ESE-2018 PRELIMS TEST SERIES

Date: 3 December, 2017

ECE–Test–11 (OBJECTIVE SOLUTION)...

ANSWERS

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

1. (d)

- All ferroelectric materials are piezoelectric materials but all piezoelectric materials are not ferroelectric materials.
- Quartz is only piezoelectric material, it is not a ferroelectric material.

2. (c)

Power transformers use silicon steel as a magnetic material and alnico is a permanent magnet.

3. (a)

In paramagnetic materials interaction between neighbouring dipoles is negligible.

4. (c)

5. (a)

6. (c)

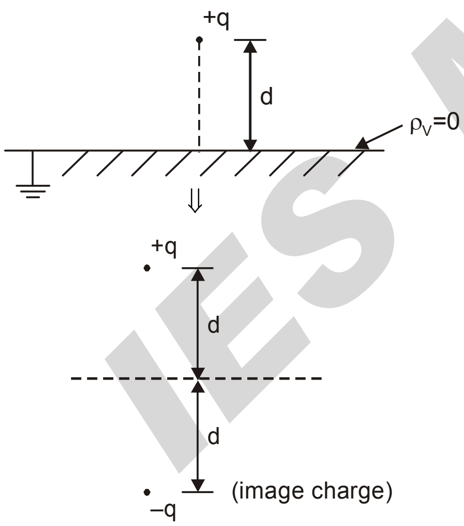
7. (c)

8. (a)

9. (c)

10. (d)

Applying image of charge method



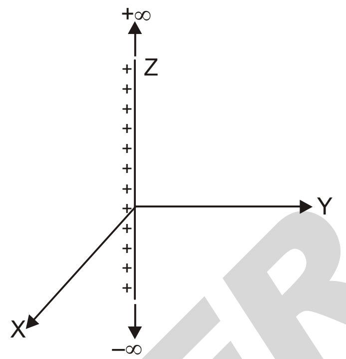
So, force,

$$F = \frac{q.q}{4\pi\varepsilon_0.(2d)^2} = \frac{q^2}{16\pi\varepsilon_0 d^2}$$

11. (c)

- As the outer sphere (or, larger sphere) is a hollow conducting sphere, so whatever or, wherever is the charge inside, it will appear on the surface of the conducting sphere.
- So, net charge on the surface of the hollow conducting sphere is zero. Hence, there will be no potential at any where.

12. (c)



According to Gauss's Law

$$\oint_s \vec{E}.\vec{ds} = \frac{\text{charge enclosed}}{\varepsilon_0}$$

$$E.2\pi R.l = \frac{\rho.l}{\varepsilon_0}$$

$$\therefore \quad E = \frac{\rho}{2\pi\varepsilon_0 R}$$

This is the electric field intensity by an infinitely long line charge at a distance R, and its direction will be radially outward.

So, $\bar{E}$ at (R, 0, 0) = $\frac{\rho}{2\pi\varepsilon_0 R}\hat{a}_x$

13. (d)

Potential at any point is work done, from bringing a unit charge from infinite to that point. So if E is zero at that point, it does not mean V is zero. V will have some value.

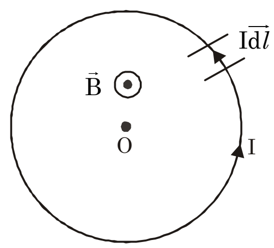
14. (c)

$$\text{Reluctance} = \frac{1}{a\mu_0\mu_r}$$

μ_r is dependent on flux density

15. (b)

Magnetic field density at the centre due to circular loop.



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Applying Biot-Savart law,

$$\int dB = \frac{\mu_0}{4\pi}\frac{I}{r^2}\int dl$$

$$\therefore \quad B = \frac{\mu_0}{4\pi}\frac{I}{r^2}.2\pi r$$

$$= \frac{\mu_0 I}{2r}$$

$$\Rightarrow \quad B \propto \frac{1}{r}$$

So, $$\frac{B_{\text{Loop A}}}{B_{\text{Loop B}}} = \frac{r_B}{r_A} = \frac{2a}{a} = 2:1$$

16. **(d)**

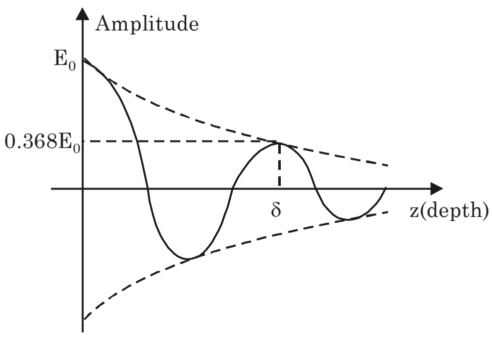
17. **(c)**

Waves	Frequency (f)	Wavelength (C/f)
Visible light	$(300-3000)\times10^{12}$ Hz	$(1-10)\times10^{-7}$ m
TV, FM	$(30-300)\times10^{6}$ Hz	$(1-10)$ m
Microwave	$(3-300)\times10^{9}$ Hz	$(1-100)\times10^{-3}$ m
Gamma Rays	$(300-3000)\times10^{15}$ Hz	$(1-10)\times10^{-10}$ m

18. **(a)**

19. **(c)**

When an EM wave travels in a conducting medium, its amplitude is attenuated by the factor $e^{-\alpha z}$. The distance 'δ' through which the wave amplitude decreases to a factor e^{-1} (or 37% of the original value) is called skin depth of the medium.



20. **(b)**

According to Maxwell's equation

$$\nabla \times \bar{H} = \bar{J}$$

So, $$\bar{J} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 10x & z & 12 \end{vmatrix}$$

$$= \left(\frac{\partial(12)}{\partial y} - \frac{\partial z}{\partial z}\right)\hat{a}_x - \left(\frac{\partial(12)}{\partial x} - \frac{\partial(10x)}{\partial z}\right)\hat{a}_y + \left(\frac{\partial z}{\partial x} - \frac{\partial(10x)}{\partial y}\right)\hat{a}_z$$

$$= -\hat{a}_x$$

21. **(b)**

$\bar{E} = 4\sin(10^8 t - 0.8x)\hat{a}_x$ V/m

Here,

$\beta = 0.8,\ \omega = 10^8,\ \mu = \mu_0$ (nonmagnetic)

Hence,

$$\beta = \omega\sqrt{\mu\varepsilon} = \omega\sqrt{\mu_0\varepsilon_0\varepsilon_r}$$

$$= \frac{\omega}{c}\sqrt{\varepsilon_r}$$

$$\left[\because c = \frac{1}{\sqrt{\mu_0\varepsilon_0}} = \text{speed of light}\right]$$

So, $$\sqrt{\varepsilon_r} = \frac{\beta c}{\omega}$$

$$= \frac{0.8\times3\times10^8}{10^8} = 2.4$$

$$\therefore \quad \varepsilon_r = (2.4)^2 = 5.76$$

22. **(a)**

The given current lag voltage in phase so the two elements will be inductor and resistor.

23. **(b)**

Nodal analysis

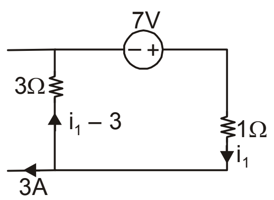
$$\frac{V_a}{1} + \frac{V_a - 2}{2} = 2$$

$$V_a + \frac{V_a}{2} - 1 = 2$$

$$\frac{3V_a}{2} = 3$$

$$V_a = 2\text{ V}$$

24. **(d)**



$$7 = 1\Omega\times i_1 + (i_1 - 3)\times 3\Omega$$

$$7 = i_1 + 3i_1 - 9$$

$$16 = 4i_1$$

$$i_1 = 4\text{ A}$$

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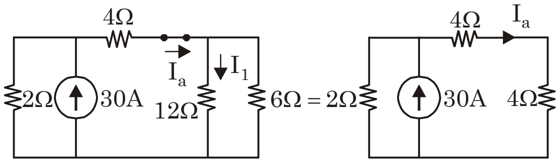
25. (b)

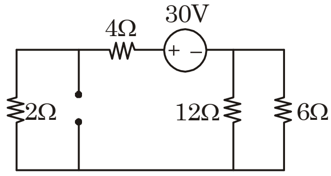
Due to only current source of 30A,



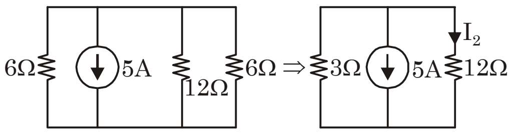
$$I_\infty = \frac{2}{2+8}(30) = 6A$$

$$I_1 = \frac{6}{6+12}(6A) = 2A$$

Due to only voltage source of 30V,



Using SourceTransformation

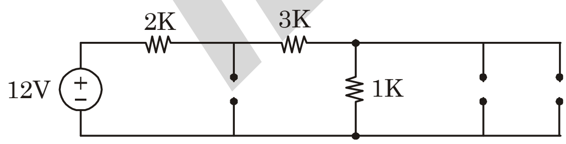


$$I_2 = \frac{-3\times 5}{12+3} = -1A$$

26. (b)

$$Z_{11} = Z_1 + Z_3 = 50$$
$$Z_{12} = Z_{21} = Z_3 = 30$$
$$Z_{12} = Z_2 + Z_3 = 40$$
$$Z_2 = 40 - Z_3$$
$$= 40 - 30$$
$$= 10\Omega$$

27. (b)

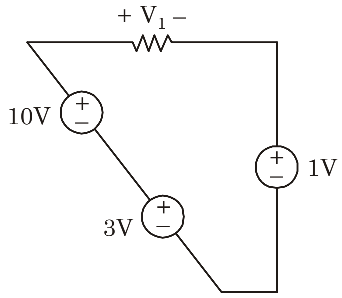


$$V_{C_1} = \left(\frac{3+1}{3+1+2}\right)12V = 8V$$

$$V_{C_2} = V_{C_3} = \left(\frac{1}{3+1+2}\right)12V = 2V$$

28. (c)

Applying KVL around the loop



$$1V + V_1 - 10 - 3 = 0$$
$$V_1 = 12\ V$$

29. (d)

All are applicable to only linear, time invariant systems or circuits.

30. (a)

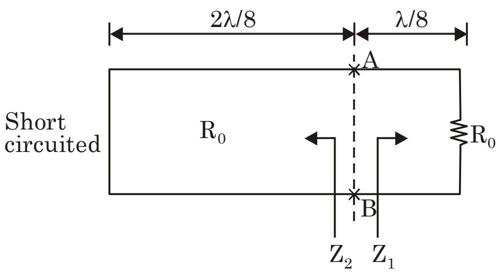
The Directivity D of an antenna is the ratio of maximum radiation intensity to average radiation intensity. D is the maximum directive gain $G_{d,\ mas}$.

Thus $$D = \frac{U_{max}}{U_{average}} = G_{d,\,max}$$

31. (d)

Optical fiber provides a very high capacity for carrying information. It has sufficient bandwidth that direct serial transmission can be used thereby reducing the size, cost and complexity of hardware.

32. (b)



Since, the terminated load at one end is R_0.

i.e. same as characteristic impedance.

So, $Z_1 = R_0$

and the input impedance,

$$Z_2 = Z_0\left(\frac{Z_L + jZ_0\tan\beta l}{Z_0 + jZ_L\tan\beta l}\right)$$

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$$Z_2 = Z_0\left(\frac{0+jZ_0\tan\beta l}{Z_0+0}\right)$$

$$= jZ_0\tan\left(\frac{2\pi}{\lambda}.\frac{2\lambda}{8}\right)$$

$$= jZ_0\tan\left(\frac{\pi}{2}\right)$$

$$= \infty$$

Now, effective impedance at AB,

$$Z_{AB} = Z_1 \parallel Z_2 = R_0 \parallel (\infty) = R_0$$

33. (b)

For a distortionless transmission line. Characteristic impedance.

$$R = \sqrt{\frac{L}{C}}$$

$$\Rightarrow \quad R^2 = \frac{L}{C}$$

$$\Rightarrow \quad L = R^2C$$

34. (a)

Voltage reflection coefficient

$$\rho = \frac{|Z_R|-|Z_0|}{|Z_R|+|Z_0|}$$

$$= \frac{200-100}{200+100}$$

$$= \frac{100}{300} = \frac{1}{3}$$

and, voltage standing wave ratio (VSWR,

$$S = \frac{1+\rho}{1-\rho} = \frac{1+\frac{1}{3}}{1-\frac{1}{3}} = \frac{4}{2} = 2$$

35. (d)

Since, reflection coefficient,

$$\Gamma = \frac{Z_L - Z_0}{Z_L + Z_0}$$

- if $Z_L = Z_0$ [i.e. perfectly matched line], $\Gamma = 0$
- if $Z_L = 0$ (i.e. short circuited line), $\Gamma = -1$
- if $Z_L = \infty$ (i.e. open circuited line), $\Gamma = +1$

36. (d)

Reflection coefficient, $\Gamma = 0.8 + j0.6$

So, $\quad |\Gamma| = \sqrt{(0.8)^2 + (0.6)^2}$

$$= \sqrt{1} = 1$$

So, $\quad \text{VSWR} = \frac{1+|\Gamma|}{1-|\Gamma|} = \frac{1+1}{1-1} = \frac{2}{0} = \infty$

37. (b)

Since each line has length $\lambda/4$

so, $\quad Z_{in2} = \frac{Z_0^2}{Z_L} \quad [\text{since } \tan\beta l = \infty]$

$$\Rightarrow \quad Z_{in2} = \frac{Z_0^2}{R}$$

Now, $\quad Z_{in1} = \frac{(Z_0^1)^2}{Z_L^1}$

$$= \frac{(2Z_0)^2}{(Z_0^2/R)} \quad [\because Z_L^1 = Z_{in2}]$$

$$= \frac{4Z_0^2}{Z_0^2}R = 4R$$

38. (a)

$$Z_{in} = \infty$$

$$= Z_0\left[\frac{Z_1 + jZ_0\tan\beta l}{Z_0 + jZ_1\tan\beta l}\right]$$

ie. $\quad \tan\beta l = \infty$

$$\Rightarrow \quad \beta l = \pi/2$$

$$\Rightarrow \quad \frac{2\pi}{\lambda}\cdot l = \pi/2$$

$$\Rightarrow \quad l = \frac{\lambda}{4}$$

So, option (a)

39. (a)

Shunts are not used for extension of current range since they are subject to temperature errors.

40. (a)

In a portable instrument the controlling torque is provided by spring control.

The instruments employing gravity control must be used in vertical position. The instruments must be mounted in lend oposition otherwise there will be serious zero error. Therefore, gravity control is not suitable for portable instruments.

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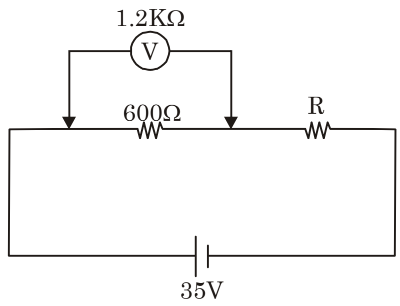
41. (d)



Effective resistance for voltmeter.

$$R_{eff} = \frac{600 \times 1200}{60 + 1200}$$

$$= \frac{600 \times 1200}{1800} = 400\Omega$$

So, reading of voltmeter $= \frac{400}{400 + R} \times 35$

$$\Rightarrow \quad 5 = \frac{400}{400+R} \times 35$$

$$\Rightarrow \quad R = 2400\Omega$$

$$= 2.4\,K\Omega$$

42. (a)

43. (c)

$$R_1 = 100\Omega \pm 5\Omega$$

$$R_2 = 150\Omega \pm 15\Omega$$

$$R = R_1 + R_2$$

$$= 100 + 150 = 250\Omega$$

Standard deviation of R,

$$\sigma_R = \sqrt{\left(\frac{\partial R}{\partial R_1}\right)^2 (\sigma_{R_1})^2 + \left(\frac{\partial R}{\partial R_2}\right)^2 (\sigma_{R_2})^2}$$

$$= \sqrt{(1)^2 \times (5)^2 + (1)^2 \times (15)^2}$$

$$= \sqrt{25 + 225}$$

$$= \sqrt{250}$$

$$= 15.8$$

So, $\quad R = 250\Omega \pm 15.8\Omega$

44. (b)

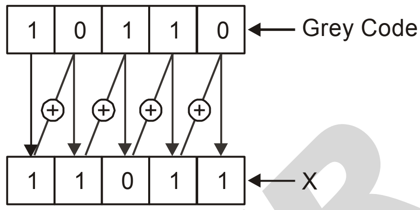
In Excess-3 code, each decimal digit is coded into a 4-bit binary code. The code for each decimal digit is obtained by adding decimal 3 to the natural BCD code of the digit.

So, for 25 :

$$\begin{array}{r} \underline{2} \\ 0010 \\ +\quad 11 \\ \hline 0101 \end{array} \qquad \begin{array}{r} \underline{5} \\ 0101 \\ +\quad 11 \\ \hline 1000 \end{array}$$

i.e. 0101 1000 $\leftarrow$ Exces-3 code of 25.

45. (c)



[where, $\oplus$ represents EXOR operation]

So, $\quad X = (11011)_2$

$$= (1 \times 2^4) + (1 \times 2^3) + (1 \times 2^1) + (1 \times 2^0)$$

$$= 16 + 8 + 2 + 1$$

$$= 27$$

Note : $Y = A \oplus B$ [EXOR Gate]

If A = B ; Y = 0

If $A \neq B$; $Y = 1$

46. (b)

47. (b)

48. (c)

49. (a)

50. (d)

51. (c)

52. (c)

53. (a)

54. (d)

55. (a)

56. (b)

57. (c)

58. (a)

59. (b)

60. (a)

61. (c)

62. (c)

63. (b)

64. (b)

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65. (a)

With increase in temperature, intrinsic concentration increases, which results into increment of conductivity therefore resistivity decreases.

With increase in temperature a large number of covalent bond gets broken which generates a large no. of electrons hole pairs.

In intrinsic semiconductor current in contributed by both electron in conduction band and holes in valence band.

At temperature T = 0K or below electron remains in perfect covalent bonding.

66. (c)

In p-type holes are mojority carriers. Electron density changes with temperature.

67. (c)

Tunnel diode current starts as voltage is applied = 0 V

Germanium diode = 0.2 V

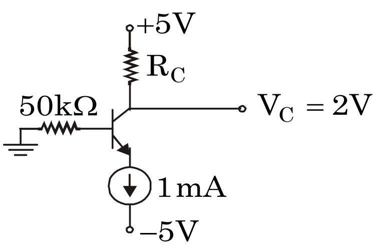
Schottky diode = 0.4 V

Silicon diode = 0.6 V

68. (c)

Depletion region is created due to diffusion of majority charge carriers across junction so it does not contain any free charge (electron or hole). It only contains ions, negative ions on p-side and positive ions on n-side.

69. (a)



Given,

$$I_E = 1 \text{ mA}$$

$$I_C = \alpha I_E = \frac{\beta}{1+\beta} I_E$$

$$= \left(\frac{75}{75+1}\right) \times 1\,\text{mA}$$

$$I_C = 0.987\text{mA}$$

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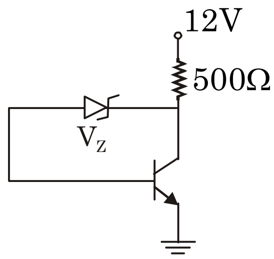
70. (b)



KVL for input, we get

$$V_{CC} = 500\,(I_B + I_C) + V_z + V_{BE}$$

$$\Rightarrow \quad 12 = 500\ I_E + 5 + 0.7$$

$$\Rightarrow \quad I_E = 12.6 \text{ mA}$$

$$\therefore \quad I_C = 12.47 \text{ mA}$$

KVL for output, we get

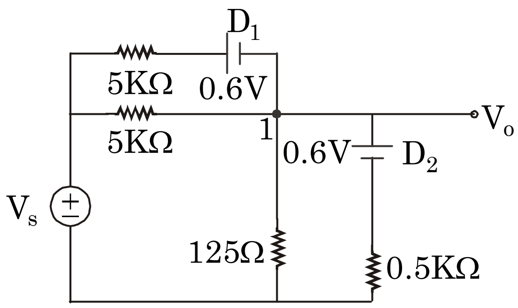
$$V_{CC} - V_{CE} = 500 \times I_E$$

$$V_{CE} = 12 - 500(I_C + I_B)$$

$$= 12 - 500 \times 12.6 \times 10^{-3}$$

$$= 5.7 \text{ V}$$

71. (d)



Applying KCL at node 1, we get

$$\frac{V_s - 0.6 - V_0}{5\text{K}} + \frac{V_s - V_0}{5\text{K}} = \frac{V_0}{125} + \frac{V_0 - 0.6}{0.5\text{ K}}$$

$$\therefore \quad V_S = 26V_0 - 2.7$$

Diode D_2 conducts when $V_0 = 0.6$V.

$$\therefore \quad V_S = 26 \times 0.6 - 2.7 = 12.9\text{V}$$

72. (c)

From the Fermi-dirac statistics, the probability of electron occupation of an energy level equal to the fermi level is given by

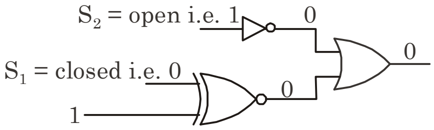
$$f(E) = \frac{1}{1 + \exp\left(\frac{E - E_f}{KT}\right)}$$

For $E = E_f$,

$$f(E) = \frac{1}{1 + \exp(0)} = 0.5$$

73. (c)

LED will glow only when output from OR will be ‘0’ and it is possible only when both input of OR gate will be ‘0’ i.e. output of NOT gate and EXNOR gate should be zero. It is possible only when S_1 is closed and S_2 is open.



74. (c)

Using Karnaugh map, for the given expression.

A \ BC	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	1			1
A	1		1	1

Output, $Y = \bar{C} + AB$

75. (c)

Push H instruction has

Fetch	Write	Write
6 T states	3 T states	3 T states

$$n = 3$$
$$T = 6 + 3 + 3$$
$$= 12$$

76. (d)

Number of chips required

$$= \frac{\text{Required size}}{\text{Available size}}$$

$$= \frac{32K \times 8}{1024 \times 8}$$

$$= \frac{32 \times 1024 \times 8}{1024 \times 8}$$

$$= 32$$

77. (a)

XRA A instruction execution resets contents of accumulator and hence sets zero flag.

78. (a)

A monostable multivibrator can be used as pulse stretcher.

79. (c)

$$C = \bar{A} \cdot B \text{ and } D = A \oplus B$$

This is the expression of half subtractor.

80. (d)

$$64 = 2^n$$
$$n = \text{input data lines}$$
$$n = 6$$

81. (b)

In gray code only one bit position changes between any two successive (nearby) entries. This allows us to group the terms producing the same (normally) and eliminate the variable corresponding to the common bit position. As the K-map is used for reduction of min terms, this approach is used. It is the basis of the K-map itself.

82. (a)

Truth table of JK flip-flop is

J_n	K_n	Q_{n+1}
0	0	Q_n
1	0	1
0	1	0
1	1	$\bar{Q}_n$

equation $Q_{n=1} = J_n\bar{Q}_n + \bar{K}_nQ_n$ satisfies. Using K-map and characteristic of JK flip-flop. We can arrive at the expression.

83. (c)

CLK	$\bar{Q}_0$	Q_2	Q_1	Q_0
0	–	0	1	0
1	1	1	0	1
2	0	0	1	0

So for 2 clock pulses, the values of $Q_2Q_1Q_0$ resets, so frequency $= \frac{18\text{KHz}}{2} = 9\text{KHz}$

84. (c)

For 4-flip flops the count is $2^4 = 16$, So the no. of unused or missed states are

$$16 - 10 = 6 \text{ counts.}$$

85. (a)

Data bus is a 8-bit wide and hence 8-bits of data can be transmitted in parallel from or to the microprocessor to memory or I/O.

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86. (b)

For instruction MVI A, 05H; 4T states are required for opcode fetch cycle.

Time for one 'T'-state = $\frac{1}{f} = \frac{1}{3\times 106}$ sec

$\therefore$ Time required for 4T-states = $4\times\frac{1}{3\times 10^6}$

$= 1.33\,\mu\text{sec}$

87. (d)

In microprocessor 8085; following are the active low signal :

$\overline{\text{REST IN}}$, $\overline{\text{RD}}$, $\overline{\text{WR}}$ & $\overline{\text{INTA}}$

88. (b)

Time constant = RC

$$\frac{1}{f_c} < RC < \frac{1}{f_m}$$

$$\frac{1}{1\,\text{MHz}} < RC < \frac{1}{2\,\text{KHz}}$$

$$1\mu s < RC < 500\,\mu s$$

89. (c)

$$f_c + f_m = 605 \text{ KHz}$$

BW = 10 KHz, so $2f_m$ = 10 KHz

$$f_m = 5 \text{ KHz}$$

$$f_C = 605 \text{ KHz} - 5 \text{ KHz}$$

$$= 600 \text{ KHz}$$

90. (a)

$$I_t = I_c\left(1+\frac{\mu^2}{2}\right)^{1/2}$$

$$20 = 18\left(1+\frac{\mu^2}{2}\right)^{1/2}$$

$$1+\frac{\mu^2}{2} = \left(\frac{20}{18}\right)^2$$

$$1+\frac{\mu^2}{2} = 1.234$$

$$\mu^2 = 0.4690$$

$$\mu = 0.68$$

91. (c)

Total bandwidth of signal = 12 × 5 = 60 KHz. There would be 11 guard bands between 12 signals, so that bandwidth of guard band is 1×11 = 11 KHz.

Total BW = 60 + 11

= 71 KHz

92. (c)

Sample and hold circuits make the varying analog input voltage constant till the next sampling is done. Then, output of the sample and hold circuit is converted to digital signal by means of an analog-to-digital (A/D) converter circuit.

93. (d)

- SAR type of Analog-to-digital converter has fixed conversion time.
- In this type of converter, conversion time does not depend on the input applied i.e. whatever will be the input voltage, it takes same conversion time.
- In SAR A/D converter, conversion time depends on the number of bit of output required. i.e. For 'n' number of output bit.

$\therefore$ Conversion time = n × t_{CLK}

94. (b)

For counter type ramp ADC, maximum conversion time for n-bit

$$= 2^n \times t_{CLK}$$

Here n = 8

$\therefore$ Maximum conversion time = $2^8 \times t_{CLK}$

$$= 2^8 \times \frac{1}{40\times 10^3}$$

$$= \frac{256}{40}\,\text{m sec.}$$

$$= 6.4 \text{ ms}$$

95. (a)

512 levels = 2^9, so 9 bits are required to encode a sample. As the sampling rate is 18KHz, in a second, there will be 18KHz × 9 bits = 162 K bits.

The duration of each bit = $\frac{1}{162\times 10^3}$ sec.

$$= 6.17\,\mu s$$

96. (c)

Peak-to peak value = $2m_p$

$$\text{error} = \frac{0.5\times 2m_p}{100} = 0.01\,m_p$$

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If L level are used, then step size $\delta = \frac{2m_p}{L}$

Maximum quantization error

$$\frac{\delta}{2} = \frac{2m_pL}{2} = 0.01m_p$$

L = 100, since 100 < 2^n, thus n = 7

97. **(c)**

Current through $1K\Omega$ of 1st transistor

$$= \frac{5V}{1K\Omega} = 5mA$$

$$V_{C1} = 15 - 1.8 \times 5 = 6V$$

Current through R_L = current through $1K\Omega$ of 2nd transistor.

$$= \frac{(15-6)}{1K\Omega} = 9mA$$

$$R_L = \frac{6-1.5}{9\times 10^{-3}} = 500\Omega$$

98. **(a)**

$V_s > 0 \Rightarrow D_2$ is ON and D_1, is off

$$\frac{V_0}{V_S} = \frac{-R_2}{R_1} \Rightarrow A_V = \frac{-R_2}{R_1}$$

$V_S < 0$ $D_1 = ON$ and $D_2 = off$

$$\frac{V_0}{V_S} = -\frac{R_3}{R_1}$$

$$A_V = -\frac{R_3}{R_1}$$

99. (b)

The joint entropy of X and Y is H(X, Y) = H(X) + H(Y/X)

If X and Y are statistically independent

$$H\left(\frac{Y}{X}\right) = H(Y)$$

Hence H (X, Y) = H(X) + H(Y)

100. **(b)**

Shanon's source-coding theorem states that the maximum extent to which the source data can be compressed using a code, is limited by the fact that the average length of code word cannot be less than the average information in bits per symbol i.e. entropy of the source. However, the theorem does not provides for designing such codes, merely states the bound.

101. **(c)**

From the given figures it is written as

x(t) = u(t + 1) – u(t –1)

$$\xleftrightarrow{LT} \frac{1}{s}e^{s} - \frac{1}{s}e^{-s} = x(s)$$

and y(t) = U(t) + U(t – 2) – 2U(t –4)

$$\xleftrightarrow{LT} \frac{1}{s} + \frac{e^{-2s}}{s} - \frac{2\,e^{-4s}}{s} = Y(s)$$

Given m(t) = x(t) * y(t) ...(1)

taking laplace transform both side for eqn (1)

M(s) = X(s) · Y(s)

Putting the value of x(s) and y(s)

$$M(s) = \left(\frac{1}{s}e^{s} - \frac{1}{s}e^{-s}\right)\left(\frac{1}{s} + \frac{e^{-2s}}{s} - \frac{2\,e^{-4s}}{s}\right)$$

$$M(s) = \frac{1}{s^2}[e^{+s} - 3e^{-3s} - 2e^{-5s}]$$

taking inverse laplace transform of M(s), we get m(t) as

m(t) = (t + 1) u(t + 1) – 3(t – 3) u(t – 3) – 2 (t – 5) u(t – 5)

by putting t = 3.5, we get m(3.5) as

m(3.5) = (3.5 + 1) – 3(3.5 – 3) = 3.5 + 1 – 1.5 = 3

102. **(c)**

Using long division

$$\frac{1}{3}z^{-1}+1 \;\big)\; z^{-1}+1 \;\big(\; 3 - 6z + 18z^2$$

$$\begin{array}{l} z^{-1}+3 \\ \hline -2 \\ -2-6z \\ \hline 6z \\ 6z+18z^2 \\ \hline -18z^2 \end{array}$$

x(z) = 3 – 6z + 18z² = x[0] + x[–1] z¹ + x[–2] z²

On comparing x[0] = 3

x[–1] = –6

x[–2] = 18

So x[0] + x[–1] + x[–2] = 15

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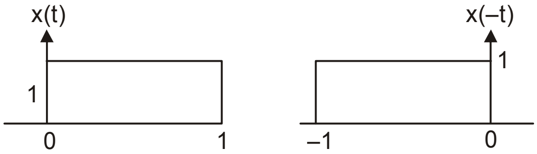
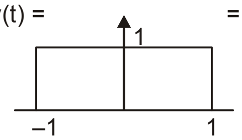
103. (c)

$$x(t) = \text{rect}\left(t - \frac{1}{2}\right)$$

Given



y(t) =



= x(t) + x(–t)

Taking Fourier transform of y(t)

$$Y(j\omega) = 2Sa(\omega)$$

$$= 2\frac{\sin\omega}{\omega}$$

$$= 2\cdot\frac{2\sin(\omega/2)\cdot\cos(\omega/2)}{\omega}$$

$$Y(j\omega) = 2\frac{\sin(\omega/2)}{(\omega/2)}\cos(\omega/2) \quad \ldots(1)$$

$$\because \quad Sa(k) = \text{Sinc}(k/\pi)$$

$$Sa\left(\frac{\omega}{2}\right) = \text{Sinc}\left(\frac{\omega}{2\pi}\right) \quad \ldots(2)$$

From eqn. (1) and (2)

$$\Rightarrow \quad Y(j\omega) = 2\ Sa\left(\frac{\omega}{2}\right)\cdot\cos\left(\frac{\omega}{2}\right)$$

$$Y(j\omega) = 2\ \text{sinc}\left(\frac{\omega}{2\pi}\right)\cdot\cos\left(\frac{\omega}{2}\right)$$

104. (b)

$$g(t) = x(t)\cos t$$

Let $w(t) = \cos t$

$$g(t) = x(t)w(t)$$

Taking Fourier transform both side

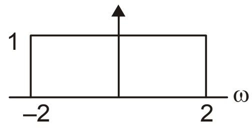
$$\Rightarrow \quad G(j\omega) = \frac{1}{2\pi}(X(j\omega) * W(j\omega))$$

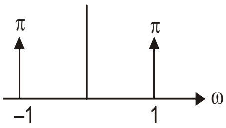
$$w(t) = \cos t \xrightleftharpoons{F.T} W(j\omega) = \pi[\delta(\omega-1)+\delta(\omega+1)]$$

$$G(j\omega) = \frac{1}{2\pi}(\pi)\left[X[j(\omega-1)] + X[j(\omega+1)]\right]$$

$$G(j\omega) = \frac{1}{2}X[j(\omega-1)] + \frac{1}{2}Xj[(\omega+1)]$$

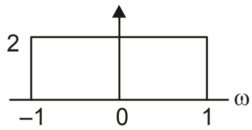
Given





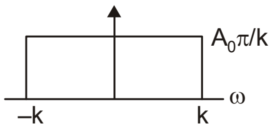
X(jω) interval will be (–1 to 1) because G(jω) is (–2 to 2)

So, X(jω)



$$X(j\omega) \xleftrightarrow{F.T} x(t) = \frac{2\sin t}{\pi t}$$

$$A_0 Sa(kt) \xleftrightarrow{F.T}$$



$$k = 1\ ;\ \frac{A_0\pi}{k} = A_0\pi = 2$$

$$A_0 = \frac{2}{\pi}$$

$$\boxed{\frac{2}{\pi}Sa(t) = x(t)}$$

105. (b)

x(t) =

$$\cos t \xleftrightarrow{FT} X(j\omega) = \pi[\delta(\omega+1)+\delta(\omega-1)] \ldots(1)$$

$$h(t) \xleftrightarrow{F.T} H(j\omega) = -2 + \frac{5}{2+j\omega} \quad \ldots(2)$$

$$y(t) = x(t) * h(t)$$

$$y(t) \xleftrightarrow{F.T} Y(j\omega) = H(j\omega)X(j\omega)$$

By putting the values from equation (1) and equation (2)

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$$Y(j\omega) = \pi[\delta(\omega+1)+\delta(\omega-1)]\cdot\left[-2+\frac{5}{2+j\omega}\right]$$

$$= -2\pi\left[\delta(\omega+1)+\delta(\omega-1)\right]$$

$$+5\pi\left[\frac{\delta(\omega+1)}{2+j\omega}+\frac{\delta(\omega-1)}{2+j\omega}\right]$$

$$\because \quad x(t)\delta(t-t_1) = x(t_1)\delta(t-t_1)$$

$$Y(j\omega) = -2\pi\left[\delta(\omega+1)+\delta(\omega-1)\right]$$

$$+5\pi\left[\frac{\delta(\omega+1)}{2-j}+\frac{\delta(\omega-1)}{2+j}\right]$$

$$-2\pi\left[\delta(\omega+1)+\delta(\omega-1)\right]+\frac{5\pi}{5}\left[2(\delta(\omega+1)\right]+2\delta(\omega-1)]$$

$$+\pi\left[j(\delta(\omega+1)-j(\delta(\omega-1)\right]$$

$$= \pi j\left[\delta(\omega+1)-\delta(\omega-1)\right]$$

$$Y(j\omega) \xleftrightarrow{\text{IFT}} y(t) = \sin(t)$$

106. (d)

By using partial fraction expainsion we get from given X(z)

$$X(z) = \frac{1}{1-\frac{1}{4}z^{-1}}+\frac{2}{1-\frac{1}{3}z^{-1}}$$

Inverse z transform of X(z) can be represented as

$$x[n] = x_1[n] + x_2[n]$$

$$x_1[n] \xleftrightarrow{\text{Z.T}} \frac{1}{1-\frac{1}{4}z^{-1}}; |z| > \frac{1}{4}$$

by taking inverse z transform of right side signal

$$\Rightarrow \quad x_1[n] = \left(\frac{1}{4}\right)^4 u[n]$$

$$x_2[n] \xleftrightarrow{\text{Z.T}} \frac{2}{1-\frac{1}{3}z^{-1}} \quad ; \ |z| < \frac{1}{3}$$

So by taking inverse z transform of right side signal

$$\Rightarrow \quad x_2[n] = 2(-1)\left(\frac{1}{3}\right)^n u[-n-1]$$

$$x[n] = \left(\frac{1}{4}\right)^n u[n] - 2\left(\frac{1}{3}\right)^n u[-n-1]$$

107. (a)

$$X(z) = \log(1 + az^{-1}),\ |z| > |a| \quad \ldots(1)$$

we know $X(z) = \sum_{h=-\infty}^{\infty} x[n]z^{-n}$

differentiating both side wrt z we get

$$\frac{dX(z)}{dz} = \sum_{h=-\infty}^{\infty} -n\,x[n]z^{-n-1}$$

Multiplying by z both side

$$= \frac{dX(z)}{dz} = \sum_{h=-\infty}^{\infty} -nx[n]z^{-n}$$

$$\Rightarrow \quad = \frac{dX(z)}{dz} \leftrightarrow -nx[n] \quad \ldots(2)$$

From eqn. (1) and eqn. (2)

$$\frac{az^{-1}}{1+az^{-1}} \xleftrightarrow{\text{I.Z.T}} nx[n]$$

$$\because \quad (-a)^n u(n) \xleftrightarrow{\text{Z.T}} \frac{1}{1+az^{-1}}, |z| > |a|$$

$$a(-a)^n u[n] \xleftrightarrow{\text{Z.T}} \frac{a}{1+az^{-1}}, |z| > |a| \ldots(3)$$

Combining time shifting property to eqn. (3) yields

$$a(-a)^{n-1}u[n-1] \xleftrightarrow{\text{Z.T}} \frac{az^{-1}}{1+az^{-1}} \quad , |z| > |a|$$

$$nx[n] \leftrightarrow a(-a)^{n-1}\ u[n-1]$$

$$\Rightarrow \quad \boxed{x[n] = \frac{a[-a]^{n-1}u[n-1]}{n}}$$

$$a = 2\ ,\ n = 2$$

$$x[2] = \frac{2(-2)^{2-1}u[2-1]}{2}$$

$$= (-1)^1\ u(1)$$

$$x[2] = -1$$

108. (b)

We know

$$X(z) = \sum_{n=-\infty}^{\infty} x[n]\ z^{-n}$$

$$= \sum_{n=-\infty}^{\infty} \left(\frac{1}{5}\right)^{n+3-3} u[n-3]\ z^{-n-3+3}$$

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$$\Rightarrow \quad z^{-3}\left(\frac{1}{5}\right)^3 \sum_{n=-\infty}^{\infty}\left(\frac{1}{5}\right)^{(n-3)} u[n-3]\, z^{-(n-3)}$$

$$n-3 = n'$$

$$\Rightarrow \quad \frac{z^{-3}}{125} \times \sum_{n'=-\infty}^{\infty}\left(\frac{1}{5}\right)^{n'} u[n']\, z^{-n'}$$

Since $\quad u[n'] = 0 \quad n \geq 0$

$$X(z) = \left[\frac{z^{-3}}{125}\right]\frac{1}{1-\frac{1}{5}z^{-1}}, \ |z| > \frac{1}{5}$$

$$\text{So } X(z) = \frac{z^{-3}}{125}\sum_{0}^{\infty}\left(\frac{1}{5}\right)^{n'} z^{-n'}$$

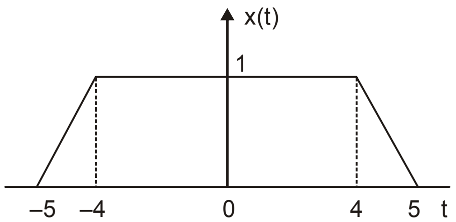
$$= \frac{z^{-3}}{125}\left[\left(\frac{1}{5z}\right)^0 + \left(\frac{1}{5z}\right)^1 + \left(\frac{1}{5z}\right)^2 + \ldots\right]$$

$$= \frac{z^{-3}}{125}\left[1 + \frac{1}{5z} + \left(\frac{1}{5z}\right)^2 + \ldots\right]$$

$$= \frac{z^{-3}}{125}\left[\frac{1}{1-\frac{1}{5z}}\right] \text{ provided } \left|\frac{1}{5z}\right| < 1$$

109. (d)

Signal x(t) is as shown in figure below



the signal x(t) is even, its total energy is therefore

$$E = 2\int_0^5 x^2(t)\,dt$$

$$= 2\int_0^4 (1)^2\,dt + 2\int_4^5 (5-t)^2\,dt$$

$$= 2(t)_{t=0}^{t=4} + 2\left[-\frac{1}{3}(5-t)^2\right]_{t=4}^{5}$$

$$= 8 + 2/3$$

$$= 26/3$$

$$= 8.666$$

110. (b)

Given

$$x[n] = \cos\frac{\pi}{3}n + \sin\frac{\pi}{4}n$$

$$x[n] = x_1[n] + x_2[n]$$

$$\because \quad x_1[n] = \cos\frac{\pi}{3}n = \cos\Omega_1 n$$

Since $\frac{\Omega_1}{2\pi} = \frac{1}{6}$ (Rational numbers)

$\Rightarrow$ $x_1[n]$ is periodic with fundamental period $N_1 = 6$

$$x_2[n] = \sin\left(\frac{\pi}{4}n\right) = \sin(\Omega_2 n)$$

Since $\frac{\Omega_2}{2\pi} = \frac{1}{8}$ (Rational number)

$x_2[n]$ is periodic with fundamental period N_2= 8

So x[n] will be periodic

with fundamental period = LCM (N_1, N_2)

= LCM (6, 8)

= 24

111. (b)

Loops :

$L_1 = G_1H_1, L_2 = G_2H_2$

$L_3 = G_3H_1H_2, L_2 = G_1G_2G_4H_3$

$L_5 = G_3G_4H_3$

112. (c)

Field controlled dc servomotor,

$$\frac{\theta(s)}{e_f(s)} = \frac{K_T}{s(Js+f)(sL_f+R_f)}$$

Armature controlled dc servomotor,

$$\frac{Q(s)}{e_a(s)} = \frac{K_m}{s(s\tau_m+1)}$$

AC servomotor,

$$\frac{\theta(s)}{e(s)} = \frac{K_m}{s(\tau_m s+1)}$$

Tachometer,

$$\frac{V_0(s)}{\theta_i(s)} = K_T s$$

Potentiometers, $\frac{V_0(s)}{X_i(s)} =$

$$\frac{V_{ref}}{x_t} = \text{constant} = K$$

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113. (c)

$$(s+6-j8)(s+6+j8)=0$$

$$(s+6)^2+8^2=0$$

$$s^2+2\times 6\times s+10^2=0$$

$$\omega_n = 10$$

$$\xi = \frac{2\times 6}{2\times 10} = 0.6$$

114. (c)

Single pole at origin $G(s) = \frac{1}{s}$

Unit impulse $F(s) = 1$

Response $= 1\times\frac{1}{s}=\frac{1}{s}$

This is constant.

115. (a)

116. (b)

The characteristic equation of the system is $4s^2-2s+1$

$\therefore \quad a_2=4,\ a_1=-2,\ a_0=1$

$$\therefore \qquad A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -a_0 & -a_1 & -a_2 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & 2 & -4 \end{bmatrix}$$

117. (d)

Asymptotes is difference of number of poles and zeros, so all the options satisfies three asymptotes.

118. (a)

K =gain, will not contribute to the slope.

$$K = K\angle 0°$$

It contributes 0°.

119. (c)

$T \propto \phi I_a \propto I_a^2$ (series motor $\phi \propto I_a$)

$$\frac{T_2}{T_1} = \frac{I_{a_2}^2}{I_{a_1}^2}$$

$$T_2 = T_1\left(\frac{20^2}{10^2}\right)$$

$= 20$ Nm × 4

$= 80$ Nm

120. (d)

121. (a)

The reactance voltage is developed due to the poor commutation which causes the delay in quick reversal of current because of inductive effect occuring due to reversal.

122. (d)

Reactance voltage $\propto \frac{di}{dt}$

where i = armature current and t is the commutation time.

$i_2 = 2i_1$ and $t_2 = 0.5t_1$

(Reactance voltage)$_2$

$$= \frac{i_2}{t_2} = \frac{2i_1}{0.5t_1} = \frac{4i_1}{t_i} = 4 \text{ times}$$

123. (b)

Airgap input power = P_{air}

Rotor loss= s × Pair

Power to rotor = $P_{air}-sP_{air}=(1-s)P_{air}$

h = efficiency = $\frac{(1-s)P_{air}}{P_{air}}=(1-s)$

This efficiency is without considering other losses, so the efficiency would be less than (1 –s) if frictional and other losses are considered.

124. (a)

$$N_s = \frac{120\times 50}{8}=750\,\text{r.p.m.}$$

$$s = \frac{750-630}{750}=0.16$$

$$s = \frac{R_2}{X_2}$$

$$X_2 = \frac{R_2}{s}=\frac{0.07}{0.16}=0.44\,\Omega$$

125. (a)

Skewing is done to eliminate the space harmonics in the synchronous machine. This would give a voltage profile near to sinusoidal.

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126. (c)

Alternators driven by steam turbines do not have a tendency to hunt, since the torque applied does not pulsate.

127. (b)

This is motor and type of winding used in different types of motors.

128. (a)

Reluctance power is developed in the salient pole alternator, as the reluctance offered by direct axis and quadrature axis is different.

129. (a)

In a klystron the resonant structure limits the bandwidth.

A TWT is a broadband device. Its main components are electron gun (to produce the electron beam) and a structure supporting the slow electromagnetic wave.

The velocity of wave propagation along the helix structure is less than velocity of light.

The beam and wave travel along the structure at the same speed.

Thus interaction occurs between beam and wave and the beam delivers energy to the RF wave.

Therefore the signal gets strengthened and amplified output is delivered at the other end of tube.

The main features of TWT are :

1. Frequency range - 0.5 GHz to 90 GHz

2. Power output - 5 mW at low frequencies(less than 20 GHz) 250 kW (continuous wave) at 3 GHz 10 MW (pulsed) at 3 GHz

3. Efficiency - about 5 to 20%

4. Noise - about 5 dB for low power TWT 25 dB for high power TWT

TWT is used as RF amplifier in broadband microwave receivers, repeater amplifier in broad band communication systems, communication satellites etc.

130. (b)

A Gunn diode uses GaAs which has a negative differential mobility, i.e., a decrease in carrier velocity with increase in electric field.

This effects is called transferred electron effect. The impedance of a Gunn diode is tens of ohms.

A Gunn diode oscillator has a resonant cavity, an arrangement to couple Gunn diode to cavity, biasing arrangement for Gunn diode and arrangement to couple RF power to load.

Applications of Gunn diode oscillator include continuous wave radar, pulsed radar and microwave receivers.

An Impatt diode has n+ - p - i - p + structure and is used with reverse bias.

It exhibits negative resistance and operates on the principle of avalanche breakdown. Impatt diode circuits are classified as broadly tunable circuit, low Q circuit and high Q circuit.

The impedance of Impatt diode is a few ohms. The word Impatt stands for Impact Avalanche Transit Time diode.

The features of Impatt diode oscillator are: Frequency 1 to 300 GHz, Power output (0.5 W to 5 W for single diode circuit and upto 40 W for combination of several diodes), efficiency about 20%.

Its applications include police radar systems, low power microwave transmitter etc.

131. (a)

132. (c)

133. (c)

134. (a)

135. (a)

136. (b)

From the equation,

$S=\frac{2}{T}\left(\frac{1-z^{-1}}{1+z^{1}}\right)\}$ it is clear that transformation occurs from s-plane to z-plane.

137. (b)

138. (b)

139. (c)

140. (a)

Velocity of light in any medium

$$v = \frac{1}{\sqrt{\mu\varepsilon}} = \frac{1}{\sqrt{\mu_0\mu_r\varepsilon_0\varepsilon_r}} = \frac{c}{\sqrt{\mu_r\varepsilon_r}}$$

In free space $\mu_r = \varepsilon_r = 1$, but in any medium

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$\mu_r \geq 1$ and $\varepsilon_r > 1$

141. (c)

Electrical applicances are connected in parallel because the operation of appliances becomes independent of each other. So the assertion is true but the following reason is not true.

142. (c)

The PMMC meters used in rectifier type voltmeters are provided with shunts even at the expense of lowering sensitivity. The shunting of the meter causes the circuit current to be high thereby making the rectifier work in the linear protions of its v-i characteristics.

143. (d)

Electromagnetic or eddy current damping is not used for damping purposes in case of electrodynamometer wattmeters as introduction of a permanent magnet for damping purposes will greatly distort the weak operating magnetic field.

144. (a)

145. (a)

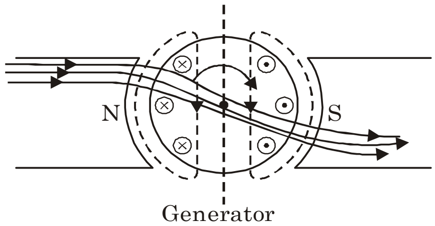
DMA is faster form of data transfer. The DMA technique does not make use of the interrupt mechanism.

146. (a)

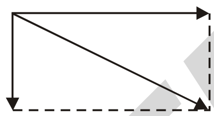
We have channel capacity $C = B \log_2 \left(1+\frac{S}{N}\right)$

$\because$ $C \propto B$, it is easier to increase C by increasing B.

147. (a)



Generator



In case of generator armature reaction increases the flux density over one half of trailing pole and in case of motor, armature reaction increases the flux density over one half of leading pole. The increase in the flux density leads to the saturation and decreases the flux per pole slightly.

148. (c)

The airgap is kept as small as possible in induction motors to improve power factor and decrease no load current.

149. (a)

A squirrel cage rotor slots are semi closed or fully closed to reduce teeth loss and magnetizing current.

150. (c)

Orientation polarization is inversely proportional to temperature.

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