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UPSC ENGINEERING SERVICES - 2017

ESE 2017 - PRELIMS

ELECTRONICS & TELECOMMUNICATION ENGINEERING

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SET - D

UPSC Engineering Services - 2017 (Prelims)

Electronics & Telecommunication Engineering [SET - D]

01. In VLSI n-MOs process, the thinox mask

(a) Patterns the ion implantation within the thinox region

(b) deposits polysilicon all over the thinox region

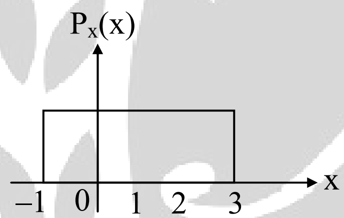
(c) Patterns thickox regions to expose silicon where source, drain or gate areas are required

(d) grows thickox over thinox regions in gate areas

01. Ans: (c)

Sol: Thinox mask is used immediately after well definition and this patterns the $si0_2$ layer to expose the active region of the transistor.

02. For a random variable x having the PDF shown in the figure given below



The main and the variance are, respectively

(a) 0.5 and 0.66

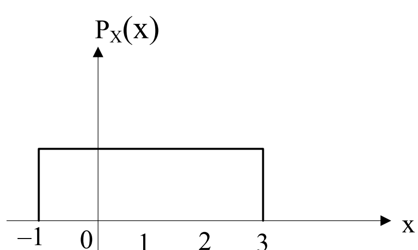
(b) 2.0 and 1.33

(c) 1.0 and 0.66

(d) 1.0 and 1.33

02. Ans: (d)

Sol:



Mean $E[x] = \int_{-\infty}^{\infty} x\, P_X(x)\ dx = \int_{-1}^{3} x\left(\frac{1}{4}\right) dx$

Since $P_X(x) = \int_{-\infty}^{\infty} P(x)\ dx = \frac{1}{4}$

$$= \frac{1}{4}\left.\frac{x^2}{2}\right|_{-1}^{3}$$

$$= 1$$

Variance $\sigma_X^2 = E[X^2] - \{E[X]\}^2$

$E[X^2] = \int_{-1}^{3} x^2\left(\frac{1}{4}\right)dx = \frac{1}{4}\left.\frac{x^2}{3}\right|_{-1}^{3}$

$$= \frac{1}{4}\left[\frac{27+1}{3}\right]$$

$$= \frac{7}{3}$$

$\sigma_X^2 = \frac{7}{3} - (1)^2$

$$= \frac{4}{3} = 1.33$$

03. Consider the following statements with respect to bilinear transformation method of digital filter design:

1. It preserves the number of poles and thereby the order of the filter
2. It maintains the phase response of the anlaog filter
3. The impulse response of the analog filter is not preserved

Which of the above statements are correct ?

(a) 1, 2 and 3 (b) 1 and 2 only

(c) 1 and 3 only (d) 2 and 3 only

03. Ans: (c)

04. Consider the following statements

The 8259A programmable interrupt controller can

1. manage eight interrupts
2. vector an interrupt request anywhere in the memory map
3. have 8-bit or 16-bit interval between interrupt vector locations
4. be initialized with operational command words

Which of the above statements are correct ?

(a) 1, 2 and 3 only

(b) 1, 2 and 4 only

(c) 3 and 4 only

(d) 1, 2, 3 and 4

04. Ans: (b)

Sol: 8259A can have only 4-bit and 8-bit interval between interrupt vector locations. Hence statement (3) is incorrect. Hence (a), (c), (d) are wrong

05. What are the conditions which are necessary for using a parallel port?

1. initializing by placing appropriate bits at the control register
2. Calling on interrupt whenever a status flag sets at the status register
3. Interrupting servicing (device driver) programming

Select the correct answer using the code given below

(a) 1 and 2 only

(b) 1 and 3 only

(c) 1, 2 and 3

(d) 2 and 3 only

05. Ans: (b)

06. Consider a point-to-point communication network represented by a graph. In terms of the graph parameters, the maximum delay (quality of service) experienced by a packet employing Bellman-Ford routing algorithm is/are

1. diameter of the graph
2. shortest path on the graph
3. sum of all edge weights in the graph

Select the correct answer using the code given below

(a) 1 only (b) 2 only (c) 3 only (d) 1, 2 and 3

06. Ans: (b)

Sol: Bellman ford algorithm used to find the path which has shortest delay.

07. Let RSA prime numbers be p = 3 and q = 11. If the corresponding public key e = 3, what is the private key?

(a) 4 (b) 5

(c) 6 (d) 7

07. Ans: (d)

Sol: RSA Algorithm:

Step: (I) p = 3, q = 11

Step: (II) $n = p \times q = 3 \times 11 = 33$

$z = (p-1)(q-1)$

$= (3-1)(11-1)$

$= (2 \times 10)$

$= 20$

$z = 20$

Step: (III) Given e = 3: Public key

Step: (IV) $(d \times e) \bmod z = 1$

$(d \times 3) \bmod 20 = 1$

$21 \bmod 20 = 1$

$(d \times 3) = 21$

$d = \frac{21}{3} = 7$

private key = 7

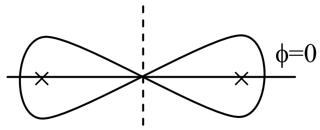
08. The maximum radiation for an endfire array occurs at

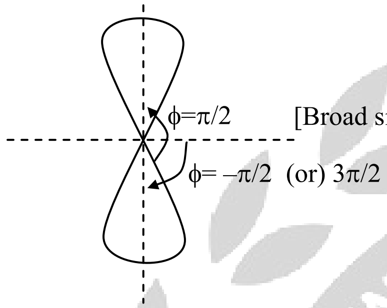
(a) $\phi_0 = 0$ (b) $\phi_0 = \frac{\pi}{2}$

(c) $\phi_0 = -\frac{\pi}{2}$ (d) $\phi_0 = \frac{3\pi}{2}$

08. Ans: (a)

Sol:





09. Consider the following statements regarding TCP:

1. It enable two hosts to establish a connection and exchange streams of data.
2. It guarantees delivery of data in the same order in which they are sent
3. TCP segmentation offload is used to reduce the CPU overhead of TCP/IP on fast networks

Which of the above statements are correct?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

09. Ans: (d)

Sol: → TCP enable two hosts to establish a connection and exchange streams of data.

→ TCP guarantees delivery of data in the same order in which they are sent.

→ TCP segmentation offload is used to reduce the CPU overhead of TCP/IP on fast networks.

10. The transmission path loss for a geostationary satellite signal for uplink frequency of 6GHz is

(a) 60dB

(b) 92dB

(c) 184dB

(d) 200dB

10. Ans: (d)

Sol: Method-I:

Transmission path loss $L_P = 20\log\left(\frac{4\pi d}{\lambda}\right) = 20\log\left[4\pi \times 36 \times 10^6\,(20)\right]$

$$\left[\begin{aligned} \because \lambda &= \frac{C}{f} = \frac{3\times10^8}{6\times10^9} \\ &= \frac{1}{20} \end{aligned}\right]$$

$L_P = 20\log(36\pi\times8) + 20\log(10^7)$

$= 20\log(904.32) + 140$

$\approx 20\log(10^3) + 140$

$\approx 60 + 140 \approx 200$ dB

Method-II: (directly)

$L_p(\text{dB}) = 92.5 + 20\log(d\,\text{km}) + 20\log(f\,\text{MHz})$

≈ 200 dB

11. Consider the following statements

If the maximum range of radar has to be doubled

1. The peak transmitted power may be increased 16 folds
2. the antenna diameter may be doubled
3. The sensitivity of receiver may be doubled
4. The transmitted pulse width may be doubled

Which of the above statements are correct?

(a) 1 and 2 (b) 2 and 3

(c) 3 and 4 (d) 1 and 4

11. Ans: (a)

Sol: Radar equation $P_r = \frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 R^4} = \frac{P_t A^2 \sigma}{4\pi\lambda^2 R^4}$

$$R = \left[\frac{P_t A^2 \sigma}{4\pi\lambda^2 P_{r\,min}}\right]^{\frac{1}{4}}$$

A is effective Area of antenna

$A \propto D^2$

$\therefore R \propto P_t^{1/4}$ and $R \propto D$

Conclusions:

(i) $R_{max} \propto P_{tx}^{1/4}$

(ii) $R_{max} \propto D$

(iii) $R_{max} \propto \left[\frac{1}{P_{r\,min}}\right]^{\frac{1}{4}}$

$R_{max} \propto [\text{sensitivity}]^{\frac{1}{4}} \left(\because P_{r\,min} \propto \frac{1}{\text{sensitivity}}\right)$

(iv) $R_{max} \propto [\text{pulse width}]^{\frac{1}{4}} \quad (\because P_{tx} \propto \text{Pulse width})$

P_{tx} : Transmitted signal power

D : Diameter of antenna

$P_{r\,min}$: Minimum received signal power

12. What is maximum signal propagation time for a geosynchronous satellite transmission system?

(a) 140 ms

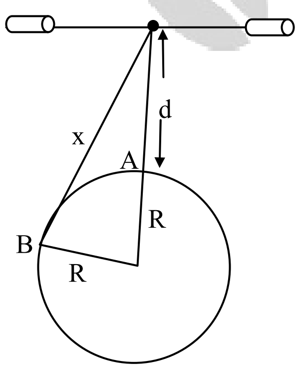
(b) 220 ms

(c) 280 ms

(d) 560ms

12. Ans: (c)

Sol:



For geosynchronous orbit d ≃ 36000 km

Minimum signal propagation time is at location A and signal takes maximum propagation time when the observer at location 'B' (extreme edge of coverage area of satellite)

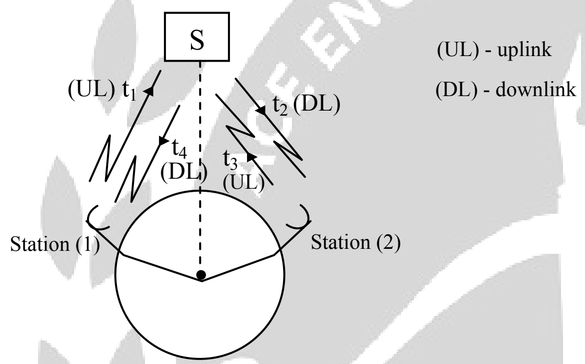
$$t_{max} \approx \frac{x}{C}$$

$x \approx d + R \approx 36000 \text{ km} + 6000 \text{ km}$

R is radius of earth

$$t_{max} \approx \frac{42000 \times 10^3}{3 \times 10^8}$$

≈ 140 ms



∴ Total delay from station (1) to station (2) $= t_1 + t_2 = 280$ ms

∴ Maximum signal propagation time is 280 ms

Note: If we consider full duplex communication where acknowledgement have to be received from station (2) to station (1)

Total delay = $t_1+t_2+t_3+t_4 = 560$ ms

13. The field strength at the receiving antenna location at a distance of 28km from a half-wave dipole transmitter radiating 0.1 kW is

(a) 1.5mV/m

(b) 2.5mV/m

(c) 3.5mV/m

(d) 4.5mV/m

13. Ans: (c)

Sol: $P = \frac{E_{max}^2}{2\eta} = D \times \frac{P_t}{4\pi r^2} \Rightarrow E_{max} = \sqrt{\frac{D \times P_t \times 2\eta}{4\pi}} \frac{1}{r}$

$= \sqrt{\frac{1.6 \times 0.1 \times 10^3 \times 2 \times 120 \times 30}{40\pi}} \frac{1}{28 \times 10^3}$

$= \frac{\sqrt{9.6 \times 10^3}}{28} \times 10^{-3}$

$\approx 3.5 mV/m$

14. Consider the following loop:

```
        MOV  CX,  8000h
L1:     DEC  CX
        JNZ  L1
```

The processor is running at 14.7456/3 MHz and DEC CX requires 2 clock cycles and JNZ requires 16 clock cycles. The total time taken is nearly

(a) 0.01s

(b) 0.12s

(c) 3.66s

(d) 4.19s

14. Ans: (b)

15. A Microwave communication link employs two antennas for transmission and reception elevated at 200m and 80m, respectively. Considering obliqueness of the Earth, the maximum possible link distance is

(a) 46 km

(b) 64 km

(c) 96 km

(d) 102 km

15. Ans: (c)

Sol: Considering obliqueness of the earth

The maximum possible link distance

$$d \approx 4.12\left(\sqrt{h_t} + \sqrt{h_r}\right)$$

Where h_t , h_r in meters and 'd' in kilometer

$$d \approx 4.12\left(\sqrt{200} + \sqrt{80}\right)$$

$D \approx 4.12\ (14.14+9) \approx 96$ km

16. Consider a packet switched network based on a virtual circuit mode of switching. The delay jitter for the packets of a session from the source node to the destination node is/are

1. always zero
2. non-zero
3. for some networks, zero

Select the correct answer using the code given below.

(a) 1

(b) 2 only

(c) 3 only

(d) 2 and 3

16. Ans: (a)

Sol: A packet can be forwarded before the next packet arrives in virtual circuit connections, so in between the packets the delay jitter is zero.

17. Molybdenum has a Body-centred cubic (BCC) structure with an atomic radius of $1.6\,\mathring{A}$. then the lattice parameter for BCC molybdenum is

(a) $2.77\,\mathring{A}$

(b) $3.14\,\mathring{A}$

(c) $5.12\,\mathring{A}$

(d) $6.28\,\mathring{A}$

17. Ans: (b)

Sol: In BCC structure, radius of the atom,

$$r = \frac{\sqrt{3}a}{4}$$

$$\therefore \text{ lattice parameter } a = \frac{4r}{\sqrt{3}} = \frac{4\times 1.36}{\sqrt{3}} = 3.14\mathring{A}$$

Directions:

Each of the next thirteen (13) items consist of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)' Examine these two statements carefully and select the answer to these items using the code given below.

Code:

(a) Both statement (I) and Statement (II) are individually true and statement (II) is the correct explanation of statement (I)

(b) Both statement (I) and Statement (II) are individually true but statement (II) is not the correct explanation of statement (I)

(c) statement (I) is the true but statement (II) is false

(d) statement (I) is false but statement (II) is true

18. Statement (I): The coupling between two magnetically coupled is said to be ideal if the coefficient of coupling is unity

Statement (II): Lower the self –inductance of a coil, more will be the e.m.f induced.

18. Ans: (c)

Sol: Statement (I): Correct

Ideal coupling (OR) perfect coupling K = 1

Statement (II): Wrong

Self-Inductance varies induced EMF also various directly proportional $\left(V_L = L\frac{dI}{dt}\right)$

19. Statement (I): The direction of dynamically induced e.m.f in a conductor is determined by Fleming's left-hand rule.

Statement (II): The mutual inductance between two magnetically isolated coils is zero

19. Ans: (d)

Sol: Statement (I): Wrong

EMF determined by fleming Right hand rule

Statement (II): Correct

Isolated coils mutual flux = 0

Mutual inductance M = 0

20. Statement (I): Photodiodes are not used in relay circuits

Statement (II): The currents needed to activate photodiodes is very low even at a high light intensities.

20. Ans: (d)

Sol: Photodiodes are commonly used in relay circuits which are called photo relay circuits.

21. Statement (I): An autotransformer is economical in using copper in its manufacture

Statement (II): The section of the winding common to both primary and secondary circuits carriers only the difference of primary and secondary currents.

21. Ans: (b)

Sol: Statement (I) is true

Since. Using Auto transformer copper wage will reduce compared to 2-winding transformer.

Statement (II) is true

But it is not a correct explanation

for Statement (I)

22. Statement (I): FIR filters are always stable

Statement (II): IIR filters requires less memory and are less complex

22. Ans: (b)

Sol: FIR filters are always stable because all poles located at zero, and IIR filters require less memory and are less complex.

23. Statement (I): Nuclear power plants are suitable only for base load operation

Statement (II): Nuclear power reactor cannot respond to load fluctuation efficiently

23. Ans: (a)

24. Statement (I): Solar insolation is a measure of solar irradiance over a specified period of time

Statement (II): Solar insolation data are commonly used for isolated PV system design

24. Ans: (b)

25. Statement (I): The smallest change of input detectable at the output is called the resolution of a transducer.

Statement (II): A high resolution means high accuracy

25. Ans: (b)

Sol: Both statement I& II are correct but no relation between then.

26. Statement (I): Constant M and N circles, as also Nichols charts, are graphical techniques to assess closed-loop performance in the frequency domain.

Statement (II): While constant M and N circles use Nyquist polar plots data, Nichol's chart uses Bode plots data.

26. Ans: (b)

Sol: M & N - circles & Nichol's chart are graphical techniques to do complete frequency domain analysis.

In M & N - circles uses polar plots & Nichol's chart uses bode plots.

27. Statement (I): PID controller is an essential part of any control loop in process industry

Statement (II): PID control system performs better than most predictive control methods in the context of measured disturbances

27. Ans: (a)

Sol: PID controller is essential part in process industry. In the context of measured disturbance compare to predictive control methods.

28. Statement (I): Large RAM with MOS circuit technology is used for the main memory in a compute system.

Statement (II): An important application of ROM is to store system programs, library subordinates, etc

28. Ans: (b)

Sol: Statements (I), (II) are correct

29. Statement (I): Elements with non-minimum phase transfer functions introduce large phase lags with increasing frequency resulting in complex compensation problems.

Statement (II): Transportation lag commonly encountered in process control system is a non-minimum phase element

29. Ans: (b)

Sol: Non-minimum phase system has a zero in the RH-S-plane which gives more phase lag at high frequency.

30. Statement (I): Speech enhancement technique are used to make a processed speech signal sound superior to the unprocessed one.

Statement (II): A ‘perfect signal’ is a required as a reference for speech enhancement.

30. Ans: (c)

31. Consider the following statements

The output of a linear circuit, driven with a sine wave at a frequency f, is itself a sine wave

1. at the same frequency
2. with chance of changed amplitude
3. with chances of changed amplitude and phase

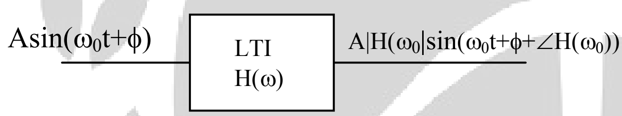
Which of the above statements is/are correct

(a) 1 and 2 (b) 1 only

(c) 1 and 3 (d) 2 only

31. Ans: (c)

Sol:



The output is same frequency as input and their may be chance that change in amplitude and phase.

32. Consider the following statements

The main contribution to photoconduction is by

1. the generation of electron and hole pair by a photon
2. a donor electron jumping into the conduction band because of a photon’s energy
3. A valance electron jumping into an acceptor state because of a photon’s energy

Which of the above statements is/are correct

(a) 1 only (b) 2 only (c) 3 only (d) 1, 2 and 3

32. Ans: (a)

Sol: Generally at room temperature all the donor and acceptor atoms are completely ionized. Hence main contribution to photo current is due to electron hole pair created because of band to band transition within the depletion region.

33. Thermal runaway is not possible in FET because as the temperature of the FET increases

(a) mobility decrease

(b) trans-conductance increase

(c) drain current increases

(d) trans-conductance decreases

33. Ans: (a)

Sol: In FET, the major factor effecting the drain current is the mobility of majority carriers and this decreases with increase in temperature and therefore no thermal runaway.

34. For JFET, the drain current I_D is

(a) $I_{DSS}\left(1-\frac{V_{GS}}{V_P}\right)^{\frac{1}{2}}$ (b) $I_{DSS}\left(1-\frac{V_{GS}}{V_P}\right)$

(c) $I_{DSS}\left(1-\frac{V_{GS}}{V_P}\right)^{\frac{3}{2}}$ (d) $I_{DSS}\left(1-\frac{V_{GS}}{V_P}\right)^{2}$

34. Ans: (d)

Sol: In JFET the saturation drain current is given as $I_D = I_{DSS}\left(1-\frac{V_{GS}}{V_P}\right)^{2}$

35. For n-channel depletion MOSFET, the highest trans-conductance gain for small signal is at

(a) $V_{GS} = 0V$

(b) $V_{GS} = V_P$

(c) $V_{GS} = |V_P|$

(d) $V_{GS} = -V_P$

35. Ans: (a)

Sol: Depletion mode ($V_{GS} < 0$):

The trans-conductance of a depletion MOSFET when operated in depletion mode is given by $g_m = \frac{\partial I_P}{\partial V_{GS}} = \frac{-2I_{DSS}}{V_P}\left[1-\frac{V_{GS}}{V_P}\right]$ and this is max when $V_{GS} = 0$.

Note: Enhancement mode ($V_{GS} > 0$)

If D-MOSFET is used in enhancement mode then trans-conductance increases with V_{GS}

$$\therefore \text{ Maximum trans-conductance occurs at} \begin{cases} V_{GS} = -V_p \ [\because V_p \text{ is negative}] \\ \\ V_{GS} = |V_p| \end{cases}$$

36. The n-p-n transistor made of silicon has a DC base bias voltage 15V and a input base resistor 150kΩ. Then the value of the base current into the transistor is

(a) 0.953 μA

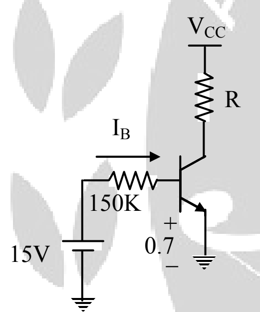
(b) 9.53 μA

(c) 95.3 μA

(d) 953 μA

36. Ans: (c)

Sol:



$$I_B = \frac{150 - 0.7}{150\,K\Omega} = 95.3\mu A$$

37. A signal may have frequency components which lie in the range of 0.001Hz to 10Hz. Which one of the following types of coupling should be chosen in a multistage amplifier designed to amplify the signal ?

(a) Capacitor coupling

(b) Direct coupling

(c) transformer coupling

(d) Doubled-tuned transformer coupling

37. Ans: (b)

Sol: Given that signal contains frequency components almost down to DC (0.001 HZ)

$\therefore$ For signal containing finite dc components direct coupling is preferred

38. If an input impedance of op-amp is finite, then which one of the following statements related to virtual ground is correct ?

(a) virtual ground condition may exist

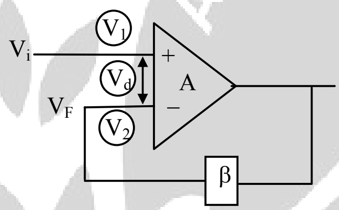
(b) Virtual ground condition cannot exist

(c) in case of op-amp, virtual ground condition always exists

(d) cannot make a valid declaration

38. Ans: (a)

Sol: Virtual ground (or) virtual short can still be valid if gain of the op-amp is infinite (very large), even though it has finite input impendence.



$$V_d = \frac{V_i}{1 + A\beta}$$

If $A \to \infty$

$V_d \approx 0$

$V_1 - V_2 = 0$

$V_1 = V_2$ (Virtual ground (or) virtual short)

39. Hysteresis is desirable in a Schmitt trigger because

(a) energy is to be stored/discharged in parasitic capacitance

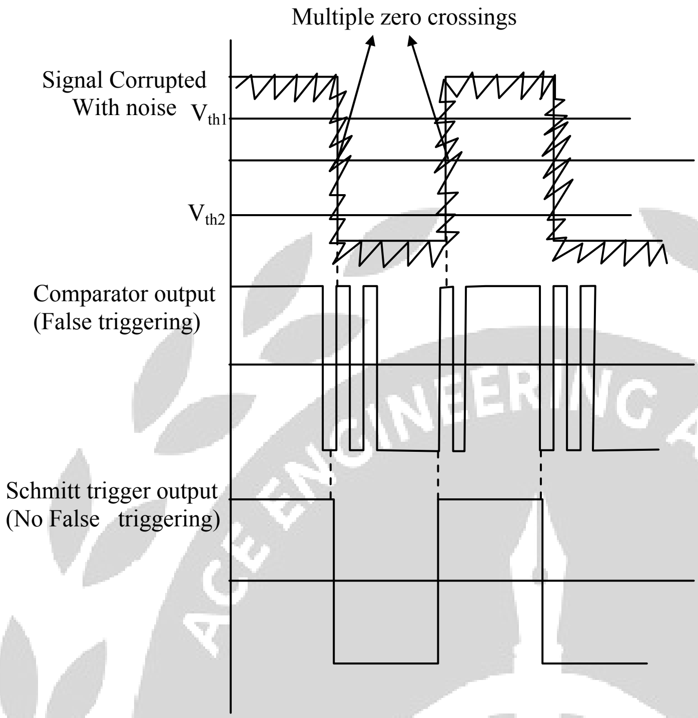
(b) effects of temperature variations would be compensated

(c) devices in the circuit should be allowed time for saturation and de-saturation

(d) it would prevent noise from causing false triggering

39. Ans: (d)

Sol: The main application of Hysteresis is to avoid False triggering which is caused due to noise



40. In a photoconductive cell, the resistance of the semiconductor material varies with intensity of incident light

(a) directly

(b) inversely

(c) exponentially

(d) logarithmically

40. Ans: (b)

41. In graded index multimode optical fiber, the refractive index of the core is

(a) uniform across its radial distance, except for the cladding

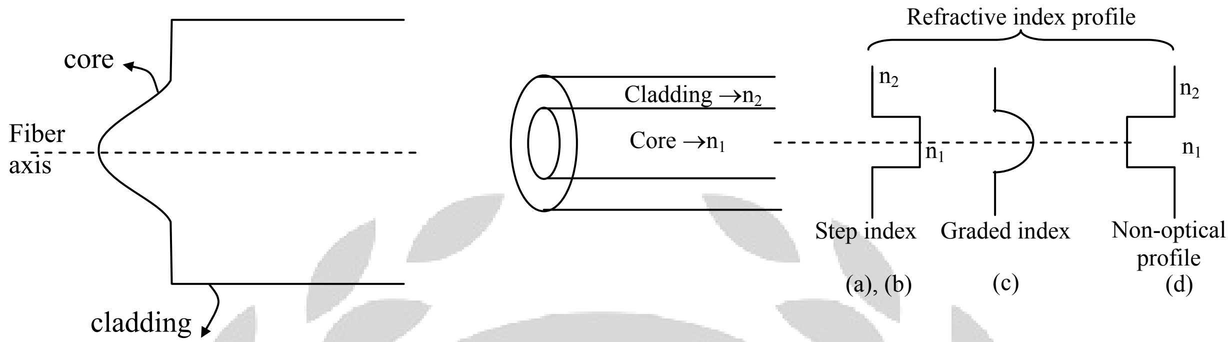
(b) maximum at the fiber axis and decreases stepwise towards the cladding

(c) maximum at the fiber axis and decreases gradually towards the cladding

(d) maximum at the fiber axis and increase stepwise towards the cladding

41. Ans: (c)

Sol:


core
Fiber axis
cladding
Cladding →n2
Core →n1
Refractive index profile
n2
n1
n2
n1
Step index
(a), (b)
Graded index
(c)
Non-optical profile
(d)

42. Consider the following factors

(a) Number of turns of the coil

(b) Length of the coil

(c) Area of cross-sectional of the coil

(d) Permeability of the core

On which of the above factors does inductance depend

(a) 1,2 and 3 only

(b) 1,3 and 4 only

(c) 1,2,3 and 4

(d) 2 and 4 only

42. Ans: (c)

Sol: Inductance depends upon

$$L = \frac{N^2 \mu a}{\ell}$$

43. A mathematical expression for 50Hz sinusoidal voltage of peak value 80V will be

(a) v = 50sin 314t

(b) v = 50sin 80t

(c) v = 80sin 314t

(d) v = 80sin 50t

43. Ans: (c)

Sol: f = 50Hz

$V_m = 80V$

$V(t) = V_m \sin\omega t$

V(t) = 80sin 314t

44. Consider the following statements

1. Fleming's rule is used where induced e.m.f is due to flux cutting

2. Lenz's law is used when the induced e.m.f is due to change in flux linkages.

3. Lenz's law is a direct consequence of the law of conservation of energy

Which of the above statements are correct

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

44. Ans: (d)

Sol: Statement (I) is true

Flemings right hand rule for dynamically induced emf ($E = B\ell v$)

Statement (II) is true

statically induced emf

$$|E| = N\frac{d\phi}{dt}$$

Statement (III) is also true

45. A conductor of length 1m moves at right angles to a uniform magnetic field of flux density $2wb/m^2$ with a velocity of 50m/s. What is the value of the induced e.m.f when the conductor moves at an angle of 30^0 to the direction of the field

(a) 75V (b) 50V

(c) 25V (d) 12.5V

45. Ans: (b)

Sol: Given

$\ell = 1m$

$B = 2\ Wb/m^2$

$v = 50\ m/s$

$\theta = 30^0$

$$V_{emf} = \oint_L (\overline{v} \times \overline{B}).d\ell = B\ell v \sin\theta$$

$$= (2)\,(1)\,(50)\,\sin 30^0 = 2\times1\times50\times\frac{1}{2}$$

$V_{emf} = 50V$

46. The total flux at the end of a longer bar magnet is 500μWb. The end of the bar magnet is withdrawn through a 100-turn coil in $\frac{1}{10}$ second. The e.m.f generated across the terminals of the coil is

(a) 5V (b) 10V (c) 25V (d) 50V

46. Ans: (a)

Sol: $\phi = 500\mu\ \omega b$

$N = 1000$ turns

$dt = \frac{1}{10}$ sec

EMF generated $E = N\frac{d\phi}{dt}$

$$E = 1000\left(\frac{500\times10^{-6}}{\frac{1}{10}}\right)$$

$E = 5V$

47. The slip of a 400V, 3-phasae, 4-pole, 50Hz machine running at 1440 r.p.m is

(a) 6%

(b) 5%

(c) 4%

(d) 3%

47. Ans: (c)

Sol: 4-pole, 50 Hz, machine,

$$N_S = \frac{120\ f}{P} = \frac{120 \times 50}{4} = 1500\ \text{rpm}$$

Speed, N = 1440 rpm

$$\text{Slip} = \frac{N_S - N}{N_S} = \frac{1500 - 1440}{1500}$$

$$= \frac{60}{1500}$$

$$= 0.04$$

$$= 4\%$$

48. A 500HP, 440V, 3-Phase, 50Hz induction motor runs at 950 r.p.m when on full load with a synchronous speed of 1000 r.p.m for this condition, the frequency of the rotor current will be

(a) 4.0 Hz

(b) 3.5 Hz

(c) 2.5 Hz

(d) 2.0 Hz

48. Ans: (c)

Sol: Frequency of rotor current (f_r) = slip × f

$$\text{Slip} = \frac{1000 - 950}{1000} = 0.05$$

$$\therefore\ f_r = 0.05 \times 50$$

$$= 2.5\ \text{Hz}$$

49. By adding resistance in the rotor circuit of a slip ring induction motor, the starting current

(a) as well as torque reduce

(b) as well as torque increase

(c) reduces but the starting torque increases

(d) increases but the starting torque decreases

49. Ans: (c)

Sol: As rotor resistance increases, net impedance of machine increases and starting current reduces

starting torque (T_{st}) $\propto$ rotor resistance

So, T_{st} is increases

50. Consider the following statement with regards to an induction motor

1. Maximum torque is independent of rotor resistance

2. Starting torque is maximum when rotor resistance equals rotor reactance

3. torque is very sensitive to any changes in supply voltage

Which of the statement are correct

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

50. Ans: (d)

Sol:

1. T_{max} independent on rotor resistance and it depends on rotor reactance

2. Slip at which T_{max} occurs in $S_m = \frac{R_2}{X_2}$ to have maximum starting torque, $S_m = 1$

$\Rightarrow R_2 = X_2$

3. Torque $\propto V^2$, So, 'T' is so sensitive to 'V' variation.

51. A transformer has 2% resistance and 5% reactance. What is its voltage regulation at full load with 0.8 p.f lagging

(a) 5.3% (b) 4.6 %

(c) 0.53% (d) 0.46%

51. Ans: (b)

Sol: Voltage Regulation = % Rcosϕ + %Xsinϕ

for lagging load

= (2 % × 0.8) + (5 % × 0.6)

= 1.6 % + 3 %

= 4.6 %

52. A voltage is generated across a piezo electric material, 0.5 cm thick, subjected to an impact $5N/m^2$. The voltage coefficient of the material is 23 kV-m/N. The magnitude of the voltage generated will be

(a) 2300V

(b) 1650V

(c) 1150V

(d) 575V

52. Ans: (d)

Sol: V = voltage coefficient(g)×thickness(t)×pressure(P) = $23\times10^3\times5\times0.5\times10^{-2}$ = 575 V

53. The 'residual resistivity' of a material is

(a) due to lattice vibrations at high temperature

(b) due to photon scattering at high temperature

(c) temperature - dependent

(d) temperature – independent

53. Ans: (d)

Sol: In metals, residual resistivity means resistivity left out at zero Kelvin. It is due to the impurities present and crystal defects. It is independent of temperature.

54. Electrical conductivity, thermal conductivity and magnetic properties of ceramic material are

(a) very high all the time

(b) very low all the time

(c) dependent on the material

(d) ascertainable, instance to instance

54. Ans: (b)

Sol: Ceramics are materials having strong ionic and covalent - bonds together and hence are hard, brittle and have high melting points. Due to lack of free electrons they have very low electrical and thermal conductivities.

55. Laminated insulation, coated with varnish is a staple adoption in transformer assemblage in order to

(a) reduce the reluctance of the magnetic path

(b) minimize losses due to eddy currents

(c) increase the reluctance of the magnetic path

(d) increase the effect of eddy current

55. Ans: (b)

56. When a ferromagnetic substance is magnetized, there are marginal diminutions in its linear dimensions. This phenomenon is called

(a) hysteresis

(b) magnetostriction

(c) diamagnetism

(d) dipolar relaxation

56. Ans: (b)

Sol: The change in the dimensions of a ferromagnetic material upon magnetizations is called magnetostriction. Length may increase or decrease depending on the material.

57. When the working temperature becomes more than the Curie temperature, a ferromagnetic material becomes a

(a) diamagnetic material

(b) paramagnetic material

(c) ferromagnetic material

(d) Mu-material

57. Ans: (b)

Sol: For ferromagnetic materials, Curie - weiss law is

$$\chi = \frac{C}{T - \theta_f}\left(T > \theta_f\right).$$

Here θ_f is curie – temperature. Above curie temperature ferromagnetic becomes paramagnetic.

58. Compared to other materials, a material with a wider hysteresis loop has

(a) lower permeability, higher retentivity and higher coercivity

(b) higher permeability, lower retentivity and higher coercivity

(c) lower permeability, higher retentivity and lower reluctance

(d) lower permeability, lower retentivity and lower residual magnetism

58. Ans: (a)

Sol: When Hysteresis loop is wider, the slope of the B – H loop (i.e. permeability) will be less and saturation magnetization (and hence retentivity) will be higher. It's a hard magnetic material with higher coercivity.

59. Which of the following material is used in light-emitting diodes?

(a) Gallium arsenide sulphate

(b) Gallium arsenide phosphide

(c) Gallium chromate phosphide

(d) Gallium phosphide sulphate

59. Ans: (b)

Sol: $GaAs_{1-x}P_x$ (GsAsP) Gallium Arsenide Phosphide is a direct band gap semiconductor and hence is used in LEDs.

60. Consider the following methods in nanoparticle synthesis

(1) Bottom - up

(2)Top - down

(3) side - by - side

Which of these methods is/are slow and does/do not conduce to large –scale production

(a) 1 only (b) 2 only

(c) 3 only (d) 1, 2 and 3

60. Ans: (b)

Sol: Top – down techniques like Ball – milling (Reducing a bulk material to nano – size) is a slow process and is not conducive to large scale production. Bottom – up techniques like Chemical Vapour Deposition (CVD), PVD process are fast.

61. Consider that in a system loop transfer function, addition of pole result in the following

1. Root locus gets pulled to the right hand side
2. Steady-state error is increases
3. system response gets slower.

Which of the above are correct ?

(a) 1, 2 and 3 (b) 1 and 2 only

(c) 1 and 3 only (d) 2 and 3 only

61. Ans: (c)

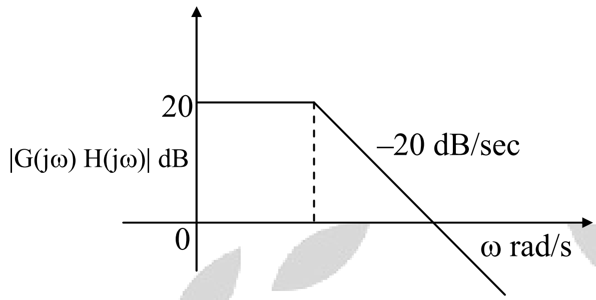
Sol: Addition poles shift the RL branches to the Right hand side.

Addition poles decreases the bandwidth

$$\downarrow \text{BW} \propto \left(\frac{1}{t_r \uparrow}\right)$$

Rise increases. Hence system response gets slower

62. The magnitude plot for the open-loop transfer function of a control system is shown in the figure give below



Its open-loop transfer function, G(s) H(s), is

(a) 10 (s+1)

(b) $\frac{1}{s+1}$

(c) $\frac{10}{s+1}$

(d) 20(s+1)

62. Ans: (c)

Sol: $G(s)H(s) = \frac{k}{(1+s)}$

$20\log k = 20$

$k = 10$

$G(s)H(s) = \left(\frac{10}{s+1}\right)$

63. The open-loop transfer function of a unity feedback control system is

$G(s)\ H(s) = \frac{10}{s(s+2)(s+K)}$

Here K is a variable parameter. The system will be stable for all values of

(a) K > –2

(b) K >0

(c) K>1

(d) K > 1.45

63. Ans: (d)

Sol: $G(s)H(s) = \frac{10}{s(s+2)(s+k)}$

CE: 1+G(s) H(s) = 0

CE: $s^3 + s^2(k+2) + 2ks + 10 = 0$

$$\begin{array}{c|ll} s^3 & 1 & 2k \\ s^2 & (k+2) > 0 & 10 \\ s^1 & \left(\frac{2k(k+2)-10}{k+2}\right) > 0 & \\ s^0 & 10 & \end{array}$$

For (s) $k + 2 > 0$; $k > -2$

$2k^2 + 4k - 10 > 0$

$k > 1.45$ (or) > -3.45

valid k is greater than 1.45

64. A control system has $G(s) = \frac{10}{s(s+5)}$ and H(s) = K. What is the value of K for which the steady-state error for unit step input is less than 5% ?

(a) 0.913

(b) 0.927

(c) 0.953

(d) 1.050

64. Ans: (d)

Sol: $\text{CLTF} = \frac{10}{s^2 + 5s + 10k}$

$$e_{ss} = \underset{s\to 0}{\text{lt}}\, sR(s)[1 - \text{CLTF}]$$

$$e_{ss} = \underset{s\to 0}{\text{lt}}\, s \times \frac{1}{s}\left[1 - \frac{10}{s^2 + 5s + 10k}\right]$$

$$e_{ss} = \left(1 - \frac{10}{10k}\right) = \left(1 - \frac{1}{k}\right)$$

Given $e_{ss} < 5\% \Rightarrow e_{ss} < 0.05$

$$\left(1 - \frac{1}{k}\right) < 0.05$$

$$\left(\frac{k-1}{k}\right) < 0.05 \Rightarrow k - 1 < 0.05k$$

$$(k - 0.05k) < 1 \Rightarrow k < \frac{1}{0.95} = 1.05$$

65. What is the time required to reach 2% of steady-state value, for the closed-loop transfer function $\frac{2}{(s+10)(s+100)}$, when the input is u(t)

(a) 20s

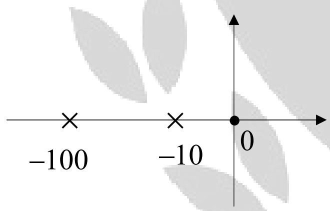
(b) 2s

(c) 0.2s

(d) 0.02s

65. Ans: (c)

Sol: $\frac{C(s)}{R(s)} = \frac{2}{(s+10)(s+100)}$



$\Rightarrow -100$ is insignificant pole

$\Rightarrow -10$ is a dominant pole

$\tau = 0.1$ sec

$\pm 2\%$ $t_s = 4\tau = 0.4$sec

Nearest Answer is Option (c)

66. If the characteristic equation of a closed-loop system is $2s^2 + 6s + 6 = 0$ then the system is

(a) overdamped (b) critically damped

(c) underdamped (d) undamped

66. Ans: (c)

Sol: CE: $2s^2 + 6s + 6 = 0$

$$s^2 + 3s + 3 = 0$$

$$\omega_n = \sqrt{3}\ \text{rad/sec}$$

$$2\xi\omega_n = 3$$

$$\xi = \frac{\sqrt{3}}{2} < 1 \text{ under damped system}$$

67. For derivative control action, the actuating signal consists of proportional error signal with addition of

(a) derivative of the error signals

(b) integral of the error signals

(c) steady-state error

(d) a constant which is a function of the system type

67. Ans: (a)

Sol: Controller output = $k_p e(t) + D\frac{d}{dt}e(t)$

Controller output is proportional error signal with addition of derivative of the error signals

68. Consider the following statements regarding a PID controller

1. The error is multiplied by a negative (for reverse action proportional constant P, and added to the current output.

2. The error is integrated (averaged) over a period of time, and then divided by a constant I, and added to the current control output.

3. The rate of change of the error is calculated with respect to time, multiplied by another constant D, and added to the output.

Which of the above statements are correct ?

(a) 1, 2 and 3

(b) 1 and 3 only

(c) 1 and 2 only

(d) 2 and 3 only

68. Ans: (a)

Sol: PID controller output $= \left[Ke(t) + I\int_0^t e(t)\,dt + D\frac{de(t)}{dt} \right]$

PID controller output is proportional error signal and error is integrated over the period of time and rate of change of error signal.

69. A 32 kB RAM is formed by 16 numbers of a particular type of SRAM IC. If each IC needs 14 address bits, what is the IC capacity ?

(a) 32 kbits

(b) 16 kbits

(c) 8 kbits

(d) 4 kbits

69. Ans: (b)

Sol: Size of RAM = 32 k × 8 bits

Number of pieces = 16, with 2^{14} addressable bits

$2^{15} \times 8 = (2^{14} \times x) \times 24$

$2^{18} \times 1 = 2^{18} \times x, x = 1$

Size of each IC = $2^{14} \times 1$ bits

= 16 kbits

70. A cache line has 128 bytes. The main memory has latency 64ns and band width 1GB/s. The time required to fetch the entire cache line is

(a) 32 ns (b) 64 ns

(c) 96 ns (d) 192 ns

70. Ans: (d)

Sol: MM Bandwidth = 1 GB/S

10^9 Bytes $\Rightarrow$ 1 sec

2^7 Bytes $\Rightarrow$ 2^7 ns

Total time = MM latency + Data transfer time

= 64 ns + 128 ns

= 192 ns

71. An Asynchronous link between two computers uses the start-stop scheme, with one start bit and stop bit, and a transmission rate of 48.8 kbits/s. What is the effective transmission rate as seen by the two computers?

(a) 480 bytes/s

(b) 488 bytes/s

(c) 4880 bytes/s

(d) 4800 bytes/s

71. Ans: (c)

Sol: Total number of bits = One start bits + Eight data bit + One stop bits

= 10 bits

$$\text{Efficiency } (\eta) = \frac{\text{Number of data bits}}{\text{Total number of bits}} = \frac{8}{10}$$

Effective transmission rate = η * Data transfer rate

$$= \left(\frac{8}{10}\right) * 48.8\,\text{k bit / sec}$$

$$= \frac{8 * 48.8 * 10^3}{10}\ \text{bits / sec}$$

= 4880 Bytes/sec

72. The noise factor of an attenuator pad that has an insertion loss of 6dB is

(a) 0.25 (b) 0.5

(c) 2 (d) 4

72. Ans: (d)

Sol: The Noise factor $F = \dfrac{\left(\frac{S}{N}\right)_i}{\left(\frac{S}{N}\right)_o}$

Insertion loss = 6 dB

$$10\log\left[\frac{\left(\frac{S}{N}\right)_i}{\left(\frac{S}{N}\right)_o}\right] = +6\ , \qquad F = L$$

$\Rightarrow N = 10^{+0.6} = 4$ ($\because 10^{0.3} = 2$)

73. A weighted complete graph with n vertices has weights 2|i–j| at edges (v_i, v_j). The weight of a minimum spanning tree is

(a) $\frac{n^2}{2}$ (b) $\frac{n}{2}$

(c) 2n–2 (d) n–1

73. Ans: (c)

Sol: n = number of vertices (or) Nodes

For weight of edge (V_i, V_j) is = 2|i–j|

the weight of minimum spanning tree will be 2(n–1) = 2n–2

74. Consider the following statements regarding the functions of an operating system in a computer

1. It controls hardware access
2. It manages files and folders
3. It provides a user interface
4. It manages applications

Which of the above statements are correct

(a) 1, 2 and 3 only (b) 1, 2 and 4 only

(c) 3 and 4 only (d) 1, 2, 3 and 4

74. Ans: (d)

75. Consider the following processes which arrived in the order P_1, P_2 and P_3

Process	Burst time
P_1	24 ms
P_2	3 ms
P_3	3 ms

What is the average waiting time by FCFS scheduling?

(a) 17 ms (b) 19 ms

(c) 21 ms (d) 23 ms

75. Ans: (a)

Sol: P_1 (W. T.) = 0

P_2 (W. T.) = 24

P_3 (W. T.) = 27

Average W. T. = $\frac{0+24+27}{3}$ = 17 ms

76. The cumulative distribution function of a random variable x is the probability that X takes the value

(a) less than or equal to x

(b) equal to x

(c) greater than x

(d) zero

76. Ans: (a)

Sol: CDF $F_X(x) = P(X \le x)$

77. A disk unit has 24 recording surfaces. It has a total of 14000 cylinders. There is an average of 400 sectors per track. Each sector contains 512 bytes of data. What is the data transfer rate at a rotational speed of 7200 r.p.m.?

(a) 68.80×10^6 bytes/s (b) 24.58×10^6 bytes/s

(c) 68.80×10^3 bytes/s (d) 24.58×10^3 bytes/s

77. Ans: (b)

Sol: One track size = Number of Sectors per track * sector size

= 400 sectors * 512 Bytes/sector

= 400 * 512 Bytes

Rotational speed = 7200 RPM

7200 Revolution → 1 min

One Revolution → $\frac{60\,\text{sec}}{7200}$

→ $\frac{1}{120}$ sec

Data transfer rate $= \frac{\text{One track size}}{\text{One revolution time}}$

$= \frac{400 * 512\,\text{Byte}}{\frac{1}{120}\,\text{sec}}$

= (400 * 512 * 120) Bytes/sec

= 24576 * 10^3 Bytes/sec

= 24.58 * 10^6 Bytes/sec

78. In the demand paging memory, a page table is held in registers. If it takes 1000 ms to service a page fault and if the memory access time is 10 ms, what is the effective access time for a page fault rate of 0.01?

(a) 19.9 ms

(b) 10.9 ms

(c) 9.99 ms

(d) 0.99 ms

78. Ans: (a)

Sol: EAT = (Page hit ratio * Memory access time) + (page fault ratio * page fault service time)

EAT = (0.99 * 10 ms) + (0.01 * 1000 ms) = 19.9 ms

79. Consider the following statements regarding database normal forms

1. Any relation with two attributes is BCNF.
2. Lossless, dependency-preserving decomposition into BCNF is always possible.
3. Lossless, dependency-preserving decomposition into 3NF is always possible
4. BCNF is stricter than 3NF

Which of the above statements are correct?

(a) 1, 2 and 3

(b) 1, 3 and 4

(c) 1, 2 and 4

(d) 2, 3 and 4

79. Ans: (b)

Sol: Both lossless, dependency preserving decomposition into BCNF. May not be possible always.

80. Consider the following schedules for transactions T_1, T_2 and T_3

T_1	T_2	T_3
Read (X)		
	Read (Y)	
		Read (Y)
	Write (Y)	
Write (X)		
		Write (X)
	Read (X)	
	Read (X)	

The correct schedule of serialization will be

(a) $T_1 \rightarrow T_2 \rightarrow T_3$

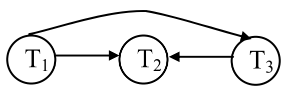
(b) $T_2 \rightarrow T_3 \rightarrow T_1$

(c) $T_3 \rightarrow T_1 \rightarrow T_2$

(d) $T_1 \rightarrow T_3 \rightarrow T_2$

80. Ans: (d)

Sol: Precedency graph for the scheduled given is



The topological sort of the graph is $T_1 \rightarrow T_3 \rightarrow T_2$

81. A receiver tunes signals from 550 kHz to 1600 kHz with an IF of 455 kHz. The frequency tuning range ratio for the oscillator section of the receiver is nearly

(a) 2·90 (b) 2·05 (c) 1·65 (d) 1·30

81. Ans: (b)

Sol: $f_{LO} = f_S + f_{IF}$

$$(f_{LO})_{max} = (f_s)_{max} + f_{IF} = 1600k + 455k$$

$$= 2055\text{ k}$$

$$(f_{LO})_{min} = (f_s)_{min} + f_{IF} = 550k + 455k$$

$$= 1005\text{ k}$$

$$\text{Tuning ratio } = \frac{(f_{LO})_{max}}{(f_{LO})_{min}} = \frac{2055}{1005} = 2.05$$

82. In a basic transmission line, the voltage at the receiving end without load is 660 V; and it is 420 V with full load. What is the percentage of voltage regulation?

(a) 77% (b) 67%

(c) 57% (d) 47%

82. Ans: (c)

Sol: No load voltage of transmission line a receiving end side, $V_{r_0} = 660\text{ V}$

At full load condition receiving end voltage,

$V_r = 420$ V

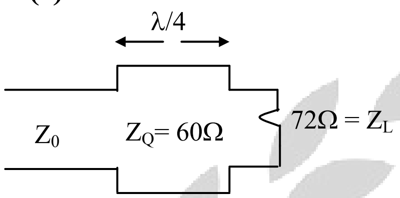
$$\text{Voltage Regulation } = \frac{|V_{ro}| - |V_r|}{|V_r|} = \frac{660 - 420}{420} = 57.14\ \%$$

83. A quarter-wave transformer of characteristic impedance 60Ω has been used to match a transmission line of characteristic impedance Z_0 with a load of 72Ω. What is the characteristic impedance of the transformer, when the load of 72 Ω is replaced by 98Ω?

(a) 98Ω (b) 80Ω (c) 70Ω (d) 60Ω

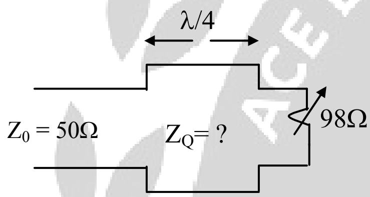
83. Ans: (c)

Sol:



$$Z_Q = \sqrt{Z_o Z_L}$$

$$Z_o = \frac{60\times 60}{72} = 50\Omega$$



$$Z_Q = \sqrt{50\times 98}$$

$$Z_Q = 7\times 10 = 70\Omega$$

84. Consider the following statements:

Stokes' theorem is valid irrespective of

1. Shape of closed curve C
2. type of vector A
3. type of coordinate system
4. whether the surface is closed or open

Which of the above statements are correct?

(a) 1 , 2 and 4 (b) 1, 3 and 4 (c) 2, 3 and 4 (d) 1, 2 and 3

84. Ans: (d)

Sol: Stokes' theorem is valid irrespective of shape of closed path, type of vector and type of co-ordinate system

$\oint_L A.d\ell = \int_S (\nabla\times A).dS$. Here surface 'S' is open not closed one.

85. A plane y = 2 carries an infinite sheet of charge 4 nC/m^2. If the medium is free space, what is the force on a point charge of 5 mC located at the origin?

(a) $0.54\pi\ \overline{a_y}$ N (b) $0.18\pi\overline{a_y}$ N

(c) $-0.36\pi\overline{a_y}$ N (d) $-0.18\pi\overline{a_y}$ N

85. Ans: (c)

Sol: $\vec{E} = \frac{\rho_S}{2\varepsilon_0}\hat{a}_n = \frac{4\times10^{-9}}{2\times\frac{1}{36\pi}\times10^{-9}}(-a_y)$

$\vec{E} = 72\pi(-\hat{a}_y)$

$\vec{F} = Q\vec{E}$

$\vec{F} = 5\times72\pi\times10^{-3}(-\hat{a}_y)$

$\vec{F} = -0.36\pi\hat{a}_y$

86. A random process X(t) is called white noise' if the power spectral density is equal to

(a) $\frac{\pi}{8}$ (b) $\frac{\pi}{2}$

(c) $\frac{3\pi}{4}$ (d) π

86. Improper Question

87. What is the reflection coefficient for the line $Z_0 = 300\angle0°\ \Omega$ and $Z_L = 150\ \angle0°\Omega$?

(a) 0·5 (b) 0·333

(c) –0·333 (d) –0·5

87. Ans: (c)

Sol: $\Gamma = \frac{Z_L - Z_O}{Z_L + Z_O} = \frac{150-300}{150+300}$

$\Gamma = \frac{-1}{3} = -0.333$

88. An electromagnetic wave is transmitted into a conducting medium of conductivity σ. The depth of penetration is

(a) directly proportional to frequency

(b) directly proportional to square root of frequency

(c) inversely proportional to frequency

(d) inversely proportional to square root of frequency

88. Ans: (d)

Sol: Skin depth (δ) is defined as the distance through which the wave amplitude decreases to a factor e^{-1}(about 37% of the original value) is called skin depth. $\delta = \frac{1}{\alpha} = \sqrt{\frac{2}{\omega\mu\sigma}} = \frac{1}{\sqrt{\pi f\mu\sigma}}$

$$\delta \alpha \frac{1}{\sqrt{f}}$$

89. Which of the following are the properties of TEM mode in a lossless medium?

1. Its cut-off frequency is zero.
2. Its transmission line is a hollow waveguide.
3. Its wave impedance is the impedance in a bounded dielectric
4. its phase velocity is the velocity of light in an unbounded dielectric.

Select the correct answer using the code given below.

(a) 1, 2 and 3 (b) 1, 3 and 4

(c) 1, 2 and 4 (d) 2, 3 and 4

89. Ans: (b)

Sol: For TEM wave

1. Cut-off frequency is zero ($f_c = 0$)
2. Waveguide will not support TEM
3. Wave impedance is the impedance in a bounded dielectric ($\eta = \frac{E}{H}$)
4. Phase velocity is the velocity in an unbounded dielectric ($v_p = \frac{c}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}}$ .v_P = c , as f_c = 0)

90. Consider the following statements:

Plane wave propagation through a circular waveguide results in

1. TE modes
2. TM modes

Which of the above statements is/are correct?

(a) 1 only (b) 2 only (c) Either 1 or 2 (d) Both 1 and 2

90. Ans: (c or d)

Sol: (1) If plane wave having perpendicular polarization , then it transforms to TE wave.

If plane wave having parallel polarization then it transforms to TM wave.

(2) If plane wave is a combination of perpendicular and parallel polarization , then it transforms to both TE and TM wave.

So based on (1), option 'c' is correct and based on (2) option 'd' is valid.

91. Consider the following statements:

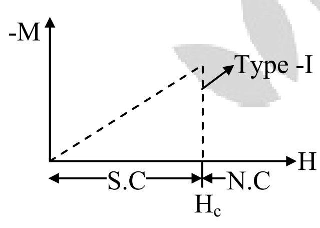
1. Type-I superconductors undergo abrupt transition to the normal state above a critical magnetic field.
2. Type-II superconductors are highly technologically useful superconductors because the incidence of a second critical field in them is useful in the preparation of high field electromagnets.

Which of the above statements is/are correct?

(a) 1 only (b) 2 only (c) Both 1 and 2 (d) Neither 1 nor 2

91. Ans: (c)

Sol:



The magnetization (M) Vs Magnetic field intensity (H), graph for Type - I superconductors is as shown. At H = Hc, M abruptly becomes zero and they become normal conductor.

For Type - II super conductors, $B_{c2} >> B_{c1}$. Hence they are used to produce very large magnetic field.

92. Consider the following statements:

1. Metal conductors have more R at higher temperatures.
2. Tungsten can be used as a resistance wire.
3. A superconductive material is one which has practically zero resistance.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

92. Ans: (b)

Sol: (1) For metals, as temperature increases, lattice vibration increase and resistivity increases.

(2) A material becoming a superconductor below a critical temperature has almost zero resistance.

(3) Tungsten gets highly oxidised and hence not suitable as a resistance wire.

93. Consider the following statements regarding precision in measurements of a quantity:

1. Precision is the measure of the spread of the incident errors.
2. Precision is independent of the realizable correctness of the measurement.
3. Precision is usually described in terms of number of digits used in the measurement by a digital instrument.

Which of the above statements are correct?

(a) 1, 2 and 3 (b) 1 and 2 only
(c) 1 and 3 only (d) 2 and 3 only

93. Ans: (a)

Sol: ⇒ Precision indicates closeness between measured values for same i/p. High precision means spread of values is less i.e. data is very close.

⇒ Accuracy can be improved by using correction but precision can't be improved

⇒ precision depends on number of digits (significant figures)

Ex: $\underset{\text{4 – significant figure}}{\underline{10.23}}$ $\underset{\text{5 – sig.fig}}{\underline{10.237}}$

More precision (more clearly defined)

94. Consider the following statements in connection with deflection-type and null-type instruments:

1. Null-type instruments are more accurate than the deflection-type ones.
2. Null-type of instrument can be highly sensitive compared to a deflection-type instrument.
3. Under dynamic conditions, null-type instruments are less preferred to deflection-type instruments.
4. Response is faster in null-type instruments as compared to deflection-type instruments.

Which of the above statements are correct?

(a) 1, 2 and 3

(b) 1, 2 and 4

(c) 1, 3 and 4

(d) 2, 3 and 4

94. Ans: (a)

Sol: ⇒Due to almost zero power consumption, null methods are more accurate than deflection methods

⇒ Response time is more for null deflections methods compared to deflection methods

95. A voltmeter having a sensitivity of 1000Ω/V reads 100V on its 150V scale when connected across a resistor of unidentified specifications in series with a milliammeter. When the milliammeter reads 5 mA, the error due to the loading effect of the voltmeter will be nearly

(a) 13%

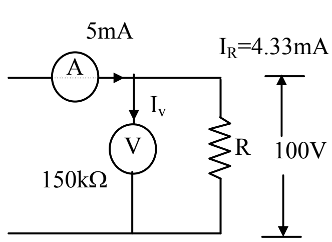
(b) 18%

(c) 23%

(d) 33%

95. Ans: (a)

Sol:



With meter readings $R_m = \frac{100V}{5mA} = 20k\Omega$

R_v (voltmeter Resistance) =1000 Ω/V ×150V = 150kΩ

$I_V = \frac{100V}{150k\Omega} = 0.67mA$, I_R = 5mA –0.67mA = 4.33mA

$R = \frac{100V}{4.33mA} = 23.08k\Omega$

$\% \text{ error} = \left(\frac{20k - 23.08k}{23.08k}\right) \times 100\% = -13.3\%$

96. Consider the following statements:

Sphere gap method of voltage measurement is used

1. For measuring r.m.s. value of a high voltage
2. for measuring peak value of a high voltage
3. as the standard for calibration purposes

Which of the above statements are correct?

(a) 1 and 2 only

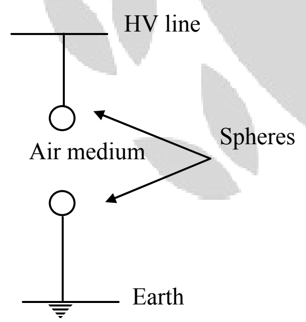
(b) 2 and 3 only

(c) 1 and 3 only

(d) 1, 2 and 3

96. Ans: (b)

Sol:



⇒ Break down of Air involved in the spheres gap depends upon the peak values & calibration curves for sphere gap referred to such peak-values.

⇒ Peak values of 2 kV to 2500 kV are measured by this meter.

⇒ Calibration of high voltage voltmeters & voltage measuring devices can be done.

97. High frequency (in the MHz range) and low amplitude (in the mV range) signals are best measured using

(a) VTVM with a high impedance probe

(b) CRO

(c) moving-iron instrument

(d) digital multimeter

97. Ans: (b)

Sol: (a) VTVM is a dc amplifier voltmeter. It is not suitable for very high frequency range (in MHz).

(b) For CRO bandwidth is in high frequency range (in MHz). So it is best for measurement of high frequency signal and as well as low frequency signal.

(c) Moving iron instrument is a conventional AC voltmeter . It is suitable for both AC and DC signal but can not operate at high frequency range. It operates around 50Hz.

(d) Digital multi meter is suitable for measuring multi quantity.

So option b is correct.

98. In scintillation coating applications, shields of which material are generally placed around the photomultiplier tube to overcome interference effects of electrons deflected from their normal path?

(a) Ferromagnetic

(b) Mu-metal magnetic

(c) Electromagnetic

(d) Dielectric

98. Ans: (b)

Sol: Mu - metal is a soft magnetic material with high permeability and is widely used for electromagnetic shielding.

99. A PMMC instrument if connected directly to measure alternating current, it indicates

(a) the actual value of the subject AC quantity

(b) zero reading

(c) $\frac{1}{\sqrt{2}}$ of the scale value where the pointer rests

(d) $\frac{\sqrt{3}}{2}$ of the scale value where the pointer rests

99. Ans: (b)

Sol: For Ac supply, the average torque (T_d) produced is zero in PMMC. Hence pointer gives no deflection.

100. Which of the following are measured by using a vector voltmeter?

1. Amplifier gain and phase shift
2. Filler transfer function
3. Complex insertion loss

Select the correct answer using the code given below.

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

100. Ans: (d)

Sol: Vector voltmeter is basically a type of amplitude and phase measuring device .Vector voltmeter is useful in VHF application measurement like

1. Insertion losses
2. Filler transfer functions.
3. Amplifier gain and phase shift.
4. Complex impedance of mixers.
5. s parameter of transistors etc.

101. In a transistor, the base current and collector current are, respectively, 60μA and 1.75mA. The value of α is nearly

(a) 0.91 (b) 0.97 (c) 1.3 (d) 1.7

101. Ans: (b)

Sol: Method I

$$\beta = \frac{I_C}{I_B} = \frac{1.75\text{mA}}{60\mu\text{A}} = 29.16$$

$$\alpha = \frac{\beta}{\beta+1} = 0.966 \approx 0.97$$

Method-II

$$\alpha = \frac{I_C}{I_C + I_B} = 0.97$$

102. A liquid flows through a pipe of 100 mm diameter at a velocity of 1 m/s. If the diameter is guaranteed within ±1% and the velocity is known to be within ±3% of measured value, the limiting error for the rate of flow is

(a) ±1% (b) ±2% (c) ±3% (d) ±5%

102. Ans: (d)

Sol: Pipe diameter (D) = 100 mm ± 1%

Liquid velocity (v) = 1 m/s ± 3%

Rate of flow (Q) = v × $\text{A}\,\text{m}^3/\text{sec}$

$$Q = v \times \pi\frac{D^2}{4}$$

$$\ln Q = \ln v + \ln\frac{\pi}{4} + 2\ln D$$

$$\frac{1}{Q} = \frac{1}{v}\times\frac{dv}{dQ} + 0 + \frac{2}{D}\times\frac{dD}{dQ}$$

$$\frac{\Delta Q}{Q}\times 100 = \frac{\Delta V}{V}\times 100 + 2\times\frac{\Delta D}{D}\times 100$$

$$= 3\% + 2 \times 1\,\% = \pm\, 5\%$$

103. A $3\frac{1}{2}$ digit voltmeter is accurate to ±0.5% of reading ±2 digits. What is the percentage error, when the voltmeter reads 0.10V on its 10V range?

(a) 0.025% (b) 0.25% (c) 2.05% (d) 20.5%

103. Ans: (d)

Sol: Given $3\frac{1}{2}$ digit display.

Error = ±(0.5% of reading + 2digits)

reading on 0-10V range = 0.1V

but real voltage range is 0–20 Volt range

($\because \frac{1}{2}$ digit doubles the voltage range of operation)

1 digit error = 1 count error

1 count = 1step i.e. resolution

so resolution of $3\frac{1}{2}$ DVM in 20V range $= \frac{20V}{2\times10^3} = 0.01V$

So error $= \pm\left[\frac{0.5}{100}\times0.1V + (2\times0.01)\right]$

$= \pm$ [0.00005V+ 0.002V] = ±(2.0205V)

% error in the reading of 0.1V

$= \frac{\pm 0.0205V}{0.1V}\times100\%$

$= \pm$ 20.5%

104. The simplest and most common method of reducing any 'effect of inductive coupling' between measurement and power circuits is achieved by using

(a) a screen around the entire measurement circuit

(b) twisted pairs of cable

(c) capacitor(s) to be connected at the power circuit

(d) capacitor(s) to be connected at the measurement circuit

104. Ans: (b)

105. A capacitance transducer uses two quartz diaphragms of area 750 mm^2 separated by a distance 3.5 mm. The capacitance is 370 pF. When a pressure of 9000 kN/m^2 is applied, the deflection is 0.6 mm. The capacitance at this pressure would be

(a) 619 pF (b) 447 pF

(c) 325 pF (d) 275 pF

105. Ans: (b)

Sol: $C = \frac{\varepsilon A}{d}, C \alpha \frac{1}{d} \ \frac{C_1}{C_2} = \frac{d_2}{d_1}; \ C_2 = \frac{C_1 \times d_1}{d_2} = (370pF) \times \frac{3.5mm}{(3.5-0.6)mm} = 447 \text{ pF}$

106. Consider the following statements regarding Time-Division Multiplexing (TDM):

1. The information from different measuring points is transmitted serially on the same communication channel.
2. It involves transmission of data samples rather than continuous data transmission.
3. It is especially useful when telemetering fast-changing, high bandwidth data.

Which of the above statements are valid in respect to TDM?

(a) 1, 2 and 3 (b) 1 and 3 only

(c) 1 and 2 only (d) 2 and 3 only

106. Ans: (a)

107. Consider the following regarding essential functional operations of a digital data acquisition system:

1. Handling of analog signals
2. Converting the data to digital form and handling it
3. Making the measurement
4. Internal programming and telemetry

Which of the above are valid in the stated context?

(a) 1, 2, 3 and 4 (b) 1, 3 and 4 only

(c) 1, 2 and 3 only (d) 2 and 4 only

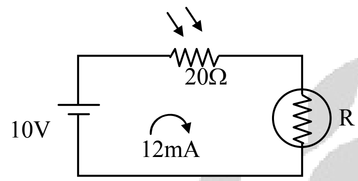
107. Ans: (a)

108. A low resistance LDR of 20Ω, operated at a certain intensity of light, is to be protected through a series resistance in such a way that up to 12 mA of current is to flow at a supply voltage of 10V. What is the nearest value of the protective resistance?

(a) 873 Ω (b) 813 Ω (c) 273 Ω (d) 81 Ω

108. Ans: (b)

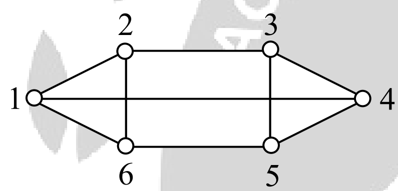
Sol:



10V = 12 m A [20Ω + R]

R = 813 Ω

109. Consider the following with regards to graph as shown in the figure given below:



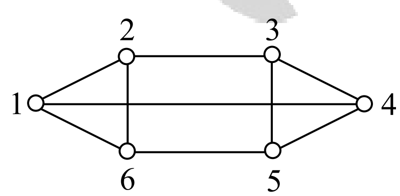
1. Regular graph
2. Connected graph
3. Complete graph
4. Non-regular graph

Which of the above are correct?

(a) 1 and 4 (b) 3 and 4 (c) 2 and 3 (d) 1 and 2

109. Ans: (d)

Sol:



It is a regular & connected graph

It is not complete graph

$\because b \neq n_{C_2}$

110. A network in which all the elements are physically separable is called a

(a) distributed network (b) lumped network

(c) passive network (d) reactive network

110. Ans: (b)

Sol: Elements if physically separable from the network are lumped elements otherwise distributed elements

111. Three identical impedances are first connected in ideal in delta across a 3-phase balanced supply. If the same impedances are not connected in star across the same supply, then

(a) the phase current will be one-third

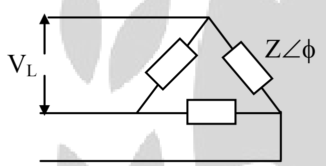
(b) the line current will be one –third

(c) the power consumed will be one-third

(d) the power consumed will be halved

111. Ans: (c)

Sol:

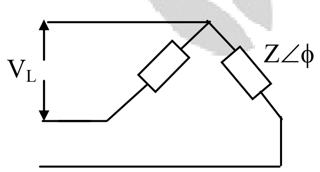


$V_L = V_{pn}$

If $Z = R$

$$P_\Delta = \frac{V_{Pn}^2}{R} = \frac{V_L^2}{R}$$

$$P_Y = \frac{P_\Delta}{3}$$



$$V_{PN} = \frac{V_L}{\sqrt{3}}$$

$$P_Y = \frac{V_{Pn}^2}{R} = \frac{V_L^2}{3R}$$

112. Consider the following statements regarding trees.

(1) A tree contains all the nodes of the graph

(2) A tree shall contain any one of the loops

(3) Every connected graph has at least one tree.

Which of the above statements are correct?

(a) 1 and 2 only

(b) 1 and 3 only

(c) 2 and 3 only

(d) 1, 2 and 3

112. Ans: (b)

Sol: Tree contains all nodes but there is no closed path (no-loop)

Every connected graph has at least one tree

113. A voltage $v(t) = 173\sin(314t+10^0)$ applied to a circuit. It causes a current flow described by $i(t) = 14.14\sin(314t-20^0)$

the average power delivered is nearly

(a) 2500W

(b) 2167W

(c) 1500W

(d) 1060W

113. Ans: (d)

Sol: $V(t) = 173\sin(31.4+10^0)V$

$i(t) = 14.14\sin(314t-20^0)A$

Average power

$P = VI\cos\phi$

$\phi = 10-(-20) = 30^0$

$$P = \frac{173}{\sqrt{2}}.\frac{14.14}{\sqrt{2}}\cos 30^0$$

$$= 1060\text{watt}$$

114. Consider the following statements with respect to a parallel R-L-C circuit

1. The bandwidth of the circuit decrease if R is increased
2. The bandwidth of the circuit remains same if L is increased
3. At resonance, input impedance is a real quantity
4. At resonance, the magnitude of the input impedance attains its minimum value.

Which of the above statements are correct?

(a) 1, 2 and 4 (b) 1, 3 and 4
(c) 2, 3 and 4 (d) 1, 2 and 3

114. Ans: (d)

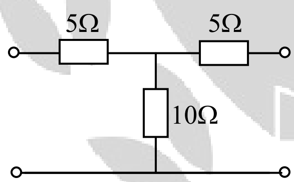
Sol: For an RL-C Parallel circuit

1. Bandwidth = $\frac{1}{RC} = (\omega_2 - \omega_1)$

If R increases then Bandwidth will decreases

2. Bandwidth independent of L value
3. At resonance Z_{in} = real (Img part =0)
4. For RL-C parallel Z_{in} at resonance is maximum

115. What is the admittance matrix for a two-port network shown in the figure given below ?

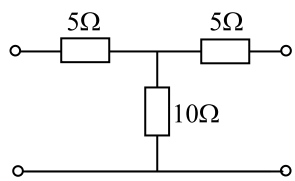


(a) $\begin{bmatrix} 15 & 5 \\ 5 & 15 \end{bmatrix}$ (b) $\frac{1}{20}\begin{bmatrix} 15 & -5 \\ -5 & 15 \end{bmatrix}$

(c) $\begin{bmatrix} 5 & 15 \\ 15 & 5 \end{bmatrix}$ (b) $\frac{1}{200}\begin{bmatrix} 20 & 5 \\ 15 & 20 \end{bmatrix}$

115. No option

Sol: Admittance matrix $[Y] = [Z]^{-1}$



$$Z = \begin{bmatrix} 15 & 10 \\ 10 & 15 \end{bmatrix}$$

$$Y = [Z]^{-1} = \frac{1}{225-100}\begin{bmatrix} 15 & -10 \\ -10 & 15 \end{bmatrix}$$

$$= \frac{1}{125}\begin{bmatrix} 15 & -10 \\ -10 & 15 \end{bmatrix}$$

116. A two-port network is characterized by

$I_1 = 3V_1+4V_2$

$6I_2 = 2V_1 - 4V_2$

It's A, B, C and D parameters are , respectively

(a) 2, 3, 6 and 9

(b) 2,–3,10 and –9

(c) 3, 2, –9 and 6

(d) 3, –2, 9 and –6

116. Ans: (b)

Sol: A two-port network

$I_1 = 3V_1 + 4V_2$ ------(1)

$6I_2 = 2V_1 - 4V_2$ -------(2)

For ABCD parameters

$V_1 = AV_2 - BI_2$

$I_1 = CV_2 - DI_2$

From (2) $V_1 = 2V_2+3I_2$

From (1) $I_1 = 3(2V_2+3I_2) + 4V_2$

$I_1 = 10V_2 + 9I_2$

$V = 2V_2 + 3I_2$

$I_1 = 10V_2 + 9I_2$

A = 2 B = –3

C = 10 D = –9

117. A unit-step voltage is applied at t =0 to a series R-L circuit with zero initial condition. Then

(a) it is possible for the current to be oscillatory

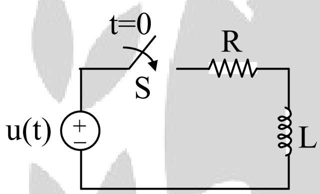
(b) the voltage across the resistor at $t = 0^+$ is zero

(c) the voltage across the resistor at $t = 0^-$ is zero

(d) the resistor current eventually falls to zero

117. Ans: (b)

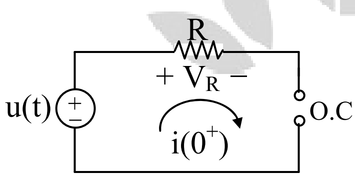
Sol:



$$i(t) = \frac{V(t)}{R}\left(1 - e^{\frac{-t}{\tau}}\right)$$

(a) i(t) is not oscillatory exponentially rising

(b) At $t = 0^+$ 'S' is closed $L \rightarrow OC$



$V_R(0) = 0V$

(c) At $t = 0^-$ 'S' is opened no voltage across 'R'

(d) Resistor current exponentially rising

118. One of the basic characteristics of any steady-state sinusoidal response of a linear R-L-C circuit with constant R, L and C values is

(a) the output remains sinusoidal with its frequency being the same as that of the source

(b) the output remains sinusoidal with its frequency differing from that of the source

(c) the output amplitude equals the source amplitude

(d) the phase angle difference between the source and the output is always zero

118. Ans: (a)

Sol: Steady state sinusoidal response of a linear R-L-C circuit with constant R, L, C values

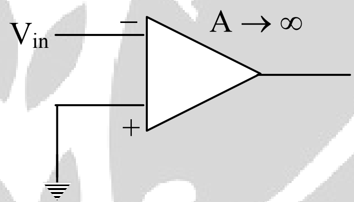
(a) output sinusoidal if it same frequency of source

(b) The response frequency should not differ with source.

(c) output amplitude may not be equal to the source amplitude

(d) the phase angle difference between source and output may not be zero.

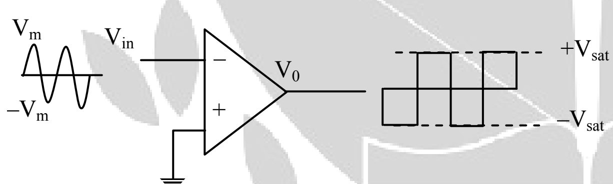
119. If the input (V_{in}) to the circuit is a sine wave, the output will be



(a) half-wave rectified sine wave (b) full-wave rectified sine wave
(c) triangular wave (d) square wave

119. Ans: (d)

Sol:

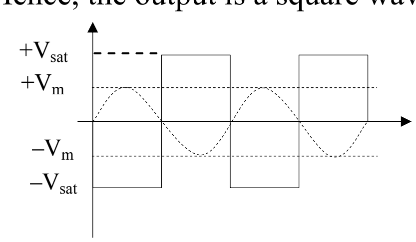


Given circuit is comparator circuit

$V_0 = -V_{sat}$ if $V_{in} > 0$

$V_0 = +V_{sat}$ if $V_{in} < 0$

Hence, the output is a square wave



120. Which one of the following Analog-to-Digital converters (ADC) does not use a DAC?

(a) Digital ramp ADC

(b) Successive approximation ADC

(c) single – slope ADC

(d) Counting ADC

120. Ans: (c)

121. A 12-bit A/D converter has a full-scale analog input of 5V. Its resolution is

(a) 1.22 mV

(b) 2.44mV

(c) 3.66 mV

(d) 4.88 mV

121. Ans: (a)

Sol: $\text{Resolution} = \dfrac{\text{Full scale input}}{\text{No.of quantization level}} = \dfrac{5}{2^{12}} = 1.22\text{mV}$

122. Which of the following circuits converts/convert a binary number on the input to a one-hot encoding at the output?

1. 3-to-8 binary decoder
2. 8-to-3 binary decoder
3. Comparator

Select the correct answer using the code given below.

(a) 1 only

(b) 2 only

(c) 3 only

(d) 1, 2 and 3

122. Ans: (a)

Sol: 3 to 8 binary decoder

123. The simplification in minimal sum of product (SOP) of

$Y = F(A, B, C, D)$

$= \sum_m (0, 2, 3, 6, 7) + \sum_d (8, 10, 11, 15)$

using K-maps is

(a) $Y = AC + B\overline{D}$

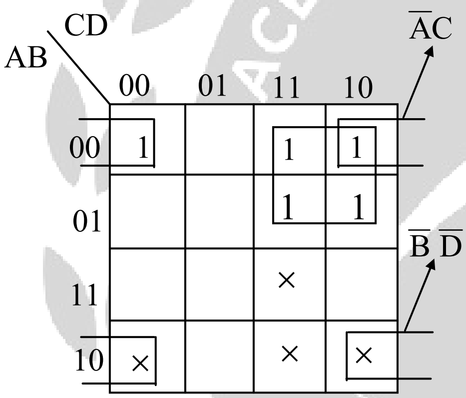
(b) $Y = A\overline{C} + B\overline{D}$

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

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

123. Ans: (d)

Sol:



$Y = \overline{A}.C + \overline{B}.\overline{D}$

124. A circuit outputs a digit in the form of 4 bits 0 is represented by 0000, 1 is represented by 0001, … , 9 by 1001. A combinational circuit is to be designed which takes these 4 bits as input and output as 1, if the digit is ≥ 5, and 0 otherwise. If only AND, OR and NOT gates may be used, what is the minimum number of gates required?

(a) 4

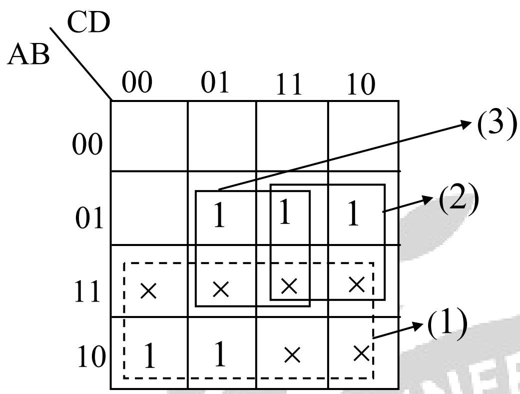
(b) 3

(c) 2

(d) 1

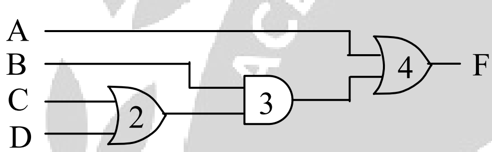
124. Ans: (b)

Sol: F(A,B,C,D) = Σm(5,6,7,8,9)+d(10,11,12,13,14,15)



F = A+BD+BC

F = A+B(C+D)



Hence require 3 gates to realise the function

125. How many 3-to-8 line decoders with an enabler input are needed to construct a 6-to-64 line decoder without using any other logic gates?

(a) 11

(b) 10

(c) 9

(d) 8

125. Ans: (c)

Sol: No. of 3 to 8 line decoder required are

$$\frac{64}{8} = 8$$

$$\frac{8}{8} = 1$$

$$\text{Total} = 9$$

126. The min-term expansion of $F(A, B, C) = AB + B\overline{C} + A\overline{C}$ is

(a) $m_2+m_4+m_6+m_1$

(b) $m_0+m_1+m_3+m_5$

(c) $m_7+m_6+m_2+m_4$

(d) $m_2+m_3+m_4+m_5$

126. Ans: (c)

Sol: $F(A,B,C) = AB + B\overline{C} + A\overline{C}$

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

$ABC + AB\overline{C} - AB\overline{C} + \overline{A}B\overline{C} + AB\overline{C} + A\overline{B}\overline{C}$

$m_7 + m_6 + m_2 + m_4$

127. The output of a NOR gate is

(a) high if all of its inputs are high

(b) low if all of its inputs are low

(c) high if all of its inputs are low

(d) high if only one of its inputs is low

127. Ans: (c)

128. If the input to a T flip- flop is a 100 MHz signal, the final output of three T flip-flops in a cascade is

(a) 1000 MHz

(b) 520 MHz

(c) 333 MHz

(d) 12.5MHz

128. Ans: (d)

Sol: Output frequency is $f_0 = \frac{f}{2^3} = \frac{100\times10^6}{8} = 12.5\text{MHz}$

129. The addition of the two numbers $(1A8)_{16} + (67B)_{16}$ will be

(a) $(889)_{16}$

(b) $(832)_{16}$

(c) $(823)_{16}$

(d) $(723)_{16}$

129. Ans: (c)

Sol: $1AB_H + 67B_H = 823_H$

130. If the operating frequency of an 8086 microprocessor is 10 MHz and , if for the given instruction, the machine cycle consists of 4T-states, what will be the time taken by the machine cycle to complete the execution of that same instruction when three wait states are inserted?

(a) 0.4 μs (b) 0.7 μs

(c) 7 μs (d) 70 μs

130. Ans: (b)

Sol: Clock period $T = \dfrac{1}{10\times10^6} = 0.1\mu s$

Total no. of states for given machine cycle = 4T+3T = 7T

time taken = 7×0.1μs = 0.7μs

131. The probability density function $F(x) = ae^{-b|x|}$, where x is a random variable whose allowable value range is from x = –∞ to x = +∞. The CDF for this function for x≥ 0 is

(a) $\dfrac{a}{b}e^{bx}$

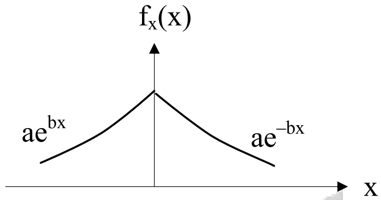
(b) $\dfrac{a}{b}\left(2 - e^{-bx}\right)$

(c) $-\dfrac{a}{b}e^{bx}$

(d) $-\dfrac{a}{b}\left(2 + e^{-bx}\right)$

131. Ans: (b)

Sol: $F_x(x) = a\,e^{-b|x|}$



$$F_x(x)\Big|_{x \ge 0} = P(X \le x) = \int_{\infty}^{x} f_x(x)dx = \int_{\infty}^{0} ae^{bx}dx + \int_{0}^{x} ae^{-}bx\,dx$$

$$= \frac{a}{b}\left(e^{bx}\right)_{-\infty}^{0} - \frac{a}{b}\left(e^{-}bx\right)_{0}^{x}$$

$$= \frac{a}{b} - \frac{a}{b}\left[e^{-}bx - 1\right]$$

$$= \frac{2a}{b} - \frac{a}{b}e^{-}bx$$

$$= \frac{+a}{b}\left[2 - e^{-}bx\right]$$

132. Consider the following statements regarding electrical properties of ceramic materials:

1. They are practically non-conductors at lower temperatures.
2. Ordinary glass and silicates in molten state are dependable as electrical non-conductors.
3. They offer high resistance to current transmission and get heated soon when conducting electric current.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

132. Ans: (b)

Sol: Ceramics are excellent insulators and offer very high resistance for the flow of electric current. But in molten state they have some ionic conductivity due to the metal ions present and hence are not dependable as non – conductors.

133. If primary and secondary windings of core-type single-phase transformer are wound on non-magnetic core, then the

1. Efficiency of the transformer with decrease
2. Efficiency of the transformer with increase
3. Transformer regulation will increase
4. Transformer regulation will decrease

Which of the above possibilities are realized?

(a) 1 and 4

(b) 1 and 3

(c) 2 and 3

(d) 2 and 4

133. Ans: (c)

Sol: If the Transformer core got removed then core loss = 0

So, power loss reduces and efficiency increases

As the core got removed, leakage flux increases, so, voltage regulation increases

134. In the case of small BJT model with common emitter, the collector current i_c is 1.3 mA, when the collector-emitter voltage is V_{ce} of 2.6 V. The output conductance of the circuit is

(a) 2.0 mΩ (b) 2.0 m ℧ (c) 0.5 mΩ (d) 0.5m℧

134. Ans: (d)

Sol: Given $v_{ce} = 2.6V$, $i_c = 1.3mA$

$$G_0 \text{ (o/p conductance)} = \left[\frac{v_{ce}}{i_c}\right]^{-1} = \frac{i_c}{v_{ce}} = \frac{1.6m}{2.6} = 0.5m\mho$$

135. An FM broadcasting radio station transmits signals of frequency 100 MHz with a power of 10 kW. The bandwidth of the modulation signal is from 100 Hz to 1.5 kHz. If the maximum deviation set by the FCC, (δ), is 75 kHz, the range of the modulation index is

(a) 100 to 750 (b) 100 to 250

(c) 50 to 750 (d) 50 to 250

135. Ans: (c)

Sol: $\beta = \dfrac{\Delta f}{f_m}$

$\Delta f = 75\text{kHz}$, $f_m \rightarrow 100$ Hz, to 1.5 kHz

Therefore $\beta \rightarrow \dfrac{75k}{100}$ to $\dfrac{75k}{1.5}$

$\beta \rightarrow 50$ to 750

136. An amplitude-modulated amplifier has a radio frequency output of 60 W at 100% modulation. The internal loss in the modulator is 6 W. What is the un modulated carrier power?

(a) 33 W

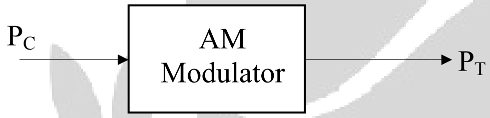
(b) 36 W

(c) 40 W

(d) 44 W

136. Ans: (d)

Sol:



Given $P_T = 60$ W and 6 W insertion loss without insertion loss P_T should be 66W

$$\therefore P_T = P_C\left(1 + \frac{\mu^2}{2}\right),$$

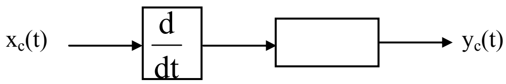
Where P_C un-modulated carrier power

$\mu = 1$ (1005)

$$66 = P_C\left(1 + \frac{1}{2}\right)$$

$$\Rightarrow P_C = \frac{2 \times 66}{3} = 44\text{W}$$

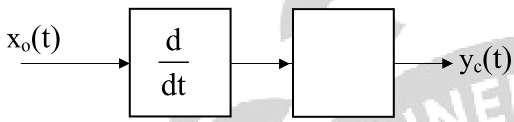
137. The figure shows the block diagram of a frequency discriminator. What does the second block represent?



(a) Envelope detector
(b) Low-pass filter
(c) Ratio detector
(d) Band-reject filter

137. Ans: (a)

Sol:



For frequency discriminator the out $y_c(t)$ proportional to message signal

Let message signal m(t)

$$x_c(t) = A_c \cos\left(2\pi f_c t + 2\pi k_f \int_{-\infty}^{t} m(t)\ dt\right)$$

$$\frac{d}{dt} x_c(t) = -A_c[2\pi f_c + 2\pi k_f\ m(t)]\sin\left((2\pi f_c + 2\pi k_f \int_{-\infty}^{t} m(t)\right)$$

If the block is envelope detector

$$\text{Envelope} = y_c(t) = 2\pi A_c f_c + 2\pi k_f A_c m(t)$$

So that we can demodulate message signal

Note: Here the differentiation operator correspond to a filter.

138. A dominant pole is determined as

(a) The highest frequency pole among all poles
(b) The lowest frequency pole at least two octaves lower than other poles
(c) The lowest frequency pole among all poles
(d) The highest frequency pole at least two octaves higher than other poles

138. Ans: (b)

Sol: Dominant pole is the nearest pole to the imaginary axis and other poles locations should be left most side and its time constant should be less by 5 times to the dominant pole time constant. That means dominant poles is a low frequency poles at least two octaves lower than other poles.

139. If only one multiplexer and one inverter are allowed to be used to implement any Boolean function of n variables, what is the maximum size of the multiplexer needed?

(a) 2^{n-2} line to 1 line

(b) 2^{n-1} line to 1 line

(c) 2^{n+1} line to 1 line

(d) 2^{n+2} line to 1 line

139. Ans: (b)

Sol: To implement n-var function we need "2^{n-1} line to 1 line" multiplier and inverter

140. What is the minimum $\frac{E_b}{N_o}$ required to achieve a spectral efficiency of 6 bps/Hz?

(a) 5.2 (b) 5.3 (c) 10.5 (d) 15.8

140. Ans: (c)

Sol: From Shannon channel capacity theorem

$R \le C$

Where 'R' is information rate of the source

'C' is the channel capacity

For AWGN channel

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

$$C = B\log_2\left(1+\frac{E_b R_b}{N_o B}\right)$$

$$\therefore R_b \le B\log_2\left(1+\frac{E_b}{N_o}\frac{R_b}{B}\right)$$

$$\Rightarrow \left(\frac{E_b}{N_o}\right) \ge \frac{2^{R_b/B}-1}{\left(\frac{R_b}{B}\right)}$$

Where $\frac{R_b}{B}$ is spectral efficiency

$$\therefore \left(\frac{E_b}{N_o}\right) \ge \frac{2^6-1}{6}$$

$$\therefore \left(\frac{E_b}{N_o}\right)_{min} = 10.5$$

141. What is the required bandwidth of a PCM system for 256 quantization levels when 48 telephone channels, each band-limited to 4 kHz, are to be time-division multiplexed by this PCM?

(a) 6.246 MHz

(b) 3.464 MHz

(c) 3.072 MHz

(d) 1.544 MHz

141. Ans: (d)

Sol: The number of bits required to encode 256 quantization levels is $n \geq \log_2 2$; n = 8

number of channels N = 48

all are band limited to 4kHz; then same sampling rate

$$(f_s)_{TDM} = \sum_{i=1}^{N} f_s = Nf_s$$

Bit rate $r_b = n(f_s)_{TDM} = nNf_s$

Required transmission bandwidth

$$(B_T)_{TDM} \geq \frac{r_b}{2}$$

Sampling is done at Nyquist rate for minimum bandwidth

$f_s = 2W$ (Where W is signal bandwidth

$$(B_T)_{TDM} \geq \frac{nN\,2W}{2}$$

$$(B_T)_{TDM} \geq nNW$$

$$(B_T)_{min} \geq nNW = 8 \times 43 \times 4k = 4536MHz$$

$(B_T)_{min}$ = 1.536 MHz

Practically f_s is more than Nyquist rate

B_T = 1.544 MHz

Comment: In this question he did not mention minimum transmission bandwidth and shape of the pulse. Actually bandwidth depends on shape of the pulse and bit rate

142. The modulation scheme used in GSM is

(a) frequency shift keying

(b) phase shift keying

(c) Gaussian minimum shift keying

(d) amplitude shift keying

142. Ans: (c)

Sol: The modulation scheme used in GSM is Gaussian minimum shift keying.

143. The basic motivation behind the development of digital modulation techniques is

(a) to develop a digital communication field

(b) to institute methods for translating digital message from baseband to passband

(c) to develop digitized version of analog modulation schemes

(d) to improve upon pulse modulation schemes

143. Ans: (b)

Sol: The basic function of the modulation is to produce a signal that contains the information sequence that occupies frequencies in the range passed by the channel.

∴ the digital modulation techniques (ASK, PSK, FSK,…..) are used to convert massager from baseband to passband.

144. The received signal level for a particular digital system is –151 dBW and the effective noise temperature of the receiver system is 1500K. The value of $\frac{E_b}{N_o}$ required for a link transmitting 2400 bps is

(a) –12 dB (b) –1.2 dB

(c) +1.2 dB (d) +12 dB

144. Ans: (d)

Sol: $P_r = -151$ dBW

$T_e = 1500K$

$r_b = 2400$ bps

$$\frac{S}{N} = \frac{E_b}{N_0}\frac{R_b}{B}$$

$$\frac{S}{KT_eB} = \frac{E_b}{N_o}\frac{R_b}{B}$$

$$\frac{E_b}{N_o} = \frac{S}{KT_e\,Rb}$$

$$\frac{E_b}{N_o} = \frac{P_r}{r_b}\times\frac{1}{KT_e} = \frac{10^{-15.1}}{2400\times 1.38\times 16^{23}\times 1500} = 15.988$$

$$Eb/N_o\big|_{2B} = 10\log(15.988) = 12.03\,dB$$

145. The largest error between reference input and output during the transient period is called

(a) peak error

(b) transient overshoot

(c) peak overshoot

(d) transient deviation

145. Ans: (c)

Sol: In the transient period, the difference between reference input and output is peak over shoot.

146. Consider the following statements regarding 'relative stability'.

It is defined

1. in terms of gain margin only
2. in terms of phase margin and certain other parameters
3. in terms of gain margin, phase margin and location of poles in s-plane
4. in relation to another identified system.

Which of the above statement are correct?

(a) 1 and 2 (b) 2 and 3

(c) 3 and 4 (d) 1 and 4

146. Ans: (c)

147. Consider the following statements:

For a type-1 and a unity feedback system, having unity gain in the forward path

1. positional error constant K_p is equal to zero

2. acceleration error constant K_a is equal to zero

3. steady-state error e_{ss} per unit-step displacement input is equal to 1

Which of the above statements are correct?

(a) 1, 2 and 3

(b) 1 and 2 only

(c) 2 and 3 only

(d) 1 and 3 only

147. Ans: (c)

Sol: Type-I system gives $k_p = \infty$, $k_a = 0$, $e_{ss} = \frac{1}{1+\infty} = 0$

No answer is matches so approximate answer is (c)

148. Consider a discrete memoryless source with source alphabet $S = \{s_0, s_1, s_2\}$

With probabilities

$P(s_0) = \frac{1}{4}, P(s_1) = \frac{1}{4} \text{ and} P(s_2) = \frac{1}{2}$

The entropy of the source is

(a) $\frac{1}{2}$ bit

(b) $\frac{2}{3}$ bit

(c) $\frac{3}{2}$ bit

(d) $\frac{1}{3}$ bit

148. Ans: (c)

Sol: $H(s) = \sum_i P(S_i)\log_2 P(S_i)$

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

$$= \frac{3}{2}\text{ bits}$$

149. For a lead compensator, whose transfer function is given by $K\frac{s+a}{s+b}; a, b \geq 0$

(a) $a < b$

(b) $a > b$

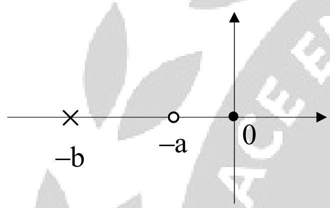
(c) $a \geq Kb$

(d) $a = 0$

149. Ans: (a)

Sol: For lead compensator

$$\text{Transfer function} = K\frac{(s+a)}{(s+b)}$$



a < b

150. A unity feedback system has open-loop transfer function with two of its poles located at –0.1, 1; and two zeros located at –2 and –1 with a variable gain K. For what value(s) of K would the closed-loop system have one pole in the right half of the s-plane?

(a) $K > 0.3$

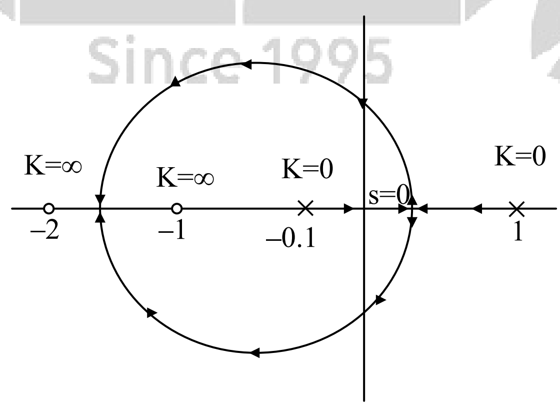
(b) $K < 0.05$

(c) $0.05 < K < 0.3$

(d) $K > 0$

150. Ans: (b)

Sol: $G(s)H(s) = \frac{K(s+1)(s+2)}{(s+0.1)(s-1)}$



One pole in the RH-S-plane. For this get K value at s = 0

$$\left|\frac{K(s+1)(s+2)}{(s+0.1)(s-1)}\right|_{s=0} = 1 \Rightarrow \left|\frac{K(2)}{(-0.1)}\right| = 1$$

$\Rightarrow K < 0.05$