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Engineering Academy

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ESE- 2018 (Prelims) - Offline Test Series Test- 7

ELECTRONICS & TELECOMMUNICATION ENGINEERING

SUBJECT: ELECTRONIC MEASUREMENTS & INSTRUMENTATION + BASIC ELECTRONICS ENGINEERING (EDC & VLSI) + ANALOG & DIGITAL COMMUNICATION SYSTEMS

SOLUTIONS

01. Ans: (b)

02. Ans: (b)

Sol: $R_{se} = R_m\left[\frac{V}{V_{in}} - 1\right]$

$= 200\left[\frac{500}{50\mu A \times 200} - 1\right]$

$= 20000 \times 500 - 200 = 9.99\ M\Omega$

03. And: (d)

04. Ans: (d)

05. Ans: (a)

06. Ans: (a)

Sol: $M = -8\cos(\theta + 60^0)mH$

$\frac{dM}{d\theta} = 8\sin(\theta + 60^0)mH$

$T_d = I^2\frac{dM}{d\theta}$

$= [25\times10^{-3}]^2\times[8\sin90^0]\times10^{-3}$

$= 5000 \times10^{-9}$

$= 5\ \mu N\text{-}m$

07. Ans: (d)

08. Ans: (b)

09. Ans: (d)

Sol: Energy Consumed = Power × time

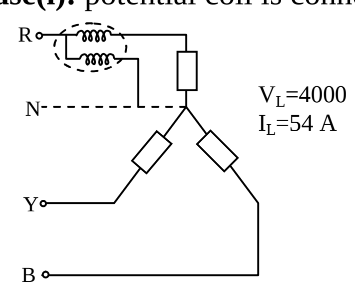
$= \frac{450}{1000}\times\frac{100}{3600} = \frac{1}{80}$ kWh

Meter Constant (k) $= \frac{rev}{kwh} = \frac{10}{(1/80)} = 800$

10. Ans: (b)

11. Ans: (b)

Sol **Case(i):** potential coil is connected across R



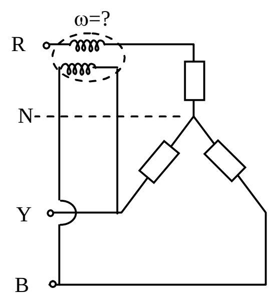
Wattmeter reading = 10 kW

$= V_{ph}I_{ph}\cos\phi$

$10\ kW = \frac{V_L}{\sqrt{3}}\ I_L\cos\phi$

$\cos\phi = 0.8$

Case (ii): The potential coil reconnected across B-Y phases



$\cos\phi = 0.8$; $\sin\phi = 0.6$

wattmeter reads, $V_L I_L \sin\phi$

$= 400 \times 54 \times 0.6$

$= 12.96$ kW

≈ 13 kW

12. Ans: (b)

13. Ans: (b)

Sol: During the retrace time or flyback time, the beam returns quickly to the left side of the screen.

14. Ans: (a)

15. Ans: (c)

Sol: No part of the coil is allowed to reach the extreme positions near the pole tips where, there is fringing field. Owing to fringing the flux density near the pole tips is smaller than that at the centre and also the field is not radial. Thus the angular span is restricted to 90°.

16. Ans: (c)

17. Ans: (a)

Sol: $\dfrac{I_1}{I_2} = \dfrac{250}{5}$

$\dfrac{I_1}{2.7} = \dfrac{250}{5}$

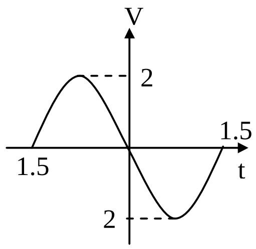
$I_1 = 135$ A

18. Ans: (a)

Sol: Wagner's earth device removes all the earth capacitances from the bridge network

19. Ans: (a)

Sol:



$$\frac{\text{time}}{\text{disvision}} = 10\mu s$$

$$\frac{\text{volt}}{\text{division}} = 200 \text{ mV}$$

Here the wave repeats for every 3 divisions.

Time period T = 10 μs × 3 = 30 μs.

Frequency $1/T = \dfrac{1}{30\times10^{-6}} = 33.33\text{kHz}$ and

Number of division for peak to peak is 4.

$\therefore$ Peak to peak voltage = $4\times\dfrac{\text{voltage}}{\text{division}}$

= 4×200 = 800 mV

20. Ans: (a)

Sol: An n-bit Flash type A/D converter requires 1 CLK cycle for total conversion. It uses 2^n-1 comparators, so hardware implementation is complex.

21. Ans: (a)

22. Ans: (b)

Sol: Vibrating reed frequency-meter indicates the supply frequency by means of individual reeds, when, rated voltage is applied across the terminals of the meter, the particular reed whose, natural frequency of vibration coincides with the supply frequency, vibrate with full amplitude.

23. Ans: (b)

Sol: In an energy meter the pressure coil current should lag voltage across pressure coil by 90° for accurate readings. Hence pressure coil circuit is designed in such a way that it is highly inductive and has low resistance

24. Ans: (b)

25. Ans: (c)

Sol: A transistor is said to be unstabilized when its operating point is shifted. Operating point is nothing but zero signal values of collector current (I_c) and collector to emitter voltage (V_{CE}). If either of the two parameters changes, the operating point is shifted. Again, we know $I_C = \beta I_B$;
If I_B getting changed then I_C will also get changed by β times of I_B

26. Ans: (a)

Sol: $I_{DS} = I_{DSS}\left(1-\frac{V_{GS}}{V_P}\right)^2$

Given that, $I_{DS} = 6.4 \times 10^{-3}$A

$V_P = 5$V

$I_{DSS} = 10 \times 10^{-3}$ A

$\therefore 6.4\times10^{-3} = 10\times10^{-3}\left(1-\frac{V_{GS}}{-5}\right)^2$

$1-\frac{V_{GS}}{-5} = \sqrt{0.64}$

$= 0.8$

$-5 - V_{GS} = -4$

$\Rightarrow -V_{GS} = 1$

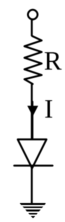
$V_{GS} = -1$

Now, $I_{DS}R_S = V_{GS} = -1$V

$|R_S| = 156\Omega$

27. Ans: (c)

Sol: For a given voltage reference diode the reverse current depends on the circuit through which this resistance is connected



28. Ans: (c)

Sol: Slope of the line between B and C points gives the electric field E between them

$\therefore E = \frac{6}{2\times10^{-4}}\frac{V}{cm}$

$= 3 \times 10^4$ V/cm

Drift velocity $V_s = \mu_n .E$

$V_s = 4000\ (3 \times 10^4)$

$= 12 \times 10^7$ cm/s

Time taken for electron to move from B to C $= \frac{\ell}{V_s}$

$= \frac{2\times10^{-4}}{12\times10^7}$

$= 1.66$ps

29. Ans: (b)

Sol: As the oxidation time is very long, so it will produce thick oxide layer

So the oxide layer thickness t_{ox} will be $\sqrt{Bt}$

Now, B/A = 23μm/h

$\therefore B = 0.213 \times 3$

$= 0.64\mu m^2/h$

$\therefore t_{ox} = \sqrt{0.64\times18} = 0.8\times3\times\sqrt{2} = 3.4\mu m$

30. Ans: (d)

Sol: Given L = 0.6m

We know

$$\Delta f = \frac{C}{2\times L}$$

$$= \frac{3\times10^8}{2\times0.6}$$

$= 250$MHz

31. Ans: (c)

Sol: $S = \overline{A+B} = \overline{A}\ \overline{B}$

$$Y = \overline{\overline{A}\,\overline{B}\,\overline{C}\,(\overline{D}+D) + A\overline{B}\,\overline{C}\,(\overline{D}+D)}$$

$$= \overline{\overline{A}\,\overline{B}\,\overline{C} + A\overline{B}\,\overline{C}}$$

$$= \overline{\overline{B}\,\overline{C}\,(\overline{A}+A)}$$

$$= \overline{\overline{B}\,\overline{C}} = \overline{\overline{B}} + \overline{\overline{C}} = B + C$$

32. Ans: (b)

Sol: The required condition for thermal stability is that the rate at which heat is released at the collector junction must not exceed the rate at which the heat can be dissipated under steady state conditions.

33. Ans: (d)

Sol: Under optical excitation hole and electrons are generated in pairs. So, excess carrier generation by optical excitation are equal for both majority and minority carriers.

But, in low-level injection
[Let consider a p-type material]
Total majority carrier concentration
$= P_0+\Delta P$; Where $\Delta P << P_0$

And total minority carrier concentration
$= n_0+\Delta n$; Where $\Delta n >> n$

$\therefore$ With optical excitation (under the low-level injection approximation), there is a very large change in the minority carrier concentration, where as the change in the majority carrier concentration is hardly noticeable.

34. Ans: (a)

35. Ans: (b)

Sol: When breakdown voltage is applied a very strong electric field appears across narrow depletion layer which breaks the bonds. So, we can state that Zener breakdown occurs due to rapture of covalent bonds.

36. Ans: (c)

Sol: Bulk resistance of the diode can be written as

$r_B = \dfrac{V - V_K}{I_f}$, where V_K = knee voltage

$$r_B = \frac{1.3-0.7}{120\text{mA}} = \frac{6}{120\text{mA}} = 5\Omega$$

The ac resistance is given by

$R_{ac} = r_B + r_j$ [where r_j is junction resistance]

$$r_j = \frac{25\text{mV}}{2.5\text{mA}} = 10\Omega$$

$r_{ac} = 5+10 = 15\,\Omega$

37. Ans: (b)

Sol: For LED

η_{ext} = Internal radiative efficiency

$\times$ extraction efficiency;

η_{ext} = external quantum efficiency;

Which is defined as the light output divided by the electrical input power.

38. Ans: (c)

Sol: $\theta_{ca} = \theta_{ja} - \theta_{jc} = (12 - 8)\ ^oC/W = 4\ ^oC/W$

$T_{junction/internal} = T_{ambient} + \theta_{ca}.P$

$$P = \frac{35-18}{4} = 4.25 \text{Watt}$$

39. Ans: (b)

40. Ans: (d)

Sol: $n_i^2(T) = A\,T^3\,e^{(-Eg/KT)}$

$$n_i(T) = A^{\frac{1}{2}}\,T^{\frac{3}{2}}\,e^{(-Eg/2KT)}$$

41. Ans: (c)

Sol: $C_T = A\sqrt{\dfrac{\in qN_D}{2(V_0 - V_d)}}$

$\therefore$ Depletion capacitance depends on
- Applied junction voltage (V_D)
- Junction built in potential (V_0)
- Doping profile (N_D).

42. Ans: (d)

Sol: Fabrication of a buried layer n-p-n transistor, the processes involved are:
1. Lithography
2. Oxidation
3. Epitaxy
4. Diffusion

43. Ans: (b)

Sol: Metallization means formation of connection pattern and bonding pads

44. Ans: (a)

Sol: This configuration is also known as emitter follower. The properties are: high input impedance, very low output impedance, a unity (or less) voltage gain and a high current gain. This circuit is also used extensively as a voltage buffer.

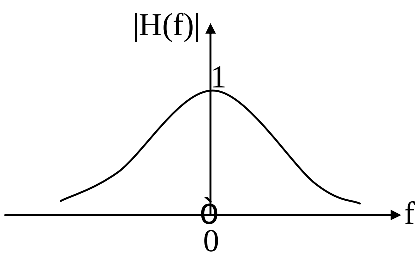
45. Ans: (a)

Sol: Noise equivalent bandwidth is given by

$$B_{eq} = \frac{\int_{-\infty}^{\infty} |H(f)|^2\, df}{2|H_{max}|^2}$$

For an RC first order LPF

$$H(f) = \frac{1}{1 + j2\pi fRC}$$



$$\int_{-\infty}^{\infty} |H(f)|^2 = \int_{-\infty}^{\infty} \frac{1}{1+4\pi^2 f^2 \tau^2} df$$

$$= 2\int_{0}^{\infty} \frac{1}{1+4\pi^2 f^2 \tau^2} df \quad \text{[Note: } \tau = RC]$$

Take $2\pi f\tau = y$

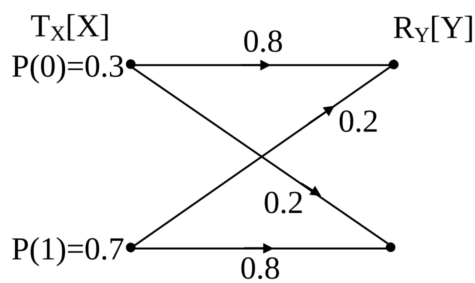
$2\pi\tau df = dy$

$$2\int_{0}^{\infty} \frac{1}{1+y^2}\frac{dy}{2\pi\tau} \Rightarrow \frac{1}{\pi\tau}\int_{0}^{\infty} \frac{1}{1+y^2} dy = \frac{1}{2\tau}$$

$$B_{eq} = \frac{\frac{1}{2\tau}}{2\times 1} = \frac{1}{4\tau} = \frac{1}{4RC}$$

46. Ans: (d)

Sol:



P[Y=1] = P[X=1]P[Y=1 / X = 1] + P[X = 0]

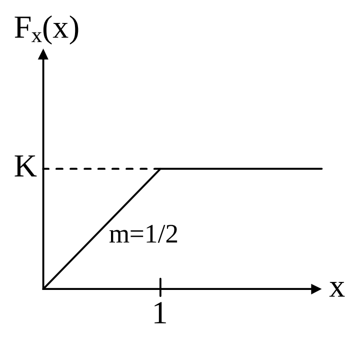
P[Y=1 / X=0]

P[Y=1] = 0.7×0.8 + 0.3×0.2

P[Y=1] = 0.56 + 0.06 = 0.62

47. Ans: (a)

Sol:



$F(\infty) = 1$

$\therefore$ K=1

$$P\left[\frac{1}{2} < x \le 1\right] = F[x=1] - F\left[x = \frac{1}{2}\right] = 1 - \frac{1}{4} = \frac{3}{4}$$

48. Ans: (c)

Sol: $\mu = 0$ [As mean value became ZERO]

$MSV = \sigma^2 = 10^{-8}$

$P[x>10^{-4}] = 1 - P[x \le 10^{-4}]$

$P[x \le 10^{-4}] = F[x = 10^{-4}]$

$P[x \le 10^{-4}] = 1 - Q\left[\dfrac{x-\mu}{\sigma}\right]$

$P[x \le 10^{-4}] = 1 - Q\left[\dfrac{10^{-4}-0}{10^{-4}}\right]$

$P[x \le 10^{-4}] = 1 - Q[1]$

$\therefore P[x>10^{-4}] = 1 - P[x \le 10^{-4}]$

$P[x>10^{-4}] = 1 - [1 - Q(1)]$

$P[x>10^{-4}] = Q(1)$

49. Ans: (c)

Sol: $K\int_0^\infty\int_0^\infty e^{-x-y}dxdy = 1$

$\therefore K = 1$

Taking $f(x) = e^{-x}$

$f(y) = e^{-y}$

And, $f(x,y) = f(x)\, f(y)$

$\therefore$ x and y are Independent Random variables.

$Cov[x,y] = E[xy] - E[x]\, E[y]$

When x and y are independent Random variables then

$E[xy] = E[x]\, E[y]$

$\therefore Cov[xy] = 0$

50. Ans: (b)

Sol: $f_1(\tau) = \sin(2\pi f_0\tau)$ ---- fails because it is a ODD function

$f_2(\tau) = \tau^2$ ---- Fails because value at $\tau = 0$ is becoming ZERO and not maximum value.

51. Ans: (b)

Sol: $P_{out} = 60$

$P_{in} = P_{out} + P_{loss} = 60+20$

$= 80W$

$\mu = 0.707$ [70.7%]

$P_{in} = P_c\left(1+\dfrac{\mu^2}{2}\right)$

$80 = P_c\left(1+\dfrac{1}{\left(\sqrt{2}\right)^2 \times 2}\right)$

$= P_c\left(\dfrac{5}{4}\right)$

$P_c = 80 \times \dfrac{4}{5} = 64W$

52. Ans: (a)

Sol: $P_t = P_c\left(1+\dfrac{\mu^2}{2}\right)$

$\mu = \dfrac{V_m}{V_{cc}} = \dfrac{150}{300} = \dfrac{1}{2}$

$P_t = 5K\left(1+\dfrac{1}{4\times 2}\right) = 5K \times \dfrac{9}{8}$

$P_t = 5.625\ kW$

53. Ans: (c)

Sol: $P_t = \frac{A_c^2 A_m^2}{8R} = \frac{(20)^2 \times (10)^2}{8\times 1} = \frac{400\times 100}{8}$

$= 5\text{kW}$

54. Ans: (c)

Sol: FOM FM $= \frac{3}{2}\beta^2$

FOM FM $= \frac{1}{2}\beta_P^2$

$\beta = \beta_P$

$\frac{\gamma_{FM}}{\gamma_{PM}} = 3$

55. Ans: (c)

Sol: $\Delta f = 3\times 2f_m$

$\frac{\Delta f}{f_m} = \beta = 6$

P_t in AM $= P_t = P_c\left(1+\frac{\mu^2}{2}\right)$

$= \frac{A_c^2}{2} + \frac{A_c^2\mu^2}{4}$

P_t in FM $= \frac{A_c'^2}{2}$

Given $A_c' \,|J_1(6)| = \frac{A_c\mu}{2}$

$\frac{A_c'^2}{2} = \frac{A_c^2}{2} + \frac{A_c^2\mu^2}{4}$

$J_1(6) = -0.28$

$\mu = \frac{2|J_1(6)|}{\sqrt{1-2J_1^2(6)}} = 0.61$

56. Ans: (b)

Sol: Overall noise figure for multistage is

$F = F_1 + \frac{F_2 - 1}{G}$

$= 100 + \frac{10-1}{10}$

$= 100.9$

57. Ans: (c)

Sol: Statement (3) is wrong.

58. Ans: (d)

Sol: $f_1 = 1$ kHz

$f_2 = 4$ kHz

BW = 2× highest frequency of m(t)

= 2×4 kHz

= 8 kHz

59. Ans: (b)

Sol: In case of single tone modulation

$s(t) = A_cA_m\cos 2\pi(f_c + f_m)t$

But the generalized equation is

$s(t) = A_c m(t)\cos 2\pi f_c t - A_c\,\hat{m}(t)\sin 2\pi f_c t$

60. Ans: (b)

61. Ans: (b)

Sol: $K_a = 1$

$\mu_1 = A_{m_1} = \frac{1}{2}$

$\mu_2 = A_{m_2} = \frac{1}{2}$

$$\mu_f = \sqrt{\frac{1}{4}+\frac{1}{4}} = \frac{1}{\sqrt{2}}$$

$= 0.707$

62. Ans: (c)

63. Ans: (a)

Sol: In DM, bit rate = sampling rate

R_b= 20000 bps = 20kbps

64. Ans: (c)

Sol: $f_c = 10$ MHz $A_c = 10$ V

$$\mu = \frac{A_m}{A_c} = \frac{6}{10} = 0.6$$

$f_m = 5$ kHz $A_m = 6$ V

Amplitude at the lower side band

$$\frac{\mu A_c}{2} = \frac{0.6\times10}{2} = 3\text{V}$$

65. Ans: (b)

Sol: H(x) = 4 bits/element

$r = 2 \times 10^6 \times 32 = 64 \times 10^6$ elements/sec

$R = rH = 64 \times 10^6 \times 4 = 256$ Mbps

66. Ans: (c)

Sol: In telecasting TV programs Audio signal through FM and video signal through AM will be transmitted.

67. Ans: (b)

68. Ans: (d)

Sol: Measurement of voltage magnitude by a CRO is not fast compared to other techniques of measurement of same voltage by AVM or DVM.

As such, statement (I) is false but statement (II) is true

69. Ans: (b)

Sol: Due to increase in temperature the covalent bonds are broken ,which increases the carrier concentrations. At any temperature, the semiconductor obeys the law of mass action

$np = n_i^2$

70. Ans: (a)

Sol: Mobility of electron is higher than mobility of hole. So highest frequency response

71. Ans: (a)

72. Ans: (b)

73. Ans: (a)

74. Ans: (a)

75. Ans: (a)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