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ESE 2020 : Prelims Exam
CLASSROOM TEST SERIES

E & T ENGINEERING

Test 10

Section A : Signals & Systems + Basic Electrical Engineering

Section B : Analog and Digital Communication Systems-1

Section C : Electronic Devices & Circuits-2 + Advanced Communication Topics-2

1.	(b)	**16.**	(b)	**31.**	(b)	**46.**	(b)	**61.**	(c)
2.	(c)	**17.**	(b)	**32.**	(b)	**47.**	(c)	**62.**	(d)
3.	(a)	**18.**	(d)	**33.**	(c)	**48.**	(a)	**63.**	(b)
4.	(c)	**19.**	(b)	**34.**	(c)	**49.**	(d)	**64.**	(c)
5.	(c)	**20.**	(a)	**35.**	(b)	**50.**	(d)	**65.**	(d)
6.	(c)	**21.**	(d)	**36.**	(b)	**51.**	(a)	**66.**	(d)
7.	(b)	**22.**	(a)	**37.**	(c)	**52.**	(c)	**67.**	(b)
8.	(b)	**23.**	(c)	**38.**	(c)	**53.**	(c)	**68.**	(d)
9.	(d)	**24.**	(c)	**39.**	(b)	**54.**	(c)	**69.**	(c)
10.	(c)	**25.**	(c)	**40.**	(b)	**55.**	(d)	**70.**	(a)
11.	(d)	**26.**	(a)	**41.**	(d)	**56.**	(c)	**71.**	(a)
12.	(b)	**27.**	(d)	**42.**	(a)	**57.**	(d)	**72.**	(d)
13.	(d)	**28.**	(c)	**43.**	(a)	**58.**	(b)	**73.**	(d)
14.	(c)	**29.**	(a)	**44.**	(b)	**59.**	(a)	**74.**	(a)
15.	(c)	**30.**	(c)	**45.**	(c)	**60.**	(d)	**75.**	(a)

E&T_Test 10_Detailed Explanation
Section A : Signals & Systems + Basic Electrical Engineering

1. (b)

$$\text{Flux} = \frac{\text{Voltage}}{\text{Frequency}}$$

If f is decreased then flux is increased
flux ↑ then B↑
As flux density is increased, large magnetization current is flown through transformer primary and transformer may start to smoke.

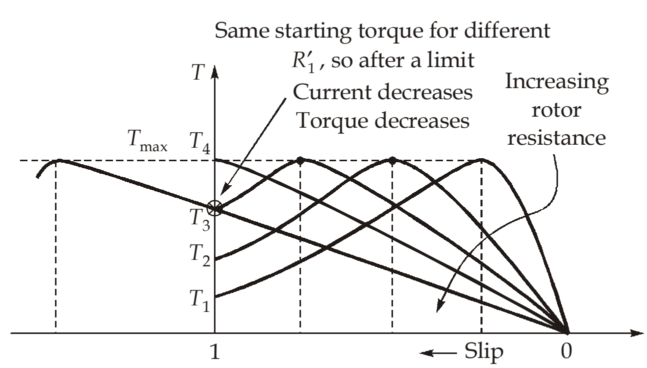
2. (c)
In order to avoid saturation in stator and rotor cores which would cause sharp increase in magnetizing current, the flux ϕ_r must be kept constant as 'f' is varied. To achieve this when 'f' is varied, 'V' must also be varied such that $\left(\frac{V}{f}\right)$ remains constant.

3. (a)
In a practical transformer the flux increases when leading load is applied and decreases when lagging load is applied.

4. (c)
Power input to motor, $P_1 = 50$ kW
stator losses $= 1$ kW
Power input to rotor, $P_2 =$ Input to motor – stator losses $= 50 - 1 = 49$ kW
Slip, $s = 4\%$ or 0.04
Total mechanical power developed,

$$P_{mech} = P_2(1 - s)$$
$$P_{mech} = 49(1 - 0.04)$$
$$= 49 \times 0.96 = 47.04 \text{ kW}$$

5. (c)



As R increases, starting torque increases upto maximum torque ($T_4 = T_{max} > T_3 > T_2 > T_1$) but rotor consumes more power so copper loss increases and efficiency decreases.

6. (c)

Power output, $P_0 = 380$ watts

Power input, $P_{in} = VI\cos\phi$

$= 230 \times 3 \times 0.7 = 483$ W

Motor efficiency, $\eta = \frac{P_o}{P_{in}} \times 100 = \frac{380}{483} \times 100$

$= 78.67\%$

7. (b)

Generated emf, $E_g = V + I_a R_a$

and back emf, $E_m = V - I_a R_a$

Now, $E_a \propto N$

$\therefore \quad \frac{E_m}{E_g} = \frac{V - I_a R_a}{V + I_a R_a} < 1$

or, $\frac{N_m}{N_g} < 1$ or $N_m < N_g$ or $N_m < 1000$ rpm

8. (b)

Given, $T \propto N^2$

Also, $T \propto \phi I_a$

or, $T \propto I_a^2$ (Since, $\phi \propto I_a$ in unsaturated region)

Hence, $\left(\frac{N_2}{N_1}\right)^2 = \left(\frac{I_{a2}}{I_{a1}}\right)^2$ or $\frac{I_{a2}}{I_{a1}} = \frac{N_2}{N_1}$

or, $I_{a2} = \frac{900}{500} \times 25 = 45$ A

9. (d)

Emf generated, $E_a = (\text{Voltage induced per conductor}) \times \frac{Z}{A}$

Here, $P = A = 6$ = Number of parallel paths (due to LAP winding)

$\therefore \quad E_a = 3 \times \frac{480}{6} = 240$ volts

10. (c)

For 750 rpm, back emf $E_{a1} = 220 - 40\,(0.5) = 200$ V ...(i)

For 500 rpm, back emf $E_{a2} = 220 - 40\,(R_s + 0.5)$ ...(ii)

As we know that, back emf $E_a \propto N$ ($\therefore \phi \propto I_a$ = constant)

or, $\frac{E_{a2}}{E_{a1}} = \frac{N_2}{N_1}$

From equation (i) and (ii), we get,

$$\frac{220-40(R_s+0.5)}{200} = \frac{500}{750}$$

$$220 - 20 - 40\,R_s = \frac{2}{3}\times 200$$

$$R_s = \left(200-\frac{2}{3}\times 200\right)\times\frac{1}{40} = \frac{1}{3}\times\frac{200}{40} = \frac{5}{3} = 1.67\ \Omega$$

11. (d)

We know that, eddy current loss $P_e \propto V^2$

and hysteresis loss, $$P_h \propto \frac{V^{1.6}}{f^{0.6}}$$

When V = constant, P_e = constant

and $$P_h \propto \frac{1}{f^{0.6}}$$

When frequency is decreased from 60 Hz to 50 Hz, P_h will increase. Thus, core loss will increase marginally, therefore efficiency will decrease marginally.

12. (b)

Permeability of core in ideal transformer tends to infinite.

$$\text{Reluctance} = \frac{l}{\mu_0\mu_r A} \text{ will tends to 0}$$

$$\text{mmf} = NI = \text{flux} \times \text{reluctance}$$

$$\Rightarrow \quad I = \text{flux} \times 0$$

$$\Rightarrow \quad I \approx 0$$

13. (d)

$$V.R = r_{pu}\cos\theta \pm x_{pu}\sin\theta$$

('+' for lagging load, '–' for leading load)

$$r_{pu} = \frac{10\text{ kW}}{100\text{ kVA}} = 0.1$$

$$x_{pu} = 0.4$$

$$\cos\theta = 0.9 \text{ leading}$$

$$\sin\theta = 0.435$$

$$V.R = [(0.1\times 0.9)-(0.435\times 0.4)]\times 100$$

$$V.R = -8.4\%$$

14. (c)

$$\frac{\text{Rotor Gross Output}}{\text{Rotor Input}} = 1 - s = \frac{N}{N_s}$$

$$\frac{1800}{2000} = 1 - s \Rightarrow s = 0.1 \text{ or } 10\%$$

$$1 - 0.1 = \frac{810}{N_s} \Rightarrow N_s = 900 \text{ rpm}$$

$$f' = sf \Rightarrow 6 = 0.1 \times f \Rightarrow f = 60 \text{ Hz}$$

$$N_s = \frac{120f}{P}$$

$$900 = \frac{120 \times 60}{P}$$

$$P = \frac{120 \times 60}{900} = 8$$

15. (c)

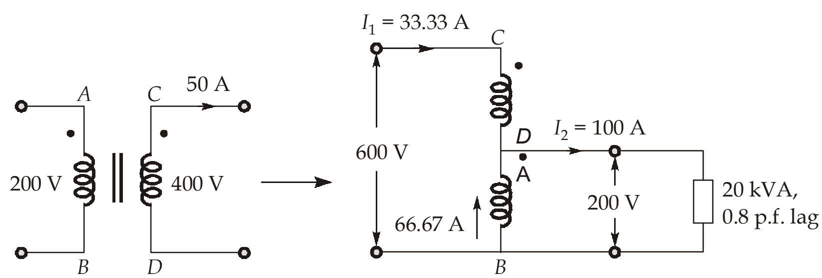
Two winding must be connected in series with the proper polarity so that 600 V can be applied across the total windings.

With 20 kVA load, load current

$$I_2 = \frac{20 \times 1000}{200} = 100 \text{ A}$$

$$I_1 = \frac{20 \times 1000}{600} = 33.33 \text{ A}$$

$$\text{current in common winding} = (100 - 33.33) \text{ A} = 66.67 \text{ A}$$



For auto transformer rating,

$$S_{auto} = \frac{S_{TW}}{1 - x}$$

Where, $x = \frac{200}{600}$

then $S_{auto} = \dfrac{20 \text{ kVA}}{1 - \frac{1}{3}} = 30 \text{ kVA}$

16. (b)

$$N\phi = Li$$

$$E = \frac{1}{2}Li^2 = \frac{1}{2}\left(\frac{N\phi}{i}\right)i^2 = \frac{1}{2}N\phi i$$

$$= \frac{1}{2} \times 1000 \times 10^{-3} \times 1 = \frac{1}{2} J$$

17. (b)

$$P_e \propto V^2 \Rightarrow P_e \text{ (at 330 V)}$$
$$= \left(\frac{330}{220}\right)^2 \times 50$$
$$= 112.5 \text{ W}$$

18. (d)

At maximum efficiency, variable loss = fixed loss

$$x^2 (P_{cu,\ FL}) = P_{iron}$$
$$x = \sqrt{\frac{40.5}{50}} = 0.9$$

19. (b)

$$E = k\,\phi\,\omega_m$$
$$\omega_m = \frac{E}{k\phi}$$

20. (a)

21. (d)

Supply frequency, $f = \frac{PN_s}{120} = \frac{1000 \times 6}{120} = 50 \text{ Hz}$

as the rotor frequency (f') = 2 Hz,

$\Rightarrow$ $s = \frac{f'}{f} = \frac{2}{50} = 0.04$

$\therefore$ $N_s = \frac{120 \times 50}{8} = 750 \text{ rpm}$

$\therefore$ $N_r = N_s(1 - s)$

$= 750\ (1 - 0.04) = 720$ rpm

22. (a)

In braking mode (at W), the motor runs in opposite direction to the rotating magnetic field, i.e., rotor speed (N_r) is negative.

So, in braking mode, slip (s) $= \frac{N_s - N_r}{N_s} = \frac{N_s + |N_r|}{N_s} > 1$

23. (c)

- Salient pole machines are used for low speed (120 to 150 rpm).
- Windage losses are less in cylindrical rotor machines.

24. (c)

1. $$\cos\left(\frac{\pi}{3}n\right)+\sin\left(\frac{\pi}{3}n\right) \Rightarrow \text{periodic}$$

$$\text{Period} = \frac{2\pi\times 3}{\pi} = 6$$

2. $$\cos\left(\frac{1}{2}n\right)+\cos\left(\frac{1}{3}n\right) \Rightarrow \text{non-periodic}$$

3. $$\text{Even }\{\cos(4\pi t)u(t)\} = \frac{\cos(4\pi t)\,u(t)+\cos(-4\pi t)u(-t)}{2} = \frac{\cos 4\pi t}{2} \Rightarrow \text{Periodic}$$

4. $$\text{Even }\{\sin(4\pi t)u(t)\} = \frac{\sin(4\pi t)u(t)+\sin(-4\pi t)u(-t)}{2} \Rightarrow \text{non-periodic}$$

25. (c)

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

$$\begin{array}{r|ccccccc}
x(n) \Rightarrow & \underset{\bullet}{1} & 2 & 3 & 4 & & & \\
h(n) \Rightarrow & \underset{\bullet}{5} & 6 & 7 & 8 & & & \\
\hline
 & \underset{\bullet}{5} & 6 & 7 & 8 & & & \\
 & & 10 & 12 & 14 & 16 & & \\
 & & & 15 & 18 & 21 & 24 & \\
 & & & & 20 & 24 & 28 & 32 \\
\hline
x(n)*h(n) \Rightarrow & \underset{\bullet}{5} & 16 & 34 & 60 & 61 & 52 & 32
\end{array}$$

$$y(n) = \{\underset{\uparrow}{5}, 16, 34, 60, 61, 52, 32\}$$

So, $$y(3) = 60$$

26. (a)

$$I = \int_{-\infty}^{\infty} \cos(2\pi t)\, e^{-t^2/2}\delta(1-2t)\, dt$$

$$= \int_{-\infty}^{\infty} \cos(2\pi t)\, e^{-t^2/2}\frac{1}{2}\delta\left(t-\frac{1}{2}\right) dt$$

$\because$ $f(t)\,\delta(t - t_0) = f(t_0)\delta(t - t_0)$ and area under impulse is 1,

$$I = \frac{1}{2}\times\cos\left(2\pi\times\frac{1}{2}\right)\times e^{-1/8} = -\frac{1}{2}e^{-1/8}$$

27. (d)

- If $x(t)$ is periodic with time period T, then $y(t) = x(2t)$ will be periodic with time period $T/2$.
- Sum of two discrete time periodic signals is always periodic.

28. (c)

$$\frac{\pi}{j}[\delta(\omega-1)-\delta(\omega+1)]\xrightarrow{IFT}\sin t$$

$$2[\delta(\omega-1)-\delta(\omega+1)]\xrightarrow{IFT}\frac{2j}{\pi}\sin t$$

$$3[\delta(\omega-2\pi)+\delta(\omega+2\pi)]\xrightarrow{IFT}\frac{3}{\pi}\cos 2\pi t$$

So, correct answer is (c).

29. (a)

$$h[n] = 3\delta[n-1] + 2\delta[n-2] + \delta[n-3]$$
$$H(z) = 3z^{-1} + 2z^{-2} + z^{-3}$$
$$H(1) = 3 \times 1 + 2 \times 1 + 1 = 6$$

30. (c)

31. (b)

$$u(n)\xleftrightarrow{ZT}\frac{1}{1-z^{-1}} \qquad \text{ROC}|z|>1$$

using time reversal property $x(-n)\xleftrightarrow{ZT}X(z^{-1})$

we get, $$u(-n)\xleftrightarrow{ZT}\frac{1}{1-z} \qquad \text{ROC}|z|<1$$

32. (b)

Since, $$x(n) = \frac{1}{2\pi}\int_{-\pi}^{\pi} X(\omega)e^{j\omega n}d\omega$$

$$x(0) = \frac{1}{2\pi}\int_{-\omega_0}^{\omega_0}(1)d\omega = \frac{\omega_0}{\pi}$$

33. (c)

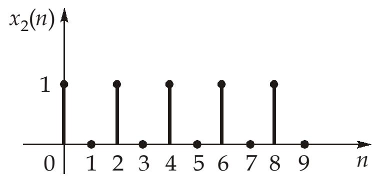
34. (c)

$$X[k] = \sum_{n=0}^{N-1} x(n)e^{-jk\frac{2\pi}{N}n} = \sum_{n=0}^{3} x(n)e^{-j\frac{kn\pi}{2}}$$

$$X[0] = \sum_{n=0}^{3} x(n) = 1+2j$$

$$X[2] = [j - 0 + j - 1] = -1 + 2j$$
$$X[1] = j + j[-j]^2 + [-j]^3 = j$$
$$X[3] = X^*[1] = -j$$
$$X[k] = [1 + 2j, j, -1 + 2j, -j]$$

35. (b)



$$x_2(n) = \delta(n) + \delta(n-2) + \delta(n-4) + \delta(n-6) + \delta(n-8)$$

$$X_2(e^{j\omega}) = 1 + e^{-j2\omega} + e^{-j4\omega} + e^{-j6\omega} + e^{-j8\omega}$$

$$= \frac{1-e^{-j10\omega}}{1-e^{-j2\omega}} = \frac{e^{-j5\omega}(e^{j5\omega}-e^{-j5\omega})}{e^{-j\omega}(e^{j\omega}-e^{-j\omega})} = e^{-j4\omega}\,\frac{\sin(5\omega)}{\sin(\omega)}$$

36. (b)

Given, $x(t) = \delta(2t+1)$

$$\delta(t) \xleftrightarrow{\text{LT}} 1$$

$$\delta(t+1) \xleftrightarrow{\text{LT}} e^{s}$$

$$\delta(2t+1) \xleftrightarrow{\text{LT}} \frac{1}{2}e^{s/2} = 0.5e^{0.5s}$$

37. (c)

38. (c)

39. (b)

$$y(n) = Ax(n-n_0) = A\sin(\omega_0(n-n_0)+\phi)$$

$$y(n) = A\sin(\omega_0 n - \omega_0 n_0 + \phi) \quad \text{...(1)}$$

also since system is LTI, $y(n) = M\sin(\omega_0 n + \phi')$ ...(2)

where $M = |H(e^{jw})|$

and $\phi' = \phi + \angle H(e^{j\omega})$ ...(3)

So comparing eq. (1) and (2),

we get, $\phi' = -n_0\omega_0 + \phi$ ...(4)

Comparing (3) and (4) we get,

$$\angle H(e^{j\omega}) = -n_0\omega_0 + 2\pi k$$

40. (b)

$$y'(t) - 4y(t) = x(t)e^{-4t}; \text{ [where } x(t) = u(t)]$$

by taking Fourier transform, we get

$$j\omega Y(j\omega) - 4Y(j\omega) = \frac{1}{4+j\omega}$$

$\Rightarrow$ $$Y(j\omega) = \frac{1}{(4+j\omega)(j\omega-4)} = -\frac{1}{4^2+\omega^2}$$

and $$Y(j\omega) \xrightarrow{IFT} -\frac{1}{8}e^{-4|t|}$$

41. (d)

42. (a)

43. (a)

As we know, induced emf in transformer

$$E \propto \phi f$$

For same emf, $\phi f = \text{constant}$

$$\phi_1 f_1 = \phi_2 f_2$$

$$B_1 A_1 f_1 = B_2 A_2 f_2 \quad [\because \phi = BA]$$

For same flux density, $B_1 = B_2$

$$A_1 f_1 = A_2 f_2$$

For high frequency, $f_2 > f_1$

$$A_2 < A_1$$

So the size of the transformer gets reduced.

44. (b)

45. (c)

For a memoryless LTI system,

$\Rightarrow$ $h(n) = b_0\, \delta(n)$

taking z transform we get, $H(z) = b_0$

which has no poles or no zeroes.

Section B : Analog and Digital Communication Systems-1

46. (b)

Modulation does not reduce the bandwidth.

47. (c)

$$A_c + \mu A_c = E_{\max} = 26.35 \text{ V}$$

$$A_c - \mu A_c = E_{\min} = 23.65 \text{ V}$$

So, $$A_c = \frac{E_{\max} + E_{\min}}{2} = \frac{50}{2} = 25 \text{ V}$$

48. (a)

49. (d)

50. (d)

In AM, $\mu = K_a |m(t)|_{\max}$

In FM, $$\beta_{FM} = \frac{K_f |m(t)|_{\max}}{f_{m(\max)}}$$

In PM, $\beta_{PM} = K_p |m(t)|_{\max}$

So, in both AM and PM, the modulation index is independent of the maximum frequency of the message signal.

51. (a)

PM signal,
$$s(t) = A_c \cos[2\pi f_c t + \phi(t)]$$
$$\phi(t) = k_p m(t)$$
$$\Delta f_{max} = \frac{k_p}{2\pi}\left|\frac{dm(t)}{dt}\right|_{max}$$

$\left|\frac{dm(t)}{dt}\right|$ is maximum at zero crossings.

52. (c)

The given FM signal can be expressed as,
$$s(t) = \cos\left[2\pi f_c t + 5\left(\frac{3}{5}\cos(5000t) + \frac{4}{5}\sin(5000t)\right)\right]$$

Let, $\cos\alpha = \frac{3}{5}$ and $\sin\alpha = \frac{4}{5}$. Then,
$$s(t) = \cos\left[2\pi f_c t + 5\cos(5000t - \alpha)\right] = \cos\left[2\pi f_c t + \beta\cos(\omega_m t - \alpha)\right]$$

So, the modulation index is $\beta = 5$.

53. (c)

$$T_{eq} = T_{ant} + T_{rec} = 3600 \text{ K}$$

Power gain, $G = 10^8$ (80 dB)

Bandwidth, $B = 40$ MHz

Output noise power,
$$N_{out} = kT_{eq}BG = 1.38 \times 10^{-23} \times 3600 \times 4 \times 10^7 \times 10^8 \text{ W}$$
$$= 1.38 \times 36 \times 4\ \mu\text{W} = 198.72\ \mu\text{W} \simeq 200\ \mu\text{W}$$

54. (c)

$$\int_{-\infty}^{\infty} f_X(x)dx = 1$$
$$\int_0^1 K(x - x^2)dx = 1$$
$$K\left[\frac{x^2}{2} - \frac{x^3}{3}\right]_0^1 = 1$$
$$K\left[\frac{1}{2} - \frac{1}{3}\right] = K\left[\frac{3-2}{6}\right] = 1$$
$$K = 6$$

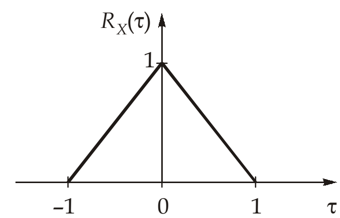
55. (d)

$$f_X(x) = \frac{1}{\sqrt{2\pi}} e^{-x^2/2}; -\infty < x < \infty$$

$$Y = |X|$$

$$f_Y(y) = \frac{2}{\sqrt{2\pi}} e^{-y^2/2}; 0 < y < \infty = \sqrt{\frac{2}{\pi}} e^{-y^2/2}; \quad 0 < y < \infty$$

56. (c)



$$R_X(\tau) = \text{rect}(\tau) * \text{rect}(\tau)$$

$$\text{rect}(\tau) \xleftrightarrow{CTFT} \text{sinc}(f)$$

So, $$S_X(f) = \text{sinc}^2(f)$$

$$= \left[\frac{\sin(\pi f)}{(\pi f)}\right]^2$$

$$= \frac{\sin^2(\pi f)}{\pi^2 f^2}$$

$$S_X(\omega) = \frac{4\sin^2(\omega/2)}{\omega^2} = \frac{2}{\omega^2}[1 - \cos(\omega)]$$

57. (d)

$$P_X = \frac{1}{2\pi}\int_{-\infty}^{\infty} S_X(\omega)d\omega = \frac{1}{2\pi}\int_{-\infty}^{\infty} \frac{1}{(1+\omega^2)^2} d\omega \text{ W}$$

Let, $\omega = \tan\theta \quad \Rightarrow \quad d\omega = \sec^2\theta \, d\theta$

$$P_X = \frac{2}{2\pi}\int_0^{\pi/2} \frac{\sec^2\theta}{\sec^4\theta} d\theta = \frac{1}{\pi}\int_0^{\pi/2} \cos^2\theta \, d\theta \text{ W}$$

$$= \frac{1}{\pi}\int_0^{\pi/2} \frac{1+\cos(2\theta)}{2} d\theta = \frac{1}{2\pi}\left(\frac{\pi}{2}\right) = \frac{1}{4}\text{W} = 0.25 \text{ W}$$

58. (b)

For proper operation of the receiver, the minimum bandwidth of the IF amplifier should be equal to 10 kHz.

$$(\text{BW})_{\text{IF (min)}} = 10 \text{ kHz}$$

Given that, IF amplifier is tuned to 450 kHz.

So, $$Q_{\text{IF(max)}} = \frac{f_r = \text{IF}}{(\text{BW})_{\text{IF(min)}}} = \frac{450}{10} = 45$$

59. (a)

60. (d)

The adjacent samples of a white Gaussian process are highly uncorrelative.

Section C : Electronic Devices & Circuits-2 + Advanced Communication Topics-2

61. (c)

Drain current, $I_D = k_n[V_{GS} - V_T]^2$

For the given circuit, $V_{GS} = 0$

$$\therefore \quad I_D = k_n(V_T)^2 = 0.1 \times 4 \text{ mA}$$

$$I_D = 0.4 \text{ mA}$$

KVL at outer loop,

$$V_{DD} - V_{DS} - I_D R_S = 0$$

$$V_{DS} = V_{DD} - I_D R_S$$

$$= 5 - 0.4 \times 10^{-3} \times 5 \text{ k}$$

$$V_{DS} = 3 \text{ V}$$

62. (d)

63. (b)

Common base current gain (α) will increase by increasing the reverse biasing voltage across the collector-base junction.

64. (c)

Given, width of base region, $W_B = 10^{-3}$ cm

Diffusion constant, $D_p = 10 \text{ cm}^2/\text{s}$

$$\therefore \quad \tau_t = \frac{W_B^2}{2D_P} = \frac{(10^{-3})^2}{2\times 10} \text{ s} = 50 \text{ ns}$$

65. (d)

All the given parameters effect the flat-band voltage of a practical MOS capacitor.

66. (d)

We know that,

For JFET, $$I_D = I_{DSS}\left[1 - \frac{V_{GS}}{V_P}\right]^2$$

given, $$I_D = \frac{1}{4} I_{DSS}$$

$$\therefore \quad \left[1 - \frac{V_{GS}}{V_P}\right]^2 = \frac{1}{4}$$

$$1 - \frac{V_{GS}}{V_P} = \frac{1}{2}$$

$$\therefore \quad V_{GS} = \frac{V_P}{2}$$

67. (b)

$$T^2 \propto a^3$$

T = orbital period; a = radius of the orbit

a = orbit height (h) + Earth's radius (r_E)

$$a \propto T^{2/3}$$

$$\frac{a_2}{a_1} = \left(\frac{T_2}{T_1}\right)^{2/3}$$

$$T_2 = 1.728T_1 \qquad [\because T_2 \text{ is 72.8\% higher than } T_1]$$

$$a_1 = h_1 + r_E = 3600 + 6400 = 10000 \text{ km}$$

$$\frac{a_2}{a_1} = \left(\frac{T_2}{T_1}\right)^{2/3} = (1.728)^{2/3} = (1.2^3)^{2/3}$$

$$a_2 = (1.2)^2 a_1 = 1.44a_1 = 14400 \text{ km}$$

$$h_2 = a_2 - r_E = 14400 - 6400 = 8000 \text{ km}$$

68. (d)

69. (c)

$$(C/N)_{down} = (C/N)_{up} = 100 \qquad [\because 10 \log_{10}(100) = 20 \text{ dB}]$$

$$(C/N)_{overall} = \left[\frac{1}{\left(\frac{N}{C}\right)_{up} + \left(\frac{N}{C}\right)_{down}}\right] = \left[\frac{1}{0.01 + 0.01}\right] = 50$$

In decilogs, $$\left[\frac{C}{N}\right]_{overall} = 10 \log_{10}(50) \simeq 17 \text{ dB}$$

70. (a)

71. (a)

72. (d)

$$(\text{FSL}) = \left(\frac{4\pi d}{\lambda}\right)^2 = \left(\frac{4\pi df}{c}\right)^2$$

73. (d)

74. (a)

75. (a)

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