ESE-2018 PRELIMS TEST SERIES PAPER-II

Date: 22nd October, 2017

EC–Test 05(OBJECTIVE SOLUTION)..

ANSWERS

1.	(b)	31.	(c)	61.	(c)	91.	(c)	121.	(b)
2.	(c)	32.	(b)	62.	(c)	92.	(d)	122.	(b)
3.	(c)	33.	(b)	63.	(a)	93.	(a)	123.	(a)
4.	(b)	34.	(c)	64.	(b)	94.	(a)	124.	(d)
5.	(c)	35.	(a)	65.	(b)	95.	(b)	125.	(a)
6.	(d)	36.	(a)	66.	(b)	96.	(b)	126.	(a)
7.	(a)	37.	(d)	67.	(a)	97.	(a)	127.	(a)
8.	(b)	38.	(a)	68.	(c)	98.	(b)	128.	(b)
9.	(d)	39.	(a)	69.	(d)	99.	(a)	129.	(a)
10.	(b)	40.	(a)	70.	(c)	100.	(a)	130.	(c)
11.	(a)	41.	(a)	71.	(b)	101.	(d)	131.	(a)
12.	(c)	42.	(c)	72.	(c)	102.	(a)	132.	(c)
13.	(a)	43.	(c)	73.	(c)	103.	(d)	133.	(a)
14.	(d)	44.	(b)	74.	(c)	104.	(d)	134.	(a)
15.	(a)	45.	(b)	75.	(d)	105.	(d)	135.	(b)
16.	(b)	46.	(d)	76.	(d)	106.	(b)	136.	(d)
17.	(b)	47.	(d)	77.	(b)	107.	(a)	137.	(a)
18.	(c)	48.	(c)	78.	(c)	108.	(b)	138.	(b)
19.	(d)	49.	(b)	79.	(c)	109.	(b)	139.	(b)
20.	(c)	50.	(d)	80.	(c)	110.	(d)	140.	(b)
21.	(c)	51.	(b)	81.	(d)	111.	(a)	141.	(a)
22.	(b)	52.	(b)	82.	(c)	112.	(c)	142.	(b)
23.	(c)	53.	(b)	83.	(c)	113.	(a)	143.	(a)
24.	(b)	54.	(a)	84.	(c)	114.	(a)	144.	(b)
25.	(b)	55.	(d)	85.	(d)	115.	(a)	145.	(c)
26.	(b)	56.	(b)	86.	(d)	116.	(a)	146.	(c)
27.	(d)	57.	(a)	87.	(b)	117.	(c)	147.	(a)
28.	(a)	58.	(b)	88.	(c)	118.	(a)	148.	(c)
29.	(a)	59.	(d)	89.	(c)	119.	(d)	149.	(a)
30.	(c)	60.	(c)	90.	(c)	120.	(c)	150.	(b)

1. (b)

After a wafer has been coated with photoresist, the correct sequence of steps carried out in photolithography is

(i) Exposure to UV radiation:

(ii) Developing : The wafer is developed using a suitable chemical like trichloroethylene. This results in the removal of photoresist film where windows are required.

(iii) Etching : Wafer is dipped in an etching solution to remove the layers to open windows for impurity diffusion or making contacts.

(iv) Stripping : Stripping is used to remove the photoresist mask with sulphuric acid and by means of mechanical abrasion process.

2. (c)

The main purpose of the buried layer is to minimize the series resistance of the collector.

3. (c)

The diffusion profile of the dopant atoms is dependent on the initial and boundary conditions. The two important cases are

(i) Constant-surface-concentration diffusion: In this case, impurity atoms are transported from a vapour source onto the semiconductor surface and diffused into the semiconductor wafers. The vapour source maintains a constant level of surface concentration during the entire diffusion period. The doping profile in this case is a complementary error function (erfc) distribution.

(ii) Constant-total-dopant diffusion: In this case, a fixed amount of dopant is deposited onto the semiconductor surface and is subsequently diffused into the wafers. The doping profile for this case is the Gaussian distribution.

4. (b)

LED works on the principle of spontaneous emission.

LASER works on the principle of stimulated emission of radiation.

Solar cells work on the principle of photovoltaic effect i.e. voltage is developed across it when illuminated by light.

Photodiode works on the principle of photoconductive effect or photoconductivity i.e. conductivity of the photodiode changes depending on the light intensity.

5. (c)

The magnitude of current under large reverse bias is given by

$$I = I_s + I_o\left(1 - e^{V/\eta V_T}\right) \quad ...(i)$$

Where I_o is the reverse saturation current,

I_s is the short-circuit current which is proportional to the light intensity

and V is voltage across the cell.

Photovoltaic potential is the voltage at which zero resultant current is obtained under open-circuit conditions.

From Equation (i),

$$0 = I_s + I_o\left(1 - e^{V_{max}/\eta V_T}\right)$$

$$\therefore \quad V_{max} = \eta V_T \, ln\left(1 + \frac{I_s}{I_o}\right)$$

6. (d)

In optocouplers, the wavelength response of the each device (light emitters and light detectors) is made as identical as possible. This is done so as to permit the highest measure of coupling possible.

7. (a)

8. (b)

9. (d)

10. (b)

11. (a)

12. (c)

13. (a)

14. (d)

The stalls are a type of hazards that affect a pipelined system.

15. (a)

Data hazards are generally caused when the data is not ready on the destination side.

16. (b)

17. (b)

18. (c)

19. (d)

It causes broadning of ion beam

20. **(c)**

21. **(c)**

22. **(b)**

23. **(c)**

24. **(b)**

25. **(b)**

26. **(b)**

27. **(d)**

28. **(a)**

29. **(a)**

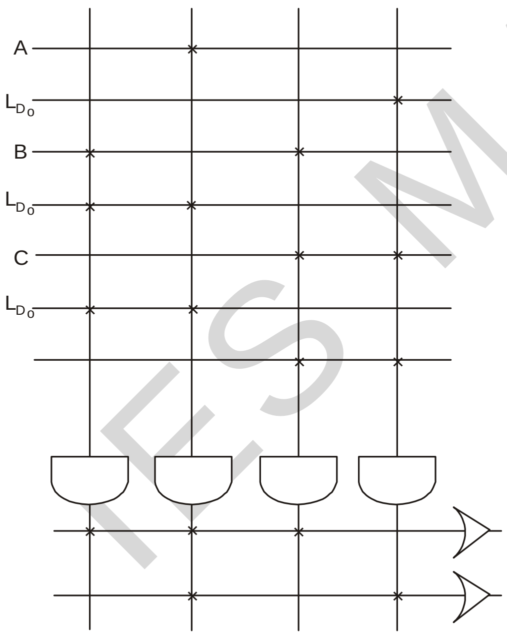
30. **(c)**

Optical lithography has high throughout good resolution low cost and ease in operation . It provides good resolution but highest resolution is provided by Ion beam lithography limitation is complexity of mask production.

31. **(c)** for example N bit counter

32. **(b)**

33. **(b)**



34. **(c)**

35. **(a)**

1 K = 2^{10} and 16 = 2 bytes, 2 k bytes = 2048

36. **(a)**

8 K × 16 bits = $2^3 \times 2^{10} \times 2$ bytes

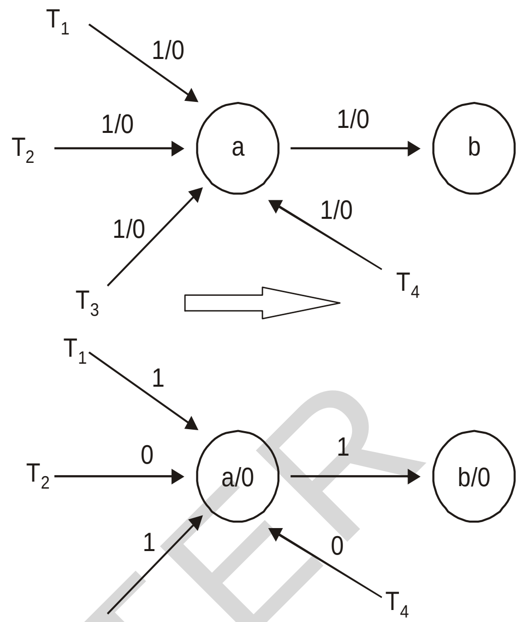
= 2^{14} bytes

37. **(d)**

38. **(a)**

39. **(a)**

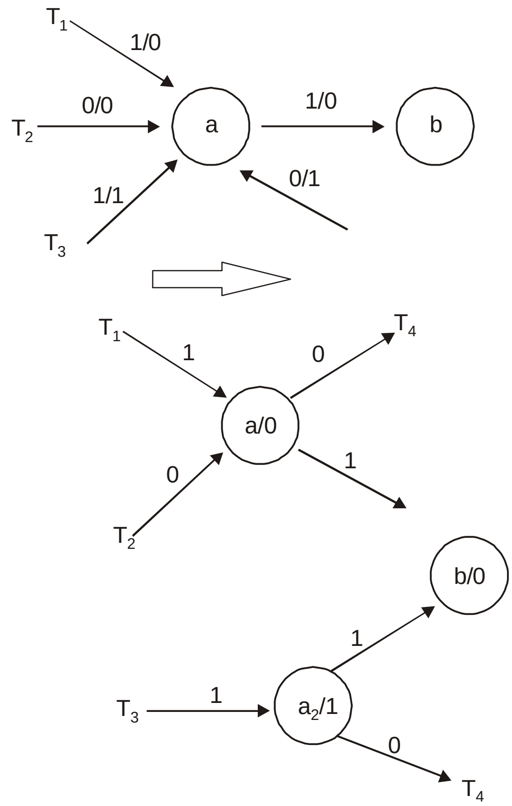
40. **(a)**



Rules to convert Mealy to Moore Model

1. If all the transitions in a Mealy model to a particular state are associated with only one type of output (0 or 1) then in corresponding moore model that output becomes stak output.

2. If the outputs of all tansitions in a mealy model to a particular state are not same we need to insert intermediate state variables.



41. **(a)**

42. **(c)**

By using cache we can reduce speed by factor of 10.

43. **(c)**

44. **(b)**

45. **(b)**

46. **(d)**

47. **(d)**

48. **(c)**

49. **(b)**

50. **(d)**

Reflection – object size is much larger than signal wavelength

Diffraction – object size is larger than signal wavelength

Scattering – object size is smaller than signal wavelength

51. **(b)**

Erlang is unit of measurement of traffic density in telecommunication system and describes total traffic volume of one hour.

52. **(b)**

The spread spectrum modulation utilizes pseudo-random or pseudo-noise sequences.

53. **(b)**

In CDMA, each user is assigned a distinct code and frequency spectrum can be used by several user all the times without interference.

54. **(a)**

In satellite communication uplink frequency is chosen greater than downlink frequency. The lower downlink frequency helps in generation of Power in space.

55. **(d)**

Ist window – Centred around 850 nm

IInd window – Centred around 1310 nm

IIIrd window – Centred around 1550 nm

56. **(b)**

NA = $\left(n_1^2 - n_2^2\right)^{\frac{1}{2}}$ which is constant as n_1 and n_2 are constant for step index fiber.

57. **(a)**

Cluster of cells is the collection of adjacent cells with different operating frequency.

58. **(b)**

The number of cells (K) per cluster satisfy the equation $K = i^2 + j^2 + ij$, hence minimum value of K comes out to be 3.

59. **(d)**

Cell shape can be triangular, circular, square or hexagonal. However, hexagonal shape cell pattern provides most effective transmission.

60. **(c)**

GSM systems are incompatible with TCP/IP.

61. **(c)**

In case of (n, K, L) linear convolutional code, code tree repeats after $(L + 1)^{th}$ stage.

62. **(c)**

In a block code $d_{min} \geq (2t+1)$, where *t* is error correction capability.

63. **(a)**

In core type transformer, the windings surround the considerable part of steel core but in shell type transformer, the steel core surrounds a major part of the windings. So, for a given output and voltage rating, core type transformer requires less iron but more conductor material as compared to a shell-type transformer.

64. **(b)**

Efficiency of transformer,

$$\%\eta = \frac{(x)(S)\times(\text{power factor})}{(x\times S\times \text{power factor}) + x^2 P_{cu} + P_i} \times 100$$

For maximum efficiency,

$$x^2 P_{cu} = P_i$$

Hence,

$$\%\eta_{max} = \frac{x\cdot S\times Pf}{(x\cdot S\cdot pf) + 2x^2 P_{cu}}$$

$$\Rightarrow \quad 0.98 = \frac{0.8\times 100\times 0.8}{(0.8\times 100\times 0.8) + 2\times(0.8)^2 \times P_{cu}}$$

$$\Rightarrow \quad 0.98 = \frac{64}{64 + 1.28 P_{cu}}$$

$$\Rightarrow \quad 1.28\ P_{cu} = \left(\frac{64}{0.98} - 64\right)$$

$\therefore \quad P_{cu} = 1020 \text{ kW} = 1020 \text{ W}$

65. (b)

Electric charges are of discrete values and with conservation applied, the total charge remains same.

66. (b)

Bit is binary unit of information

1 nat = $\log_2 e$ and 1 hartley = $\log_2 10$ bits

67. (a)

The entropy $H = \sum_{k=1}^{5} P_k \log_2\left(\frac{1}{P_k}\right)$

$$= \frac{1}{2}\log_2 2 + \frac{1}{4}\log_2 4 + \frac{1}{8}\log_2 8 + \frac{1}{16}\log_2 16 + \frac{1}{16}\log_2 16$$

$$= \frac{1}{2} + \frac{2}{4} + \frac{3}{8} + \frac{4}{16} + \frac{4}{16}$$

$= 15/8$ bits/message

Rate of information R = rH

$$= 8 \times \frac{15}{8} = 15 \text{ bits/secnd}$$

68. (c)

Power $\quad P = i^2_{rms} R$

Here $\quad i^2_{rms} = \frac{1}{T}\int_0^T \left[i(t)^2 \, dt\right]$

$$= \frac{1}{3}\int_0^3 (3t)^2 \, dt = 27$$

$\therefore \quad i^2_{rms} R = 270 \text{W}$

$$R = \frac{270}{27} = 10\Omega$$

69. (d)

$$R_{eq} = 6 \,||\, 3 = \frac{6 \times 3}{6+3} = 2\Omega$$

$$I(t) = \frac{4e^{-t} + 6e^{-5t}}{2}$$

$$= 2e^{-t} + 3e^{-5t}$$

Taking Laplace transform

$$I(s) = \frac{2}{(s+1)} + \frac{3}{(s+5)}$$

$$= \frac{2s + 10 + 3s + 3}{(s+1)(s+5)}$$

$$= \frac{5s+13}{(s+1)(s+5)}$$

Hence poles are at

$$s = -1, -5$$

And zeros at

$$s = \frac{-13}{5}, \infty$$

70. (c)

$$V = I_R R$$

$$= 200 \times 0.02\angle 30°$$

$$= 4\angle 30°$$

$$I_L = \frac{4\angle 30°}{200 \times 0.5 j}$$

$$= \frac{4\angle 30}{100 j} = 0.04\angle -60°$$

$$I_c = \frac{4\angle 30°}{10^6 / (200 \times 50 j)}$$

$$= 0.04\angle 120°$$

$$I = I_R + I_C + I_L$$

$$= 0.02\angle 30 + 0.04\angle -60° + 0.04\angle 120°$$

$$= 0.02\angle 30°$$

71. (b)

Induced emf,

$$e = (\vec{V} \times \vec{B}).\vec{l}$$

where vector $\vec{l}$ points along the direction of the wire towards the end making the smallest angle with the respect to the vector $(\vec{V} \times \vec{B})$.

The voltage is the wire will be built up so that the positive end is in the direction of the vector $(\vec{V} \times \vec{B})$.

72. (c)

Compansating winding in a dc motor is used to eliminate the effect of armature reaction which leads to flashover at commulator. These windings are connected in series and contains current in the direction opposite to that in the armature winding just below the pole faces. In effect, the compensating winding prodduces on mmf which neutralises the armature flux produced by the armature conductor just under the pole faces.

The compensating winding is generally used:

(i) In large machines subject to heavy overloads.

(ii) In small motors subject to sudden reversal and high acceleration.

73. (c)

74. (c)

75. (d)

Given,

$$i_0 = 2\sin(628t - 60°)\ A$$

$$V_1 = 100\sqrt{2}\sin(628t)\,V$$

i.e. no-load current lags the applied voltage by 60°.

i.e., $\phi_0 = 60°$ (lagging)

$\therefore$ Core-loss component current,

$$I_w = I_0 \cos j_0$$

$$= \frac{2}{\sqrt{2}} \times \cos 60°$$

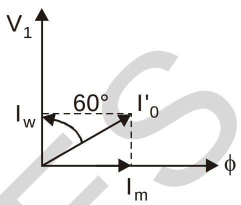
$$= \frac{2}{\sqrt{2}} \times \frac{1}{2} = 0.7076$$

and, magnetising current,

$$I_m = I_0 \sin\phi_0 = \frac{2}{\sqrt{2}} \times \sin 60°$$

$$= \frac{2}{\sqrt{2}} \times \frac{\sqrt{3}}{2}$$

$$= \sqrt{1.5} = 1.22\ A$$



76. (d)

Eddy current loss per unit volume of the material.

$$P_{eddy} = Ke f^2 B_{max}^2 \tau^2$$

Where, Ke is eddy current loss coefficient

f is frequency of applied voltage

τ is thickness of lamination.

Also, $P_{eddy} = I_{eddy}^2 R$

$$= \frac{V^2}{R} = \frac{V^2}{\left(\rho \cdot \frac{l}{a}\right)}$$

i.e., eddy current loss decreases with increase in resistivity of the core meterial.

77. (b)

Due to increase or decrease in loading of transformer, oil in the transformer gets heated and cooled respectively, which leads to expansion and contraction of oil. When oil expands air is expelled out while if it contracts air is drawn in from the atmosphere. This is called breathing of transformer. To prevent the moist air entering into tank breather is used. Breather contains a dehydrating material like silica gel crystal which is blue when dry and becomes whitish pink when damp.

78. (c)

At maximum efficiency, copper loss is equal to core-loss.

i.e., $x^2 P_{cufl} = P_i$

$$\Rightarrow \quad x = \sqrt{\frac{P_2}{P_{cufl}}} = \sqrt{\frac{1080}{1920}}$$

$$= \frac{3}{4} = 0.75$$

i.e., maximum efficiency will occur at 75% of full-load.

$\therefore$ Max. efficiency,

$$\eta_{max} = \frac{(x \cdot s \times pf)}{(xs \cdot pf) + losses}$$

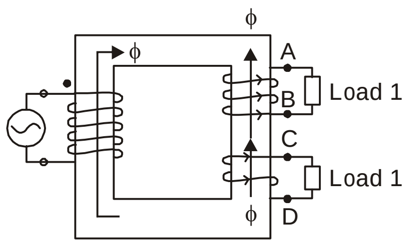
$$= \frac{(0.75 \times 100 \times 10^3 \times 0.8)}{(0.75 \times 100 \times 10^3 \times 0.8) + 2 \times 1080}$$

$$= \frac{60000}{60000 + 2160} = 0.9652$$

i.e., = 96.52%

79. (c)

80. (c)



For a given dot in primary winding, the direction of flow of flux is shown in fig. According to Lenz's law, the direction of current in secondary and tertiary winding are in such a way that the flux developed would oppose the primary flux. Hence, in secondary and tertiary winding. position of dot will be at 'B' and 'C' respectively.

81. **(d)**

For the series R–L circuit, power factor angle

$$\phi = \tan^{-1}\left(\frac{\omega L}{R}\right)$$

$$= \tan^{-1}\left(\frac{\omega L \times I}{R \times I}\right)$$

$$\begin{bmatrix}\text{Where, I is} \\ \text{current flowing} \\ \text{through R \& L}\end{bmatrix}$$

$$= \tan^{-1}\left(\frac{V_L}{V_R}\right)$$

$$= \tan^{-1}\left(\frac{10}{17.32}\right)$$

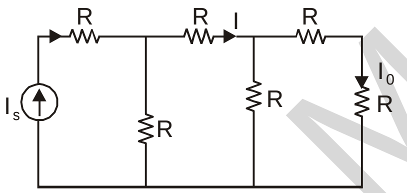
$$= \tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$$

$$= 30°$$

So, power factor of the circuit,

$$\text{Cos } \phi = \text{Cos } 30° = 0.866$$

82. **(c)**



Applying current division rule, we get

$$I = \frac{R}{R + \frac{5R}{3}} I_s = \frac{3}{8} I_s$$

Again applying current division rule we get

$$I_0 = \frac{R}{R + 2R} I = \frac{1}{3} \times \frac{3}{8} I_s = \frac{I_s}{8}$$

$$\Rightarrow \quad \boxed{I_s = 8\, I_0}$$

83. **(c)**

Since the battery is rated at 15V and each cell at 3V,

So, cells connected in series = $\frac{15}{3} = 5$ cells

Number of parallel paths = $\frac{20}{5} = 4$.

Given, Rating of one paralled path = 15A

So, total current= 1.5 × 4 = 6A

$$\therefore \quad \text{Power} = V \times I$$

$$= 15 \times 6$$

$$= 90 \text{ W}$$

84. **(c)**

Position vector $\vec{r}_p$ is (w.r.t. origin) = $\vec{r}_p = -2\hat{i} - 3\hat{j} - 4\hat{k}$.

Position vector $\vec{r}_N = 3\hat{i} - 3\hat{j}$.

$$\therefore \quad 2\vec{r}_p - 3\vec{r}_N = -4\hat{i} - 6\hat{j} - 8\hat{k} - 9\hat{i} + 9\hat{j}$$

$$= -13\hat{i} + 3\hat{j} - 8\hat{k}$$

$$\therefore \quad \left|2\vec{r}_p - 3\vec{r}_N\right| = \sqrt{(-13)^2 + (3)^2 + (-8)^2} = 15.56$$

85. **(d)**

$$\vec{S}(\text{at point P}) = \left(\frac{125}{1^2 + 2^2 + 4^2}\right)\left[a_x + 2a_y + 4a_z\right]$$

$$= 5.95a_x + 11.9a_y + 23.8a_z \text{ and}$$

$$\left|\vec{S}\right| = \sqrt{(5.95)^2 + (11.9)^2 + (23.8)^2} = 27.26$$

$\therefore$ Unit Vector

$$\hat{S} = \frac{\vec{S}}{\left|\vec{S}\right|} = 0.22a_x + 0.44a_y + 0.87a_z$$

86. **(d)**

Vector field $\vec{G}$ at point Q will be

$$\vec{G} = 5a_x - 10a_y + 3a_z$$

Now the scalar component of $\vec{G}$ along $\hat{r}$ will be :

$$\vec{G}.\hat{r} = \left(5a_x - 10a_y + 3a_z\right)\frac{1}{3}\left(2a_x + a_y - 2a_z\right)$$

$$= \frac{1}{3}(10 - 10 - 6) = -2$$

The vector component is obtained by multiplying the scalar component by unit vector in the direction of $\vec{r}$ = $\left(\vec{G}.\hat{r}\right)$

$$= \frac{-2}{3}\left(2a_x + a_y - 2a_z\right)$$

$$= \frac{-4}{3}a_x - \frac{2}{3}a_y + \frac{4}{3}a_z$$

87. **(b)**

At point P,

$$\vec{E} = \frac{1}{(0.8)^2}\left[(\cos 45°)a_r + \left(\frac{\sin 45°}{\sin 30°}\right)a_\phi\right]$$

$$= \frac{1}{0.64}\left[\left(\frac{1}{\sqrt{2}}\right)a_r + \sqrt{2}a_\phi\right]$$

$$\therefore \quad |\vec{E}| = \sqrt{\left(\frac{1}{\sqrt{2}\times 0.64}\right)^2 + \left(\frac{\sqrt{2}}{0.64}\right)^2}$$

$$= \frac{1}{0.64}\times\sqrt{\frac{1}{2}+2} = \frac{1}{0.64}\times\sqrt{\frac{5}{2}}$$

$$\therefore \text{ Unit Vector } = \frac{\vec{E}}{|\vec{E}|} = \left[\left(\frac{1}{\sqrt{2}}\right)a_r + \sqrt{2}a_\phi\right]\times\frac{\sqrt{2}}{\sqrt{5}}$$

$$= \left(\frac{1}{\sqrt{5}}\right)a_r + \frac{2}{\sqrt{5}}a_\phi$$

88. (c)

Cartesian to cylindrical : (x, y, z) to (ρ, ϕ, z)

$$\rho = \sqrt{x^2+y^2} \text{ and } \phi = \tan^{-1}\left(\frac{y}{x}\right)$$

$$\therefore \quad \rho = \sqrt{1^2 + \left(\sqrt{3}\right)^2} = \sqrt{1+3} = 2$$

$$\phi = \tan^{-1}\left(\frac{\sqrt{3}}{1}\right) = \tan^{-1}\left(\sqrt{3}\right)$$

$$\therefore \quad \phi = 60°$$

$$z = z = 2$$

Therefore, point P in cylindrical coordinate system = (2, 60°, 2).

89. (c)

If $\vec{A}$ is irrotational, then $\nabla\times\vec{A} = 0$

$$\therefore \oint_L \vec{A}.\vec{dl} = 0 \ \& \ A = -\nabla V \text{ for a scalar field V.}$$

90. (c)

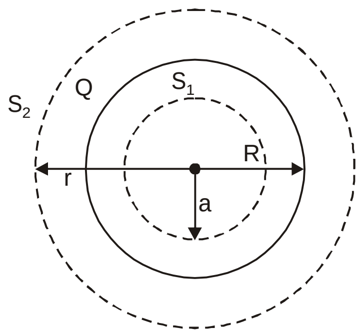
Electric flux density $\vec{D}$ is also called as Electric Displacement.

$$\because \quad \psi = \oint\vec{D}.\vec{ds} = Q_{enclosed}$$

$$\therefore \quad \text{Unit of } \vec{D} = C/m^2.$$

91. (c)

Total charge Q will be uniformly distributed over the surface of the conducting sphere.



For Gaussian surface S_1,

$$\oint\vec{E}.\vec{ds} = \frac{Q_{enclosed}}{\varepsilon} = 0$$

$$\therefore \ \vec{E} = 0 \text{ for } 0 < r < R.$$

For Gaussian surface S_2,

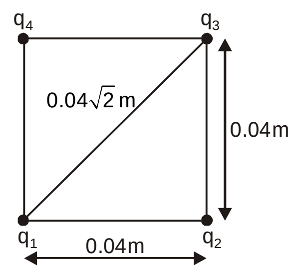
$$\oint\vec{E}.\vec{ds} = Q_{enclosed} = \frac{Q}{\varepsilon}$$

$$\therefore \ \vec{E} = \frac{Q}{4\pi\in r^2} \qquad \left[\because |\vec{E}| \propto \frac{1}{r^2} \text{ for } R \le r < \infty\right]$$

92. (d)

If the pole tips are chamfered, there is least gap between pole shoe and armature at the polar axis, and the gap increases while moving to the pole tips. Correspondingly, reluctance is minimum at the polar axis and increases while approaching to pole tips. So, the flux density is maximum at polar axis and minimum at interpolar region and the air-gap flux density distribution achieve nearly a sinusoidal waveform.

93. (a)



$$W = \frac{1}{2}\sum_{n=1}^{4} q_n V_n$$

$$V_1 = V_{21} + V_{31} + V_{41}$$

$$= \frac{q}{4\pi\varepsilon_0}\left(\frac{1}{0.04}+\frac{1}{0.04}+\frac{1}{0.04\sqrt{2}}\right)$$

$$= \frac{q}{4\pi\varepsilon_0(0.04)}\left[2+\frac{1}{\sqrt{2}}\right]$$

For the given distribution of charges,

$$V_1 = V_2 = V_3 = V_4$$

$$W = 4\times\frac{1}{2}\times q_1V_1$$

$$= \frac{2\times(2\times10^{-9})^2(2.707)}{4\pi\varepsilon_0(0.04)}$$

$$= 4.863\ \mu J$$

94. (a)

Force between the two charges,

$$\bar{F} = \frac{(Q-q)q}{4\pi\varepsilon_0 d^2}$$

For maximum force, $\frac{dF}{dq}=0$

$$\frac{dF}{dq} = \frac{1}{4\pi\varepsilon_0 d^2}[Q-q+q(-1)]=0$$

$$\Rightarrow \quad 2q = Q$$

$$\therefore \quad q = \frac{Q}{2}$$

95. (b)

Operating power factor depend's on the air gap between the stator and rotor. If the air gap is more it will require more amount of magnetizing current, this will decrease the operating power factor and vice versa. In open slot type machines air gap between the stator and rotor is more. Therefore operating power factor is poor. In closed slot type machines air gap between the stator and rotor is less. Therefore operating power factor is more. In semi closed slot type machines air gap between the stator and rotor is moderate. Therefore operating power factor is also moderate. Therefore the operating power factor in closed slot type machines is more than the other one.

96. (b)

Depending on the type of rotor used, induction motors are classified as squirrel cage induction motor and slip ring induction motor. The first motors are squirrel cage induction motors which have low starting torque. For high starting torque requirement slip ring induction motors also called as wound rotors are developed. In slip ring induction motor, the rotor core consists of slots which contain 3- phase winding similar to stator. The rotor winding is essentially connected in star and the three terminals end at 3 slip rings which are mounted on the shaft. A suitable value of external resistance is added equally into the rotor 3-phase winding through stationary sliding contacts known as brushes which are placed on the slip rings. When the motor is started with suitable external resistance it produces the high starting torque.

Starting torque $T_{st} \propto E\times I\times\cos\phi$

$$T_{st} \propto E\times I\times\frac{R}{Z}$$

Therefore the starting torque is directly proportional to resistance value, which will increase the starting torque of slip ring induction motors.

97. (a)

In slip ring induction motor brushes are present. Due to this, frequent maintenance is required. Their design is complicated due to winding, slip rings and brushes and also expensive. Slip ring induction motor is comparatively having more weight than squirrel cage induction motor. The construction of squirrel cage induction motor is simple and robust and it is cheap as compared to slip ring induction motor. Therefore squirrel cage induction motor is widely used.

98. (b)

$$\text{Slip } S = \frac{N_s - N_r}{N_s}$$

$$N_s = \frac{120-f}{p}$$

$$= \frac{120\times50}{4} = 1500\,\text{rpm}$$

$$\text{Percentage Slip} = \frac{1500\times1470}{1500} = 0.02\%$$

99. (a)

$$\text{Slip } S = \frac{N_s - N_r}{N_s}$$

$$\text{Slip at standstill} = \frac{N_s - 0}{N_s}$$

$$\Rightarrow 1(\text{Q speed of rotor at standstill is} = 0)$$

100. (a)

Voltage across string = phase voltage

$$= \frac{33}{\sqrt{3}}\text{kV}$$

101. (d)

Corona effect produces ozone gas, reduces transmission efficiency and causes line to draw non-sinusoidal current.

102. (a)

The corona effect depends upon the shape and conditions of the conductor surface. An irregular surface gives rise to more corona effect.

103. (d)

104. (d)

In power system, feeders are employed for transmission of bulk power. So, the current carrying capacity is main criteria for selection of size of feeder.

For distribution, voltage drop is the main criteria for selection of the size of conductors.

105. (d)

Higher load factor means greater average load, resulting in greater number of units generated for a given maximum demand. Thus the standing (fixed) charges, which are proportional to maximum demand and independent of number of unit generated, can be distributed over a larger number of units supplied and therefore, overall cost per unit of electrical energy generated will be reduced.

With the given number of consumers, the higher the diversity factor of their loads, the smaller will be the capacity of the plant required and consequently the fixed charges due to capital investment will be much reduced.

106. (b)

Synchronous condenser is basically an over-excited Synchronous motor which is used for power factor improvement equipment.

107. (a)

The capital cost of the power station depends upon the capacity of the power station. Lower the maximum demand of the power station, the lower is the capacity required and therefore lower is the capital cost of the plant. With a given number of consumers the higher the diversity factor loads, the smaller will be the capacity of the plant required and consequently the fixed charges due to capital investment will be much reduced.

108. (b)

109. (b)

The principle of incremental cost is employed to decide the economical operation of generators. It decides which unit should be operated at what load. It is not useful in deciding the sequence of addition of units and total plant capacity to be operated.

110. (d)

Universal motor is used for high torque. Capacitor start is used for relatively constant speed at a wide variety of loads. Split-phase for low starting torque applications and Hysteresis motor for operation at synchronous speed.

111. (a)

112. (c)

113. (a)

114. (a)

115. (a)

116. (a)

117. (c)

118. (a)

119. (d)

120. (c)

121. (b)

122. (b)

123. (a)

124. (d)

125. (a)

126. (a)

127. (a)

128. (b)

129. (a)

130. (c)

131. (a)

132. (c)

133. (a)

134. (a)

135. (b)

136. (d)

137. (a)

MOS ICs based on MOSFET structure find wide application in digital field. This is because MOS ICs have small size and easy to fabricate.

138. (b)

139. (b)

140. **(b)**

141. **(a)**

Optical lithography is widely used because of its high throughput, good resolution and ease in operation. Due to diffraction, optical lithography has limitations that limit the resolution that can be achieved in deep-submicron IC process.

Thus, next-generation lithographic methods are used for IC fabrication to process deep-submicron or even nano-structures. Electron-beam lithography is one such method which has higher resolution than photolithography.

142. **(b)**

Epitaxy means growing a single crystal silicon structure upon an original silicon substrate, such that the new structure is essentially a molecular extension of the original substrate. Thus, the structure of the grown epitaxial layer will be continuation of the single crystal substrate.

The epitaxial layer grown can be of same conductivity type as that of the substrate, but possess different value of resistivity than that of the substrate. For Example, n-type epitaxial layer grown on the n^+–type silicon crystal (substrate).

143. **(a)**

The principle side effect of the ion implantation process is the disruption or damage of the semiconductor lattice due to ion collisions. Therefore it is followed by annealing treatment to remove these damages.

144. **(b)**

145. **(c)**

146. **(c)**

147. **(a)**

For regenerative braking, the back emf E_b must be greater than the supply voltage so that the armature current is reverssed and the motoring mode will change to generating mode.

148. **(c)**

In the transformers, usually the open-circuit (OC) test and short-circuit tests are conducted on low voltage and high voltage sides respetively.

The OC test is performed at rated voltage, so, if it is done on low voltage side, it requires the instruments with standard ranges. On the other hand, if OC test is performed on high voltage side, a source of such a high voltage may not be available easily.

The SC test is performed on hV side because:

(i) The rated current on hV side is lower than that on *l*v side. This current can be safely measured.

(ii) Since, the applied voltage is less than 5% of the rated voltage of the winding, greater accuracy in the reading of the voltmeter is possible when the hV side is used as the primary.

149. **(a)**

For a required power, if the voltage is increased, the current would decrease and I^2R losses would decrease and the efficiency increases.

150. **(b)**

The power plants to be employed as peak power plants should have the capability of quick start, synchronisation and taking up of system load and quick response to load variations.

During the periods of draught, the hydro electric power plants may be used as peak load plants. HEPs have low operating cost.