short transmission lines

15. HVDC Homo polar links uses
   (a) One conductor usually of negative polarity
   (b) One conductor usually of positive polarity
   (c) Two conductors of positive and negative polarity
   (d) Two conductors of negative polarity
16. Due to low internal generation in GTO, the GTO has
(a) Lower latching current
(b) Lower holding current
(c) Lower latching and holding current
(d) Higher latching and holding current

17. In a 3 phase semiconductor, firing angle = 120° and extinction angle = 110°. Each SCR and freewheeling diode conducts respectively for
(a) 60°, 50°
(b) 30°, 50°
(c) 60°, 10°
(d) 30°, 40°

18. A single phase full wave bridge diode rectifier delivers a constant current of 10 A to the load. Average and RMS values of source current are
(a) 5 A, 10 A
(b) 10 A, 10 A
(c) 10 A, 7.07 A
(d) 0 A, 10 A

19. A step down chopper operates from a DC voltage source $V_o$ and feeds a DC motor armature with counter emf $E_o$. From oscilloscope traces it is found that current increases for time $t_r$, falls to zero over a time $t_f$ and remains zero for a time $t_o$ in every chopping cycle. Then the average voltage across the motor would be
(a) $\frac{V_o t_r}{t_r + t_f + t_o}$
(b) $\frac{V_o t_r + E_o t_f}{t_r + t_f + t_o}$
(c) $\frac{V_o t_r + E_o t_f}{t_r + t_f + t_o}$
(d) $\frac{V_o t_r + E_o (t_f + t_o)}{t_r + t_f + t_o}$

20. In a single phase inverter using single pulse modulation for control of output voltage, Harmonics of the order 'n' can be eliminated by making the pulse width equal to
(a) $4\pi/n$
(b) $2\pi/n$
(c) $\pi/n$
(d) $\pi/2n$
21. In a 132 kV system, Phase to Ground capacitance is 0.01 \( \mu F \) and inductance is 4H. Calculate the critical resistance to be connected in order to eliminate restriking if a magnetizing current of 5 A is interrupted by the circuit.
(a) 20 k\( \Omega \)
(b) 10 k\( \Omega \)
(c) 100 k\( \Omega \)
(d) 200 k\( \Omega \)

22. Making capacity of Circuit breaker is
(a) Lesser than the asymmetrical breaking capacity
(b) Greater than the asymmetrical breaking capacity
(c) Equal to the symmetrical breaking capacity
(d) Equal to the asymmetrical breaking capacity

23. What is simplified Boolean equation of a logic circuit. If the circuit output is 1 for following inputs?
ABCD = 0010
ABCD = 0110
ABCD = 1000
ABCD = 1100
And output is zero for all other inputs.
(a) \( \overline{ACD} + \overline{A}C\overline{D} \)
(b) \( \overline{A}CD + A\overline{CD} \)
(c) \( ACD + \overline{ACD} \)
(d) \( \overline{ACD} + A\overline{CD} \)

24. The output frequency of a decade counter that is clocked from 50 kHz signal is.
(a) 12.5 kHz
(b) 50 Hz
(c) 5 kHz
(d) 500 kHz
25. What is transition matrix of ideal transformer with turns ratio n:1 (i.e. \( V_1 = nV_2 \))

(a) \[
\begin{bmatrix}
  n & 0 \\
  0 & 1/n
\end{bmatrix}
\]

(b) \[
\begin{bmatrix}
  1/n & 0 \\
  0 & n
\end{bmatrix}
\]

(c) \[
\begin{bmatrix}
  n & 0 \\
  0 & -1/n
\end{bmatrix}
\]

(d) \[
\begin{bmatrix}
  1/n & 0 \\
  0 & -n
\end{bmatrix}
\]

26. At the terminals of a 3\( \phi \), 6.6 kV, 10 MVA alternator, a load \( R = 200 \Omega \) is connected between two phases and other phase is kept open. The sequence impedance of the alternator is \( Z_1 = Z_2 = j50 \Omega \) and \( Z_0 = j20 \Omega \). What is the current through the load resistance?

(a) 50 A  
(b) 66 A  
(c) 75 A  
(d) 32 A

27. Transfer function of a system is \( TF = \frac{s^3 + 2s^2 + 3s + 1}{s^3 + s^2 + 2s + 1} \). How many roots are lying on the right half side of S-Plane for numerator and denominator for the transfer function?

(a) 0, 0  
(b) 1, 0  
(c) 0, 1  
(d) None of the above

28. Which among the following is a method of absolute measurement of resistance?

(a) Voltmeter ammeter method  
(b) Wheatstone bridge method  
(c) Lorentz method  
(d) None of the above

29. A second order system has poles at \(-1 \pm j2\) and zero at 1. What is the transfer function of the system if the steady state output to an input of unit step is \( c(t) = 3 \)?

(a) \( \frac{(s-1)}{s^2 + 2s + 5} \)  
(b) \( \frac{-15(s-1)}{s^2 + 2s + 5} \)  
(c) \( \frac{(s-1)}{s^2 + 2s + 4} \)  
(d) \( \frac{5(s-1)}{s^2 + 2s + 5} \)
30. The terminal voltage of a delta connected load consisting of 3 equal impedances of 30Z30°Ω is 4.4 kV line to line. Line impedance of each of the three lines connecting the load to bus is Z_L = 2 Z30°Ω. Find the line to line voltage at the bus.
   (a) 4.62 kV    (b) 5.28 kV
   (c) 4.4 kV     (d) 4.69 kV

31. A single phase inductive load draws 10 MW at 0.6 power factor lagging. What is the value of the capacitor to be connected in parallel with the load to raise the power factor to 0.80?
   System voltage is 1000 V and system frequency is 50 Hz.
   (a) 30 mF    (b) 40 mF
   (c) 19 mF    (d) 23 mF

32. Which among the following statement is true?
   (a) Electric charge can produce electric field and magnetic field when stationary
   (b) Electric charge can produce electric field when stationary and both electric and magnetic field when moving
   (c) Electric charge can produce electric field when moving and magnetic field when stationary
   (d) Electric charge can produce electric field and magnetic field while stationary and while moving

33. A 100 MVA single phase transformer rated 80/120 kV is connected as an auto transformer in such a way that the doted terminal of LV side is connected to the un-doted terminal of HV side. Un-doted terminal of LV side is taken as common for both LV and HV. The rated voltage of 80 kV is applied to the low voltage winding of the transformer. Consider the transformer to be ideal and load to be such that the rated current flows through both primary and secondary windings. What is the kVA rating of the autotransformer?
   (a) 200 MVA    (b) 250 MVA
   (c) 172 MVA    (d) 167 MVA
34. A graph has 8 nodes and 5 independent loops. The number of branches in the graph is.
   (a) 10  (b) 14  
   (c) 12  (d) 8

35. The transfer function of a second order system is \( TF = \frac{32}{s^2 + 15s + 32} \). The nature of the system is.
   (a) Over damped  (b) Under damped  
   (c) Critically damped  (d) Oscillatory

36. The value of directional derivative of a function \( \varphi(x, y, z) = xy^2 + yz^2 + zx^2 \) at point \((2, -1, 1)\) along the direction vector \( p = i + 2j + 2k \) is.
   (a) 3  (b) 5  
   (c) 8  (d) -1

37. A MOSFET is.
   (a) Minority carrier device  (b) Majority carrier device  
   (c) Both majority and minority carrier device  (d) None of the above

38. A system is having \( TF = \frac{25s}{s^2 + 8s + 25} \). What is the time taken to reach maximum peak overshoot for a step input?
   (a) \( \pi/5 \)  (b) \( \pi/3 \)  
   (c) \( \pi/25 \)  (d) None of the above

39. In an RLC series circuit \( R = 10\Omega \), \( L = 5H \), \( C = 5F \). Output voltage is measured across the capacitor. The system is
   (a) Over damped  (b) Under damped  
   (c) Critically damped  (d) Oscillatory

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40. A box contains 2 blue, 3 black and 4 red balls. Balls are drawn from the box at random one at a time without replacement. The probability of drawing 2 blue balls first followed by 3 black balls and subsequently 4 red balls is

(a) \( \frac{2}{350} \)
(b) \( \frac{1}{629} \)
(c) \( \frac{1}{1260} \)
(d) \( \frac{1}{24} \)

41. Using trapezoidal rule and dividing the interval of integration into three equal subintervals, the definite integral \( \int_1^3 x \, dx \) is

(a) 1.11
(b) 2.22
(c) 3.33
(d) 4.44

42. A circular ring of radius 42 cm is cut and bent into the form of a rectangle whose sides are in the ratio of 6:5. The small side of the rectangle is

(a) 80 cm
(b) 30 cm
(c) 120 cm
(d) 60 cm

43. A tank is normally filled in 8 hours but takes 2 hours longer to fill because of a leak at the bottom. If the tank is full and due to leakage alone, the tank will get empty in_______ hours (Assume no further filling happens)

(a) 20
(b) 40
(c) 30
(d) 50

44. From a circular sheet of paper having radius 50 cm, a sector of 40% area is removed in the shape of an arc section. If the remaining part is used to make a conical surface, then the ratio of the radius to height of the cone is

(a) \( \frac{4}{3} \)
(b) \( \frac{5}{4} \)
(c) \( \frac{3}{4} \)
(d) \( \frac{7}{8} \)

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45. For an induction motor operating at a slip ‘s’ the ratio of gross power output to air gap power is?
(a) \((1 - s)^2\)  
(b) \((1 - s)\)  
(c) \(\sqrt{1 - s}\)  
(d) \(\frac{1 - s}{s}\)

46. Which of the following statement is true for divergence of electric and magnetic flux densities?
(a) Both are zero  
(b) Both are zero for static field densities and non-zero for time varying field density  
(c) It is zero for electric flux density  
(d) It is zero for magnetic flux density

47. In a transformer, zero voltage regulation is achieved at full load when?
(a) Load is UPF load  
(b) Load is leading power factor load  
(c) Load is lagging power factor load  
(d) Not possible

48. Which one among the following semiconductor devices is not a current triggered device?
(a) Thyristor  
(b) GTO  
(c) Triac  
(d) MOSFET

49. Equation of a line normal to \(f(x) = (x + 4)^{\frac{3}{2}} + 1\) at \(Q(0, 3)\) is
(a) \(y = 3 - 4x\)  
(b) \(y = 3 + 4x\)  
(c) \(4y = 12 - x\)  
(d) \(4y = 12 + x\)
50. Which among the following Maxwell's equation represents conservation of electric field?
   (a) $\nabla \times \mathbf{E} = 0$  
   (b) $\nabla \times \mathbf{D} = \rho_e$
   (c) $\nabla \times \mathbf{B} = 0$  
   (d) $\nabla \times \mathbf{H} = \mathbf{J}$

51. Inductive load of resistance $20 \, \Omega$ and inductance $0.1 \, \text{H}$ is connected in series and switched on to an AC voltage of $V = 100 \sin(200t + \alpha)$. Find the angle $\alpha$ such that there is no transients?
   (a) $45^\circ$  
   (b) $60^\circ$  
   (c) $30^\circ$  
   (d) $75^\circ$

52. What is quality factor of a parallel RLC circuit?
   (a) $\frac{1}{R\sqrt{LC}}$  
   (b) $R\frac{C}{\sqrt{L}}$
   (c) $\sqrt{\frac{1}{LC}}$  
   (d) $\sqrt{LC}$

53. What is analogous to electric field in Magnetic circuits?
   (a) Magnetic flux density  
   (b) Magneto motive force
   (c) Reluctance  
   (d) None of the above

54. A single phase transformer is switched on to an AC supply. In order to have minimum inrush current switch should be closed at?
   (a) Maximum supply voltage  
   (b) Zero supply voltage
   (c) $\frac{1}{\sqrt{2}}$ times of the maximum supply voltage  
   (d) $\frac{1}{2}$ times of the maximum supply voltage

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55. Hysterisis and eddy current losses of single phase transformer working on 200 V, 50 Hz is $P_h$ and $P_e$ respectively. The percentage decrease in $P_h$ and $P_e$, when the transformer operates on 160 V, 40 Hz supply, will respectively be
(a) 32, 36  
(b) 25, 50  
(c) 20, 36  
(d) 40, 80

56. A 3 phase induction machine draws 1000 kVA at a power factor of 0.866 lag. A synchronous condenser is connected in parallel to draw an additional power of 750 kVA at a leading pf of 0.707. The power factor of the total load supplied by the mains is
(a) 0.95 lag  
(b) 0.99 lead  
(c) 0.90 lag  
(d) 0.95 lead

57. A 3 phase, 4 pole, 400 V, 10 kW slip ring induction motor has rotor resistance = 0.16 $\Omega$ per phase and stator resistance of 0.27 $\Omega$ per phase. The voltage across the slip rings at standstill is 141 V per phase. The motor develops a torque of 62.4 Nm at a slip of 0.08 and the rotor current is 6 A. What is the rotor current if a voltage is injected to the rotor so that the motor runs at slip $s = 0.02$ and develops same torque?
(a) 6 A  
(b) 5 A  
(c) 4 A  
(d) 3 A

58. Double cage induction motors are used for
(a) High staring torque  
(b) Better speed control  
(c) High running torque  
(d) None of the above

59. A salient pole alternator has $X_d$ = 1.4 pu and $X_q$ = 1pu and $R_a$ = 0 pu. If the alternator develops rated power at UPF and at rated voltage what is the power angle?
(a) 45°  
(b) 60°  
(c) 30°  
(d) 55°

60. Terminal voltage of a DC shunt motor is halved and the load torque is varied as the square of the speed and field flux is kept constant. Assuming armature resistance is zero, what will be the armature current?
(a) Unchanged  
(b) Reduced to half  
(c) Reduced to one fourth  
(d) Increased twice

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61. In a JK flip flop race around condition occurs when.
   (a) Both J & K inputs are zero
   (b) Both J & K inputs are one
   (c) J = 1 and K = 0
   (d) J = 0 and K = 1

62. Which among the following logic family has least propagation delay?
   (a) TTL
   (b) CMOS
   (c) DTL
   (d) \( I^2L \)

63. What is the ratio of peak inverse voltage across the diode in center tapped full wave rectifier and the bridge rectifier?
   (a) 2
   (b) 0.5
   (c) 0.25
   (d) 1

64. When three amplifiers each having higher cut off frequency \( f_c = 10 \text{ kHz} \) are cascaded. What is the higher cut off frequency of cascaded system?
   (a) 10 kHz
   (b) 6.4 kHz
   (c) 5.1 kHz
   (d) 20 kHz

65. In 8085 microprocessors how many hardware interrupts are maskable?
   (a) 2
   (b) 3
   (c) 4
   (d) 5

66. In 8085 microprocessors, which signal is used to insert wait?
   (a) READY
   (b) ALE
   (c) HOLD
   (d) INTR
67. An 8 pole alternator runs at 750 rpm. It supplies power to 6 pole induction motor, which has full load slip of 4%. Full load speed of the motor is

(a) 705 rpm  
(b) 750 rpm  
(c) 960 rpm  
(d) 970 rpm

68. A 220 V DC machine has an armature resistance of 1 Ω. If the full load current is 20 A, what is the difference in induced voltage when the machine is running as generator and motor under full load condition

(a) 0 V  
(b) 20 V  
(c) 40 V  
(d) 60 V

69. Use of bundled conductor in EHV lines will

(a) Reduce corona loss  
(b) Increase the inductance of transmission line  
(c) Reduce the capacitance of transmission line  
(d) Increase corona loss

70. Surge impedance of 3 Phase, 400 kV transmission line is 200 Ω. The surge impedance loading of the transmission line is

(a) 400 MW  
(b) 1600 MW  
(c) 200 MW  
(d) 800 MW

71. A surge voltage of 10 kV travels along a cable towards its junction with overhead line. The surge impedance of the cable and the overhead line is 50 Ω and 450 Ω respectively. The surge voltage transmitted to the overhead line is

(a) 2 kV  
(b) 9 kV  
(c) 18 kV  
(d) 20 kV

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72. Two single phase transformers $T_a$ and $T_b$ are connected in parallel to supply a load having impedance per phase of $0.8 + j0.6$ pu at a load terminal voltage of $1\angle 0^\circ$ pu. Both transformers $T_a$ and $T_b$ has same impedance of $j0.1$ pu, on same base. The second transformer $T_b$ is stepped up to a voltage 1.05 times that of $T_a$. What is the current supplied by $T_a$ and $T_b$ to the load?

(a) $T_a = 0.4 - j0.3$ pu and $T_b = 0.4 - j0.3$ pu  
(b) $T_a = 0.4 - j0.05$ pu and $T_b = 0.4 - j0.55$ pu  
(c) $T_a = 0.4 - j0.55$ pu and $T_b = 0.4 - j0.05$ pu  
(d) $T_a = 0.4 - j0.55$ pu and $T_b = 0.4 - j0.35$ pu

73. Regarding armature reaction reactance of salient pole synchronous generator. Which of the following is correct?

(a) Direct axis armature reaction reactance will be greater than quadrature axis armature reaction reactance  
(b) Quadrature axis armature reaction reactance will be greater than Direct axis armature reaction reactance  
(c) Quadrature axis armature reaction reactance will be equal to Direct axis armature reaction reactance  
(d) None of the above

74. Loading capability diagram is generally drawn for

(a) Induction motor  
(b) DC Generator  
(c) Synchronous Generator  
(d) DC Motor

75. What is minimum phase system

(a) A System with no zeros on right half side of S-plane  
(b) A System with no zeros on left half side of S-plane  
(c) A System with no poles on left half side of S-plane  
(d) A System with no poles on right half side of S-plane
76. An air core toroid with 500 turns having a cross section area of 6 cm² and a mean radius of 15 cm is carrying a current of 5A. What is the magnetic flux density at the mean radius?
(a) 2653 T  
(b) 1/300 T  
(c) 2123 T  
(d) 1/400 T

77. The internal inductance per meter (i.e., Inductance due to internal magnetic flux linkages) of a long straight wire of circular cross section and uniform current distribution is
(a) $\frac{\mu}{\pi} H/m$  
(b) $\frac{H}{4\pi} H/m$  
(c) $\frac{\mu}{8\pi} H/m$  
(d) $\frac{H L}{4\pi} H/m$

78. Any electromagnetic disturbance is bound to travel at a velocity of
(a) Velocity of light in vacuum  
(b) $\frac{1}{\sqrt{\mu_0 \varepsilon_0}}$  
(c) $\frac{1}{\mu_0 \varepsilon_0}$  
(d) $\frac{1}{\sqrt{\mu \varepsilon}}$

79. In skin effect the skin depth is proportional to (f is frequency)
(a) $f$  
(b) $\frac{1}{\sqrt{f}}$  
(c) $\frac{1}{f}$  
(d) $\sqrt{f}$

80. An electric field is mentioned as $E = (6y^2 z a_x + 12xyz a_y + 6xy^3 a_z) \text{V/m}$ an incremental path is represented by $\Delta L = (-3a_x + 5a_y - 2a_z) \mu m$. What is the work done in moving 2 μC charge along the path if the location of the path is $P(0, 2, 5)$.
(a) 360 pJ  
(b) 540 μJ  
(c) 720 pJ  
(d) 360 μJ