ESE 2023
Preliminary Examination

Detailed Solutions

ELECTRICAL ENGINEERING

Set A

Exam held on 19-02-2023

Corporate Office: 44-A/1, Kalu Sarai, New Delhi -110016
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Electrical Engineering Paper Analysis of ESE 2023 Preliminary Examination		
Sl.	**Subjects**	**Number of Questions**
1.	Engineering Mathematics	12
2.	Electrical Materials	13
3.	Electric Circuits	7
4.	Signals and Systems	14
5.	Power Systems	14
6.	Measurements	14
7.	Computer Fundamentals	11
8.	Electromagnetic Theory	1
9.	Microprocessor	1
10.	Analog Electronics	16
11.	Communication Systems	9
12.	Control Systems	14
13.	Electrical Machines	13
14.	Power Electronics	11

UPSC ESE Prelims 2023
Electrical Engineering Analysis
by **MADE EASY faculties**

https://www.youtube.com/watch?v=l6ZvpmxS72o

1. A small region of an impure silicon crystal with dimensions 1.25×10^{-6} m $\times$ 10^{-3} m $\times$ 10^{-3} m has only the ions (with charge $+1.6 \times 10^{-19}$ C) present with a volume density of $10^{25}/m^3$. The rest of the crystal volume contains equal densities of electrons (with charge -1.6×10^{-19} C) and positive ions. The net total charge of the crystal is

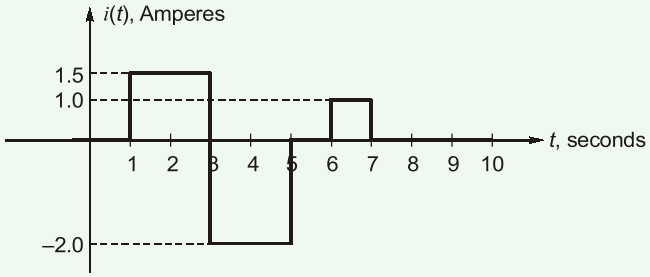
(a) 3×10^{-6} C
(b) 1×10^{-6} C
(c) 1.5×10^{-6} C
(d) 2×10^{-6} C

Ans. (d)

$$\text{Net total charge} = 1.6 \times 10^{-19} \times 10^{25} \times 1.25 \times 10^{-6} \times 10^{-3} \times 10^{-3}$$
$$= 2 \times 10^{-6} \text{ C}$$

End of Solution

2. The current wave form is shown in the figure below. What is the average value over the time interval of 1 to 7 seconds?



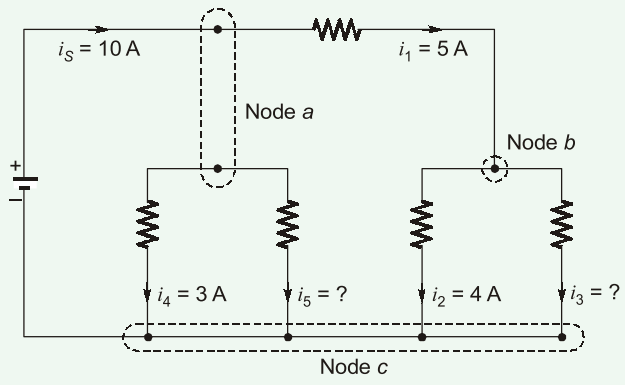
(a) 5.5 A
(b) 1.5 A
(c) 0 A
(d) 2.5 A

Ans. (c)

$$i_{av} = \frac{\text{Area}}{\text{Time}}$$
$$i_{av} = \frac{(1.5 \times 2) + (2 \times -2) + (1 \times 1)}{6}$$
$$i_{av} = 0$$

End of Solution

3. What are the unknown currents i_5 and i_3 respectively for the circuit showni n the figure below?



(a) 2 A and 1 A
(b) 1 A and 2 A
(c) 18 A and 9 A
(d) 9 A and 18 A

Ans. (a)

Given : $i_5 = 10$ A

$i_1 = 5$ A

$i_2 + i_3 = 5$ A

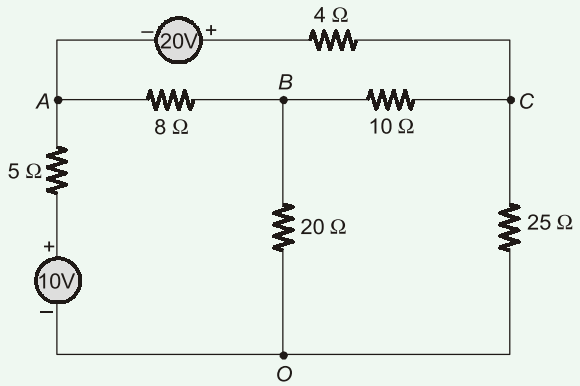
$i_3 = 5 - i_2 = 5 - 4 = 1$ A

Similarly, $i_4 + i_5 = 5$

$i_5 = 5 - 3 = 2$ A

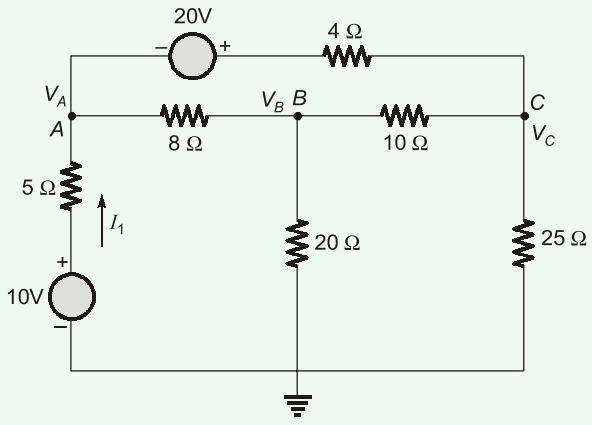
End of Solution

4. What is the current delivered by the 10 V source in the circuit shown below?



(a) 2.132 A
(b) 3.132 a
(c) 1.132 A
(d) 0.532 A

Ans. (c)



KCL at node (A)

$$\frac{V_A - 10}{5} + \frac{V_A - V_B}{8} + \frac{V_A + 20 - V_C}{4} = 0$$

$$\frac{23}{40}V_A - \frac{V_B}{8} - \frac{V_C}{4} = -3 \quad \ldots(1)$$

KCL at node (B)

$$\frac{V_B - V_C}{10} + \frac{V_B}{20} + \frac{V_B - V_A}{8} = 0$$

$$\frac{-V_A}{8} + \frac{11}{40}V_B - \frac{V_C}{10} = 0 \quad \ldots(2)$$

KCL at node (C)

$$\frac{V_C}{25} + \frac{V_C - V_B}{10} + \frac{V_C - 20 - V_A}{4} = 0$$

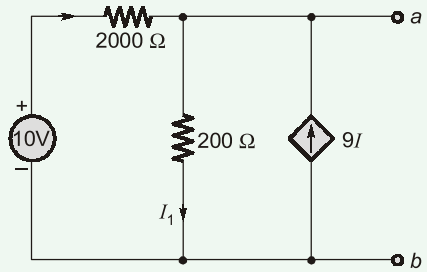
$$\frac{-V_A}{4} + \frac{-V_B}{10} + \frac{39}{100}V_B = 5 \quad \ldots(3)$$

Solving this, $V_A = 4.34$ V

So, $I_1 = \frac{10 - V_A}{5} = 1.132$

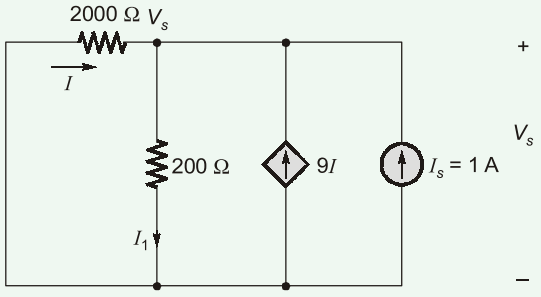
End of Solution

5. The following circuit shown in the figure has a voltage source and a dependent current source. What is the Thevenin equivalent resistance at terminals *a* – *b*?



(a) 10 Ω (b) 20 Ω
(c) 100 Ω (d) 200 Ω

Ans. (c)



$$V_s = 200(I_1) = 200(I + 9I + 1)$$

$$V_s = 200(10I_1 + 1) \quad \ldots(1)$$

Also, $V_s = -2000I \quad \ldots(2)$

$$200(10I + 1) = -2000I$$

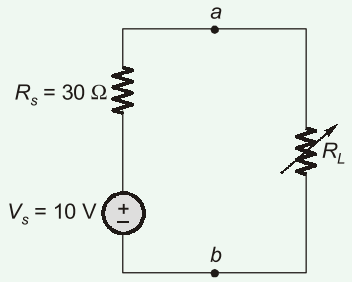
$I = -0.05$ Amp

So, $R_{th} = \frac{V_s}{I_s} = \frac{-2000(-0.05)}{1}$

$R_{th} = 100\ \Omega$

End of Solution

6. An experimental circuit as shown in the figure below has the variable resistor R_L which is adjusted to the value of the load resistor as 10 Ω. What is the maximum load power?



(a) 981 mW
(b) 816 mW
(c) 733 mW
(d) 625 mW

Ans. (d)

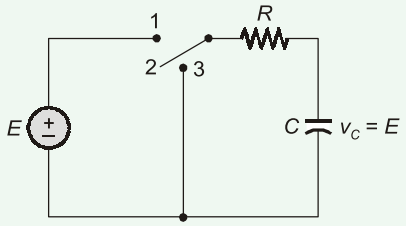
Given : $R_L = 10\ \Omega$

So, $I_L = \frac{V}{R_S + R_L} = \frac{10}{30+10} = \frac{1}{4}$ Amp

$P = (I_L)^2 R_L = \left(\frac{1}{4}\right)^2 \times 10 = 625$ mW

End of Solution

7. In the circuit of the figure shown below, the source voltage is 100 V, the resistance is 10 kΩ, and the capacitance is 0.005 μF. In how much time can the capacitor voltage be discharged to 5 V after the switch is turned to position 3?



(a) 50 μs
(b) 50 ms
(c) 150 ms
(d) 150 μs

Ans. (d)

The initial voltage, $V_c = 100$ V

Time constant, $\tau = RC = 10 \times 10^3 \times 0.005 \times 10^{-6}$

$\tau = 50$ μsec

The final voltage, $V_c(t_o) = 5$ V

The % change in voltage

$$= \frac{100-5}{100} = 95\%$$

So, $t_o = 3\tau = 3 \times 50 = 150$ μsec

End of Solution

8. A wye-connected generator is to be designed to supply a 20-kV three-phase line and supply a line current of 10 A at a lagging power factor of 0.8. How much reactive power (kVAR) should be supplied by the wye-connected generator?

(a) 200.4 kVAR (b) 207.84 kVAR

(c) 277.12 kVAR (d) 346.4 kVAR

Ans. (b)

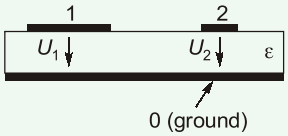
$$Q = \sqrt{3} V_L I_L \sin\phi$$

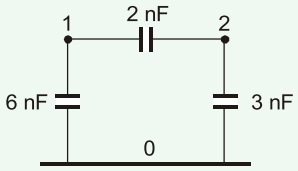
$$= \sqrt{3} \times 20 \times 10^3 \times 10 \times 0.6$$

$$= 207.84 \text{ kVAR}$$

End of Solution

9. A cross-sectional view of a Printed Circuit Board (PCB) consisting of two conducting lands on the surface of a dielectric board above a reference ground plane is shown in the figure. The three-conductor system characterized by a partial capacitance scheme is also shown. For the multiple conductor system, what is the capacitance matrix [C]?





(a) $[C] = \begin{bmatrix} -2 & 8 \\ 5 & -2 \end{bmatrix}$ nF

(b) $[C] = \begin{bmatrix} -2 & 5 \\ 8 & -2 \end{bmatrix}$ nF

(c) $[C] = \begin{bmatrix} 2 & -8 \\ -5 & 2 \end{bmatrix}$ nF

(d) $[C] = \begin{bmatrix} 8 & -2 \\ -2 & 5 \end{bmatrix}$ nF

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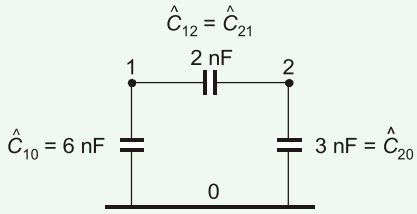
Ans. (d)



From the circuit,

$$Q_1 = \hat{C}_{10}V_1 + \hat{C}_{12}(V_1 - V_2)$$

$$\Rightarrow \quad Q_1 = \hat{C}_{10}V_1 + \hat{C}_{12}V_1 - \hat{C}_{12}V_2$$

$$\Rightarrow \quad Q_1 = (\hat{C}_{10} + \hat{C}_{12})V_1 - \hat{C}_{12}V_2$$

$$\Rightarrow \quad Q_1 = C_{11}V_1 + C_{12}V_2$$

$$\therefore \quad C_{11} = \hat{C}_{10} + \hat{C}_{12} = 8 \text{ nF}$$

$$C_{12} = -\hat{C}_{12} = -2 \text{ nF}$$

Similarly,

$$Q_2 = \hat{C}_{20}V_2 + \hat{C}_{21}(V_2 - V_1)$$

$$\Rightarrow \quad Q_2 = \hat{C}_{20}V_2 + \hat{C}_{21}V_2 - \hat{C}_{21}V_1$$

$$\Rightarrow \quad Q_2 = (\hat{C}_{20} + \hat{C}_{21})V_2 - \hat{C}_{21}V_1$$

$$\Rightarrow \quad Q_2 = C_{22}V_2 + C_{21}V_1$$

$$\therefore \quad C_{22} = \hat{C}_{20} + \hat{C}_{21} = 5 \text{ nF}$$

$$C_{21} = -\hat{C}_{21} = -2 \text{ nF}$$

$$\therefore \quad [C] = \begin{bmatrix} 8 & -2 \\ -2 & 5 \end{bmatrix} \text{nF}$$

End of Solution

10. The two wattmeter method produces wattmeter readigns P_1 = 1500 W and P_2 = 2500 W when connected to a delta-connected load. What is the per-phase reactive power if the line voltage is 220 V?

(a) 3117 VAR (b) 311.7 VAR
(c) 577.3 VAR (d) 5773 VAR

Ans. (c)

Given : P_1 = 1500 Watt, P_2 = 2500 Watt

Reactive power, $Q = \sqrt{3}[P_1 - P_2]$

$$|Q| = \sqrt{3}[1500 - 2500] = 1000\sqrt{3} \text{ (for 3-phase)}$$

$$Q_{\text{per phase}} = \frac{Q}{3} \Rightarrow Q_{\text{per phase}} = \frac{1000\sqrt{3}}{3} = \frac{1000}{\sqrt{3}}$$

$$= 577 \text{ VAR}$$

End of Solution

11. A three-phase balanced star-connected motor draws a real power of 5.6 kW from the line voltage of 220 V and the line current of 18.2 A. What is the approximate power factor of this motor?

(a) 0.6075 (b) 0.8075
(c) 0.4075 (d) 0.2075

Ans. (b)

Given that :

Real power, $P = 5.6 \text{ kW} = 5600 \text{ WA}$

$V_{\text{line}} = 220 \text{ Volt}, I_{\text{line}} = 18.2 \text{ Amp}$

$$P = \sqrt{3} V_L \cdot I_L \cos(\theta)$$

$$\Rightarrow \quad 5600 = \sqrt{3} \times 220 \times 18.2 \times \cos(\theta)$$

$$\text{P.f} = \cos(\theta) = 0.8075$$

End of Solution

12. A circuit composed with series combination of sinusoidal voltage source $V_s = 3\cos(100t - 3°)$ V, a 500 Ω resistor, a 30 mH inductor and an unknown impedance. What is the value of unknown impedance (Z_L) if the voltage source delivers maximum average power?

(a) $500 - j30\ \Omega$ (b) $500 + j30\ \Omega$
(c) $500 - j3\ \Omega$ (d) $500 + j3\ \Omega$

Ans. (c)

$$Z_L = Z_S^*$$

$$Z_S = R + jXL$$

$$= 500 + j100 \times 30 \times 10^{-3} = 500 + j3$$

$$Z_L = (500 - j3)\ \Omega$$

End of Solution

13. Which one of the following is used to protect the standard cell and galvanometer against over currents?

(a) A pressure coil in series (b) A current coil in parallel
(c) A resistance in series (d) A resistance in parallel

Ans. (c)

Resistance in series.

End of Solution

14. In the measurement of a low resistance using a potentiometer, voltage drop across the low resistance under test is 0.4 V, voltage drop across 0.1 Ω standard resistance is 1 V. What is the powr loss in unknown resistance?

(a) 0.04 W (b) 0.4 W

(c) 4 W (d) 40 W

Ans. (c)

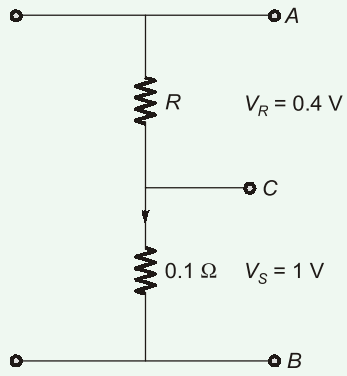
Voltage across low resistance = 0.4 V

Let R (R_{AC}) low resistance

and S = Standard resistance = 0.1 Ω = R_{AB}

Voltage difference across standard resistance

= 1 V = E



Length ratio = Voltage ratio = Resistance ration

$$\frac{I_1}{I} = \frac{E_1}{E} = \frac{R_{AC}}{R_{AB}}$$

$$\frac{0.4}{1} = \frac{R_{AC}}{0.1\,\Omega}$$

R_{AC} = 0.04 Ω (unknown resistance)

$$I = \frac{E_1}{R_{AC}} = \frac{0.4}{0.04} = 10 \text{ A}$$

Power loss in unknown resistance

$= I^2 R_{AC}$

$= (10)^2 \times 0.04$

= 4 W

End of Solution

15. Consider the following statements :

1. Potentiometer is the usual basis for calibration of voltmeters, ammeters and wattmeters.
2. The potentiometers may not be used for measurement of current, powr and resistance.

What of the above statement(s) is/are correct?

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

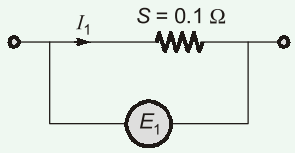
Ans. (a)

End of Solution

16. A simple slide wire is used for measurement of current in a circuit. The voltage drop across a standard resistor of 0.1 Ω is balanced at 75 cm. What is the magnitude of current in the circuit if the standard cell emf of 1.45 V is balanced at 50 cm?

(a) 21.75 A
(b) 10.87 A
(c) 9.66 A
(d) 4.83 A

Ans. (a)



V.D. across standard resistor $\Rightarrow E_1$

Let $S \Rightarrow$ Standard resistance

$$S = 0.1\ \Omega \quad \Rightarrow \quad L_1 = 75\ \text{cm}$$

Standard cell E.M.F.

$$\Rightarrow \qquad E = 1\ \text{volt} \quad \Rightarrow \quad l = 50\ \text{cm}$$

$$\frac{E_1}{E} = \frac{l_1}{l}$$

$$\Rightarrow \qquad E_1 = \left(\frac{1.45\ \text{Volt}}{50\ \text{cm}}\right) \times 75\ \text{cm}$$

$$= 2.175\ \text{Volt} \Rightarrow E_1$$

$$I_1 = \frac{E_1}{S} = \frac{2.175\ \text{Volt}}{0.1\ \Omega} = 21.75\ \text{Amp}$$

End of Solution

17. Which one of the following methods is **not** used in measurement of high resistance?

(a) Direct deflection method
(b) Megohm bridge method
(c) Megger method
(d) Kelvin double bridge method

Ans. (d)

Kelvin double bridge is used for low resistance.

End of Solution

18. Which one of the following is intended for the rapid measurement of the winding resistances of machines and transformers?

(a) Direct deflection
(b) Wheatstone bridge
(c) Megger
(d) Kelvin bridge ohmmeter

Ans. (d)

Kelvin double bridge is used for low resistance measurement.

End of Solution

19. A highly sensitive galvanometer can detect a current as low as 0.1 nA. This valvanometer is used in a Wheatstone bridge as a detector. Each arm of the bridge has a resistance of 1 kΩ. The input voltage applied to the bridge is 20 V. What is the smallest change in resistance which can be detected, if the resistance of the galvanometer can be neglected compared to the internal resistance of the bridge?

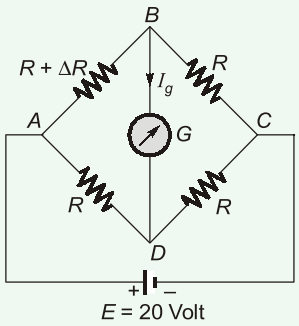
(a) 10 mΩ
(b) 10 μΩ
(c) 20 mΩ
(d) 20 μΩ

Ans. (d)

Given that : $I_g = 0.1$ nAmp $= 0.1 \times 10^{-9}$ Amp

$R = 1$ kΩ, Supply $= E = 20$ Volt

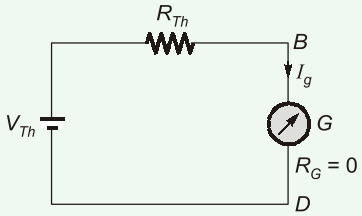
It is a quarter bridge :



$$V_{Th} = \frac{E}{4} \times \frac{\Delta R}{R}$$

$$R_{Th} = R \parallel R + R \parallel R = R = 1 \text{ k}\Omega$$

$$I_g = \frac{V_{Th}}{R_{Th}} \Rightarrow V_{Th} = I_g \times R_{Th}$$



$$V_{Th} = 0.1 \times 10^{-9} \times 10^{3} = 0.1 \times 10^{-6} \text{ Volt}$$

$$0.1 \times 10^{-6} = \frac{20}{4} \times \frac{\Delta R}{10^{3}}$$

$$\Rightarrow \quad \Delta R = \frac{0.1 \times 10^{-6} \times 10^{3}}{5} = \frac{0.1 \times 10^{-3}}{5}$$

$$\Delta R = 0.02 \times 10^{-3} = 20 \times 10^{-6} = 20\ \mu\Omega$$

End of Solution

20. Which one of the following methods is **not** used in measurement of low resistance?

(a) Direct deflection method
(b) Ammeter voltmeter method
(c) Potentiometer method
(d) Kelvin double bridge method

Ans. (a)

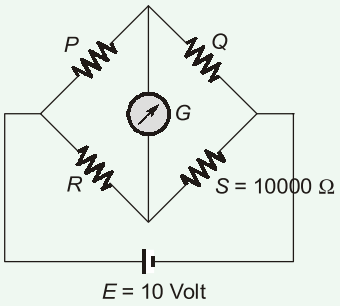
Direct deflection method is used for high resistance measurement.

End of Solution

21. A regular Wheatstone bridge is used to measure high resistance. The bridge has ratio arms of 10,000 Ω and 10 Ω. The adjustable arm has a maximum value of 10,000 Ω. A battery of 10 V emf and negligible resistance is connected from the junction of ratio arms to the opposite corner. What is the maximum resistance that can be measured by this arrangement?

(a) 10 kΩ
(b) 10 MΩ
(c) 100 kΩ
(d) 100 MΩ

Ans. (b)



Given that : $P = 10000\ \Omega = 10\ k\Omega$

$E = 10$ Volt; $Q = 10\ \Omega$; $S = 10000\ \Omega = 10\ k\Omega$

$$R = \frac{P}{Q} \times S$$

$$R = \frac{10\ k\Omega}{10} \times 10\ k\Omega = 10\ M\Omega$$

End of Solution

22. A resistance of approximately 3000 Ω is needed to balance a bridge. It is obtained on a 5 dial resistance box having steps of 1000 Ω, 100 Ω, 10 Ω, 1 Ω and 0.1 Ω. The measurement is to be guaranteed to 0.1 percent. For this accuracy, how many of these dials would it be worth to adjust?

(a) 2997 Ω to 3003 Ω
(b) 3000 Ω to 3006 Ω
(c) 2994 Ω to 3000 Ω
(d) 2996 Ω to 3002 Ω

Ans. (a)

$$3000 \pm 0.1\%$$

Limiting value of 3000 Ω

$$\Rightarrow \quad 3000 \pm 3000 \times 0.1\%$$

$$= 3000 \pm 3000 \times \frac{0.1}{100}$$

$\Rightarrow$ 2997 to 3003 Ω

End of Solution

23. Consider the following statements :

1. Campbell's bridge measures an unknown mutual inductance in terms of a standard mutual inductance.
2. Campbell's bridge is used for measurement of self-inductance in terms of a standard mutual inductance.

Which of the above statement(s) is/are correct?

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

Ans. (a)

Only 1 statement correct.

End of Solution

24. Consider the following statements :

1. Carey Foster bridge is used for measurement of a capacitance in terms of a standard mutual inductance.
2. Heydweiller bridge is used for measurement of mutual inductance in terms of a standard mutual inductance.

Which of the above statement(s) is/are correct?

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

Ans. (a)

Only 1 statement is correct.

End of Solution

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25. A benchmark program is run on a 200 MHz processor. The executed program consists of 1 million instruction executions, with the following instruction mix and clock cycle count :

Instruction Type	Instruction Count (Million)	Cycles per Instruction
Arithmetic and logic	8	1
Load and store	4	3
Branch	2	4
Others	4	3

What is the effective MIPS rate for the given program?

(a) 90 (b) 70

(c) 110 (d) 80

Ans. **(a)**

$$\text{Cycle time} = \frac{1}{200\ \text{MHz}}\text{sec}$$

$$= 0.005\ \mu\text{sec}$$

$$\text{Average instruction ET} = \left(\frac{\text{Time req/prog}}{\text{Instruction/prog}}\right)$$

$$= \frac{[(8*1)+(4*3)+(2*4)+(4*3)]0.005\ \mu\text{sec}}{8+4+2+4}$$

$$= 0.01111\ \mu\text{sec}$$

$$1\ \text{Instruction} = 0.01111\ \mu\text{sec}$$

$$\text{Instruction} = 1\ \text{sec}$$

$$= \frac{1\,\text{Instruction}}{0.01111\,\mu\text{sec}}$$

$$= 90\ \text{MIPS}$$

End of Solution

26. What is the exponent length in bits for IEEE double-precision floating point format?

(a) 32 bits (b) 8 bits

(c) 16 bits (d) 11 bits

Ans. **(d)**

Double precision (64 bit) format

64 bit

S	BE	M
1 bit	11 bit	52 bit

End of Solution

27. Which one of the following instruction formats is designed to be a large-scale time-shared system, with an emphasis on making the system easy to program, even if additional hardware expense was involved?

(a) PDP-8 (b) PDP-10
(c) PDP-6 (d) PDP-12

Ans. (b)

In large scale time shared system, PDP-10 instruction formats are used.

End of Solution

28. Which one of the following statement(s) is/are correct for machine parallelism?

(a) It is a measure of the ability of the processor to take disadvantage of instruction-level parallelism.
(b) It is determined by the frequency of true data dependencies and procedural dependencies in the code.
(c) It is determined by the number of instructions that can be fetched and executed at the same time and by the speed and sophistication of the mechanisms that the processor uses to find independent instructions.
(d) It is determined by the time until the result of an instruction is available for use as an operand in a subsequent instruction.

Ans. (c)

Parallelism means multiple (two or more). Instructions are executed at the same time.

End of Solution

29. Consider a main memory consisting of 4 K blocks, a cahce memory consisting of 64 blcoks, and a block size of 32 words. Compute the number of bits in the main memory address using direct-mapped cache techniques.

(a) 16 (b) 17
(c) 19 (d) 14

Ans. (b)

Blocks in main memory = 4 K
Lines in cache memory = 64
Block size = 32 words
$\therefore$ Main memory size = $4\text{ K} \times 32\text{ W}$
$= 2^{12} \times 2^5\text{ W}$
$= 2^{17}\text{ W}$
So, MM addr = $\log_2 2^{17} = 17$ bit

End of Solution

30. Which one of the following methods is used when the processor issues an I/O command, continues to execute other instructions, and is interrupted by the I/O module when the latter has completed its work?

(a) Interrupt-driven I/O
(b) I/O device controller
(c) I/O channel processor controller
(d) Programmed I/O

Ans. (a)

In interrupt driven I_O, CPU initializes the IO module for IO job later busy with other task. Meanwhile checking for interrupts, when interrupt occurs then CPU service the interrupt by suspend the normal flow of execution.

End of Solution

31. Which one of the following statements is correct for atomic data?

(a) Aggregation of atomic and composite data into a set iwth defined relationships are validated.
(b) Heterogeneous combination of data into a single structure with an identified key is validated.
(c) Homogeneous combination of data into a single structure with an identified key is validated.
(d) It is a data that consists of a single piece of information; that is, they cannot be divided into other meaningful pieces of data.

Ans. (d)

Atomic data is a primitive data which does not have the further decomposition. So, atomic data is a final meaning of the data.

End of Solution

32. Consider the four processes $P_1 = 6$, $P_2 = 8$, $P_3 = 7$ and $P_4 = 3$ with the length of the CPU burst time given in milliseconds and all four processes arrive at time 0. What is the average waiting time for these processes with the shortest job first algorithm?

(a) 5 ms
(b) 7 ms
(c) 9 ms
(d) 11 ms

Ans. (b)

Pid	*BT*
*P*1	6
*P*2	8
*P*3	7
*P*4	3

AT = 0

Chart :

*P*4	*P*1	*P*3	*P*4

0 3 9 16 24

	CT	TAT	WT
P_1	9	9	3
P_2	24	24	16
P_3	16	16	9
P_4	3	3	0

$$\therefore \quad \text{Average weigth} = \frac{(3+16+9+0)}{4} = 7$$

End of Solution

33. The processes that are residing in main memory and are ready and waiting to execute are kept on a list called the ready queue. Then, this queue is generally stored as

(a) a double ended queue
(b) a priority queue
(c) a linked list
(d) a double ended list

Ans. (b)

Processes are inserted into a queue based on the arrival time.

End of Solution

34. When a process creates a new process using the fork() operation, which one of the following states is shared between the parent process and the child process?

(a) Stack
(b) Heap
(c) Linked list
(d) Shared memory segments

Ans. (d)

Shared memory segments are shared between the parent and child processes.

End of Solution

35. Consider the following statements regarding thread pool :

1. It is to create a number of threads at process startup and place them into a pool, where they sit and wait for work.
2. A thread pool limits the number of threads that exist at any one point and this is particularly important on systems that cannot support a large number of concurrent threads.
3. Once the summation thread is created, the parent must wait for it to complete before outputttting the value of sum, as the value is set by the summation thread.
4. It allocates memory and initializes a new thread in the JVM.

Which of the above statements are correct?

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

Ans. (d)

A thread pool reuses previously created threads to execute current tasks and offers a solution to the problem of thread cycle overhead and resource thrashing.

Thread pool is a pool of worker threads. Worker thread is thread which can accept the task then complete it and come back again to thread pool to accept another task.

End of Solution

36. Which one of the following is used for recognizing the magnetic encoding numbers printed at the bottom of a cheque?

(a) Optical Mark Recognition
(b) Magnetic Ink Character Recognition
(c) Barcode Reader
(d) Optical Character Recognition

Ans. (b)

Magnetic encoding numbers on a bank cheque are recognized by MICR Reader, i.e., Magnetic Ink Character Recognition Reader. MICR code helps to avoid fraudulent transactions. Its a 9-digit code, representing city, bank code and branch.

End of Solution

37. Consider the following statements regarding biasing of p-n junction :

1. The depletion layer width gets narrowed down on application of forward voltage.
2. A forward-biased p-n junction offers very high resistance to current flow.
3. The barrier potential increases when the junction is reverse-biased.
4. Majority charge carrier's current is established in a forward-biased p-n junction.

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

Ans. (c)

Statement 1 : In forward bias depletion layer width will become narrower (True).
Statement 3 : In reverse bias depletion layer width will be wider (True).
Statement 4 : In forward bias majority charge carriers current is established (True).

End of Solution

38. Which one of the following is the correct representation of Boltzmann diode equation with standard notations? (where I is the diode current, V is the bias voltage and V_T is the thermal voltage)

(a) $I = I_0\left(e^{\frac{V}{\eta V_T}} - 1\right)$
(b) $I = I_0\left(e^{\frac{V}{\eta V_T}} + 1\right)$
(c) $I = I_0\left(e^{-\frac{V}{\eta V_T}} - 1\right)$
(d) $I = I_0\left(e^{-\frac{V}{\eta V_T}} + 1\right)$

Ans. (a)

The Boltzmann diode equation is

$$I = I_o\left[e^{V/\eta VT} - 1\right]$$

End of Solution

39. The common emitter configuration is widely used due to its

(a) low voltage and low power gain (b) low voltage and high power gain

(c) high voltage and high power gain (d) high voltage and low power gain

Ans. (c)

Common emitter configuration is widely used due to high voltage and high power gain.

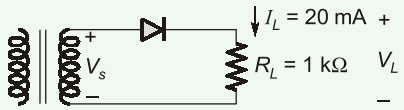
End of Solution

40. A silicon diode made half-wave rectifier produces a maximum value of load current as 20 mA through a resistance of 1 kΩ. What is the PIV of the diode?

(a) 14.7 V (b) 16.7 V

(c) 18.7 V (d) 20.7 V

Ans. (d)



$V_L = I_L \times R_L = 20\text{ mA} \times 1\text{ K}$

$= 20\text{ V}$

P.I.V. $= V_L = 20$ V (ideal)

P.I.V. $= V_{D\,on} + V_L = 20.7$ V (practical)

End of Solution

41. Ripple factor for a half-wave and a full-wave rectifier circuits respectively are

(a) 0.48 and 1.21 (b) 0.37 and 2.12

(c) 1.21 and 0.48 (d) 2.12 and 0.37

Ans. (c)

Ripple factor for HWR is 1.21.

Ripple factor for FWR is 0.48.

End of Solution

42. If a transistor has the value of common base current gain 0.98, then what is the value of common emitter current gain?

(a) 48 (b) 49

(c) 50 (d) 51

Ans. (b)

Common base current gain

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$$\alpha = 0.98$$

Common emitter current gain

$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.98}{1-0.98} = 49$$

End of Solution

43. The junction FET is a three terminal

(a) voltage controlled voltage device (b) current controlled voltage device

(c) voltage controlled current device (d) current controlled current device

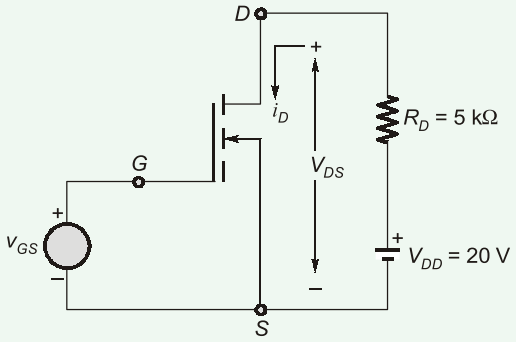
Ans. **(c)**

JFET is a VCCS (voltage controlled current device)

$$I_D \propto V_{GS}$$

End of Solution

44. Consider the basic MOSFET circuit as shown in the figure with variable gate voltage. The MOSFET is given to have very large V_A, V_T = 4 V, and I_{DSS} = 8 mA. What is the value of i_D for v_{GS} = 5 V? (Where V_A is a constant in the rantge of 30 V to 200 V)



(a) 0.2 mA (b) 0.5 mA

(c) 1.0 mA (d) 2.0 mA

Ans. **(b)**

$$I_O = I_{oss}\left[1-\frac{V_{GS}}{V_T}\right]^2$$

KVL in output loop

$$V_{DD} = I_D r_D + V_{DS}$$

$$\frac{V_{DD}-V_{DS}}{R_D} = I_{oss}\left[1-\frac{V_{GS}}{V_T}\right]^2$$

$$\frac{20-V_{DS}}{5K} = 8\text{ mA}\left[1-\frac{5}{4}\right]^2$$

$$V_{DS} = 17.5\text{ V}$$

$$V_{DD} = I_D R_D + V_{DS}$$

$$I_D = \frac{V_{DD} - r_{DS}}{R_D}$$

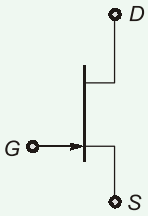
$$= \frac{20 - 17.5}{5K} = \frac{2.5}{5K}$$

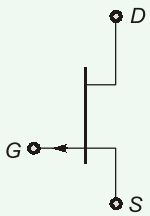
$$= \frac{1}{2}\ \text{mA}$$

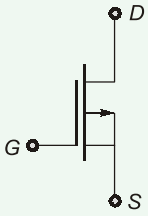
$$= 0.5\ \text{mA}$$

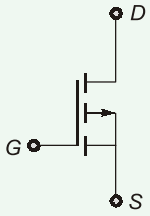
End of Solution

45. Which one of the following is the correct circuit symbol representation of p-channel JFET?

(a) 

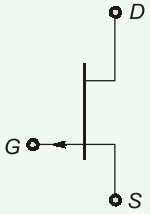
(b) 

(c) 

(d) 

Ans. **(b)**

The symbol representation of p-channel JFET is



End of Solution

46. Consider the following statements regarding FET amplifier configurations :

1. For common-source and common-drain configurations, $R_{in} = R_1 \parallel R_2$, which can be selected to be large during bias design.
2. For the common-drain configuration, the voltage gain is generally less than unity or near unity.
3. For the common-gate configuration, the current gain cannot be larger than unity.

Which of the above statement(s) is/are correct?

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

Ans. (d)

Statement 1 : For common sources common drain

$$R_{in} = R_1 \parallel R_2 \text{ (True)}$$

Statement 2 : For common drain configuration, the voltage gain is nearly unity (True).

Statement 3 : For common gate configuration, current gain is nearly unity (True).

End of Solution

47. An amplifier has a bandwidth of 500 kHz and voltage gain of 100. What is the amount of negative feedback if the bandwidth is extended to 5 MHz?

(a) 9.0 (b) 0.9

(c) 0.09 (d) 0.009

Ans. (c)

An amplifier,

Bandwidth, $BW = 500$ kHZ

$A_V = 100$

$(BW)_F = 5$ MHz

$A_F(BW)_F = A_V BW$

$$A_F = \frac{A_V \cdot 8W}{(BW)_F} = \frac{100 \times 500 \text{ kHz}}{5 \text{ MHz}} = 10$$

$$A_F = \frac{A_V}{1 + A_V\beta}$$

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

$$1 + 100\beta = 10$$

$$100\beta = 9$$

$$\beta = \frac{9}{100} = 0.09$$

End of Solution

48. An amplifier has an open loop voltage gain of 1000. If 10% negative voltage series feedback is used, what is the closed loop voltage gain?

(a) 0.19 (b) 1.9

(c) 9.9 (d) 0.99

Ans. (c)

Am amplifier has

Open loop voltage gain, $A = 1000$

$$\beta = \frac{10}{100} = 0.1$$

$$A_F = \frac{A}{1 + A\beta} = \frac{1000}{1 + 1000 \times 0.1}$$

$$= \frac{1000}{1+100} = \frac{1000}{101} = 9.9$$

End of Solution

49. Which one of the following quantities is a material parameter?
(a) Peridynamic lattice
(b) Electrical elongation
(c) Thermal elongation
(d) Electrical conductivity

Ans. (d)
Electrical conductivity is a material parameter.

End of Solution

50. The property of periodicity in crystal structure is repeated in three dimensions. The positive ions occupy the corners of a cube as well as the centres of the cubic face. Then these crystals are called
(a) Face-centered cubic crystals
(b) Body-centered cubic crystals
(c) Halite-centered cubic crystals
(d) Rock-salt-centered cubic crystals

Ans. (d)

End of Solution

51. The electrical conductivity depends on
(a) the volume concentration of the holes and on their mobility.
(b) the volume concentration of the electrons of conduction and on their mobility.
(c) concentration of both electrons and protons.
(d) concentration of electrons only.

Ans. (b)

$$\sigma = \eta q \mu_n$$

End of Solution

52. The classical theory of the diamagnetism of the bonded electrons in a free atom was elaborated by
(a) Langevin diamagnetism
(b) Larmor diamagnetism
(c) Lorentz diamagnetism
(d) Thomson diamagnetism

Ans. (a)
Theory of diamagnetism was worked out by **Paul Langevin**. Negative magnetism present in an applied field even though the material is composed of atoms that have no net magnetic moment.

End of Solution

53. Which one of the following is the process of heating a material to just below its melting point?
(a) Sinter
(b) Squid
(c) Josephson junction
(d) Stripes

Ans. (a)

Sintering is the process of compacting and farming a solid mass of material by pressure or heat without melting it to the point of liquefaction.

End of Solution

54. Which of the following are the mixtures of materials used for the sliding contacts which appear between the trolley and the trolley cable in the electrical traction of high braking power?

(a) Silver, Electrolytic copper, Lead with Zinc and Aluminium
(b) Silver, Copper, Bronze with Beryllium and Cadmium
(c) Silver, Copper, Lead with Zinc and Gold
(d) Silver, Electrolytic copper, Bronze with Zinc and Gold

Ans. (a)

Copper and aluminium alloy is used.

End of Solution

55. Which one of the following is the element exhibiting antiferromagnetism at room temperature?

(a) Iron
(b) Nickel
(c) Chromium
(d) Cobalt

Ans. (c)

At room temperature, Iron, Nickel and Cobalt are ferromagnetic.

End of Solution

56. Electro-optic devices that emit radiations of different colours are called

(a) Opto-couplings
(b) Photoresistors
(c) Light emitting diodes
(d) Void generators

Ans. (c)

LEDs emit radiations of different colours depending upon bandgap of materials.

End of Solution

57. The phenomenon where superconductivity in a material is suppressed by exceeding the maximum current the material can conduct (J_c) or the maximum magnetic field it can withstand (H_c) is called

(a) Sinter
(b) Quench
(c) Stripes
(d) Proximity effect

Ans. (d)

End of Solution

58. Which one of the following corresponds to the variation of the rotation frequency of the electron when the external field is applied?

(a) Langevin frequency
(b) Lorentz frequency
(c) Thomson frequency
(d) Larmor frequency

Ans. (d)

Larmour angular frequency is defined as the change in angular frequency of the electron due to applied flux density.

$$\omega_L = \frac{qB}{2\,m}$$

End of Solution

59. Which one of the following agents is an intrinsic agent that influences conductivity in electro insulating materials?

(a) Humidity
(b) The nature of the dielectric
(c) Temperature
(d) Pressure

Ans. (b)

Humidity, temperature and pressure are external agent.

End of Solution

60. A semiconductor indium phosphide material behaves as an insulator at

(a) high temperature
(b) medium temperature
(c) normal room temperature
(d) very low temperature

Ans. (d)

At 0 K (very low temperature)
Semiconductor behaves as a perfect insulator.

End of Solution

61. The general solution of the system

$$6x_1 - x_2 + x_3 = 0$$
$$x_1 - x_4 + 2x_5 = 0$$
$$x_1 - 2x_5 = 0$$

(a) $X = \alpha\begin{pmatrix} -\frac{1}{9} \\ -\frac{2}{3} \\ \frac{2}{3} \\ 1 \\ 0 \end{pmatrix} + \beta\begin{pmatrix} -\frac{11}{9} \\ -\frac{13}{3} \\ \frac{1}{3} \\ 0 \\ 1 \end{pmatrix}$

(b) $X = \alpha\begin{pmatrix} -\frac{1}{9} \\ -\frac{2}{3} \\ \frac{2}{3} \\ 1 \\ 0 \end{pmatrix} + \beta\begin{pmatrix} -\frac{11}{9} \\ -\frac{13}{3} \\ \frac{1}{3} \\ 0 \\ 1 \end{pmatrix} + \gamma\begin{pmatrix} -\frac{11}{9} \\ -\frac{13}{3} \\ 0 \\ \frac{1}{3} \\ 1 \end{pmatrix}$

(c) $X = \alpha\begin{pmatrix} -\frac{1}{9} \\ -\frac{2}{3} \\ \frac{2}{3} \\ 1 \\ 0 \end{pmatrix} + \beta\begin{pmatrix} -\frac{11}{9} \\ -\frac{13}{3} \\ \frac{1}{3} \\ 0 \\ 1 \end{pmatrix} + \gamma\begin{pmatrix} -\frac{11}{9} \\ 1 \\ 0 \\ \frac{1}{3} \\ 1 \end{pmatrix}$ (d) $X = \alpha\begin{pmatrix} -\frac{1}{9} \\ 0 \\ \frac{2}{3} \\ 1 \\ 0 \end{pmatrix} + \beta\begin{pmatrix} -\frac{11}{9} \\ -\frac{13}{3} \\ \frac{1}{3} \\ 1 \\ 1 \end{pmatrix}$

Ans. (*)

Assume : $x_5 = \alpha$

$x_1 = 2\alpha$

$x_1 - x_4 + 2x_5 = 0$

$2\alpha - x_4 + 2\alpha = 0$

$x_4 = 4\alpha$

$x_3 = \beta$

$6x_1 - x_2 + x_3 = 0$

$12\alpha - x_2 + \beta = 0$

$x_2 = 12\alpha + \beta$

$x_2 = 12\alpha + \beta$

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{bmatrix} = \begin{bmatrix} 2\alpha \\ 12\alpha+\beta \\ \beta \\ 4\alpha \\ \alpha \end{bmatrix} = \alpha\begin{bmatrix} 2 \\ 12 \\ 0 \\ 4 \\ 1 \end{bmatrix} + \beta\begin{bmatrix} 0 \\ 1 \\ 1 \\ 0 \\ 0 \end{bmatrix}$$

End of Solution

62. If the eigen values of the matrix $A = \begin{pmatrix} 5 & -2 \\ m & -6 \end{pmatrix}$ are 3 and –4, then what is the value of m?

(a) 6 (b) 4

(c) 8 (d) 9

Ans. (d)

$|A| = -30 + 2m = 3 \times -4$

$m = 9$

End of Solution

63. If $z = f(x + ct) + \phi(x - ct)$, then $\frac{\partial^2 z}{\partial t^2} =$

(a) $c\frac{\partial^2 z}{\partial x^2}$ (b) $c^2\frac{\partial^2 z}{\partial x^2}$

(c) $-c^2\frac{\partial^2 z}{\partial x^2}$ (d) $-C^2\frac{\partial^2 z}{\partial x^2}$

Ans. (b)

$$\frac{\partial^2 z}{\partial t^2} = c^2[f''(x+Ct)+\phi''(x-Ct)]$$

$$\frac{\partial^2 z}{\partial x^2} = f''(x + Ct) + \phi''(x - Ct)$$

$$\frac{\partial^2 z}{\partial t^2} = C^2\frac{\partial^2 z}{\partial x^2}$$

End of Solution

64. The volume of the solid enclosed between the paraboloids $z = 5x^2 + 5y^2$ and $z = 6 - 7x^2 - y^2$ is

(a) $\frac{3\pi}{2\sqrt{2}}$ (b) $\frac{3\pi}{\sqrt{2}}$

(c) $\frac{3\pi^2}{\sqrt{2}}$ (d) $\frac{3\pi^3}{\sqrt{2}}$

Ans. (b)

Given : $z = 5x^2 + 5y^2$

$z = 6 - 7x^2 - y^2$

$5x^2 + 5y^2 = 6 - 7x^2 - y^2$

$12x^2 + 6y^2 = 6$

$2x^2 + y^2 = 1$

$$\frac{x^2}{\left(\frac{1}{\sqrt{2}}\right)^2} + \frac{y^2}{1^2} = 1$$

$$\text{Volume} = \int_{-\frac{1}{\sqrt{2}}}^{\frac{1}{\sqrt{2}}} \int_{y=-\sqrt{1-2x^2}}^{y=\sqrt{1-2x^2}} \int_{z=5x^2+5y^2}^{z=6-7x^2-y^2} dz\, dy\, dx$$

Applying Jacobian of transformation

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Assume $x = \frac{r}{\sqrt{2}}\cos\theta$, $y = r\sin\theta$ and $z = z$

$$J\left(\frac{x,y,z}{r,\theta,z}\right) = \begin{vmatrix} x_r & x_\theta & x_z \\ y_r & y_\theta & y_z \\ z_r & z_\theta & z_z \end{vmatrix} = \frac{r}{\sqrt{2}}$$

So, we can rewrite

$$\int_0^{2\pi}\int_0^1 \int_{\frac{5}{2}r^2\cos^2\theta + 5r^2\sin^2\theta}^{6-\frac{7}{2}r^2\cos^2\theta - r^2\sin^2\theta} \frac{r}{\sqrt{2}}\,dz\,dr\,d\theta$$

$$= \frac{1}{\sqrt{2}}\int_0^{2\pi}\int_0^1 (6-6r^2)\,r\,dr\,d\theta$$

$$= \frac{1}{\sqrt{2}}\int_0^{2\pi}\int_0^1 (6r-6r^3)\,dr\,d\theta$$

$$= \frac{1}{\sqrt{2}} \times 2\pi \times \frac{3}{2} = \frac{3\pi}{\sqrt{2}}$$

End of Solution

65. The Fourier series representation of $f(x) = \begin{cases} x, & 0 \le x \le \pi \\ \pi, & \pi \le x \le 2\pi \end{cases}$ is

(a) $f(x) = \frac{3\pi}{4} - \frac{2}{\pi}\sum_{n=1}^{\infty}\frac{\cos(2n-1)x}{(2n-1)^2} - \sum_{n=1}^{\infty}\frac{\sin nx}{n}$ for $0 \le x \le 2\pi$

(b) $f(x) = \frac{3\pi}{4} - \frac{2}{\pi}\sum_{n=1}^{\infty}\frac{\cos(2n-1)x}{(2n-1)^2} + \sum_{n=1}^{\infty}\frac{\sin nx}{n}$ for $0 \le x \le 2\pi$

(c) $f(x) = \frac{3\pi}{4} - \frac{2}{\pi}\sum_{n=1}^{\infty}\frac{\cos(2n-1)x}{(2n-1)^4} - \sum_{n=1}^{\infty}\frac{\sin nx}{n}$ for $0 \le x \le 2\pi$

(d) $f(x) = \frac{3\pi}{4} + \frac{2}{\pi}\sum_{n=1}^{\infty}\frac{\cos(2n-1)x}{(2n-1)^2} - \sum_{n=1}^{\infty}\frac{\sin nx}{n}$ for $0 \le x \le 2\pi$

Ans. (a)

$$2l = 2\pi$$
$$l = \pi$$
$$a_o = \frac{1}{l}\int_{\alpha}^{\alpha+2l} f(x)dx$$

$$= \frac{1}{\pi}\int_0^{\pi} x\,dx + \int_{\pi}^{2\pi} \pi dx = \frac{3\pi}{2}$$

$$a_n = \int_{\alpha}^{\alpha+2l} f(x)\cos\frac{n\pi x}{l}dx$$

$$= \frac{1}{\pi}\left[\int_0^{\pi} x\cos nx dx + \int_{\pi}^{2\pi} \pi\cos nx dx\right]$$

$$= \frac{+2}{\pi}\left[\frac{(-1)^{n+1}-1}{n^2}\right]$$

$$a_n = \frac{-2}{\pi(2n-1)}$$

Similarly, $$b_n = \frac{1}{\pi}\left[\int_0^{\pi} x\sin x dx + \int_{\pi}^{2\pi} \pi\cos nx dx\right]$$

$$b_n = -\frac{1}{n}$$

Substituting a_o, a_n and b_n, we will get option (a) is correct.

End of Solution

66. The value of $\oint_{\gamma} e^{1/z}dz$ where γ is a closed path enclosing the origin is

(a) $-2\pi i$ (b) $2\pi i$
(c) $-\pi i$ (d) πi

Ans. (b)

$f(z) = e^{\frac{1}{z}}$ is not defined at $z = 0$.

By applying Cauchy residue theorem

$$\oint_C e^{\frac{1}{z}}dz = 2\pi i \text{ (Residue)}$$

We know,, $$e^{\frac{1}{z}} = 1 + \frac{1}{z} + \frac{1}{2z^2} + ...$$

$\therefore$ Residue = Coefficient of $z^{-1} = 1$

Hence, $$\oint_C e^{\frac{1}{z}}dz = 2\pi i$$

End of Solution

67. Let $f(z) = 2iz + 6\bar{z}$. The value of f at $z = \frac{1}{2} + 4i$ is

(a) $5 - 23i$ (b) $5 + 23i$
(c) $-5 - 23i$ (d) $-5 + 23i$

Ans. (c)

$$f\left(\frac{1}{2}+4i\right) = 2i\left(\frac{1}{2}+4i\right)+6\left(\frac{1}{2}-4i\right)$$
$$= i + 8i^2 + 3 - 24i$$
$$= -5 - 23i$$

End of Solution

68. What is the root of the equation $x \sin x + \cos x = 0$ up to four decimal places?

(a) 2.7689 (b) 2.7784
(c) 2.7498 (d) 2.7984

Ans. (d)

By Newton Raphson's method

$$x_1 = x_0 - \frac{f(x_0)}{f'(x_0)}$$
$$= 2.7 - \frac{2.7\sin(2.7)+\cos(2.7)}{2.7\cos(2.7)}$$
$$= 2.802$$
$$x_2 = x_1 - \frac{f(x_1)}{f'(x_1)}$$
$$= 2.7984$$

End of Solution

69. Which one of the following is the general integral of the linear partial differential equation $(y + xz)p - (x + yz)q = (x^2 - y^2)$?

(a) $F(x^2 + y^2 - z^2, xy + z) = 0$ (b) $F(x^2 - y^2 - z^2, xz + y) = 0$
(c) $F(x^2 + y^2 - z^2, xz + y) = 0$ (d) $F(x^2 + y^2 - z^2, zy + x) = 0$

Ans. (a)

By using Lagrange auxiliary equation method

$$Pp + Qq = R$$
$$\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$$
$$\frac{dx}{y+xz} = \frac{dy}{-x-yz} = \frac{dz}{x^2-y^2}$$
$$\approx \frac{ydx+xdy-dz}{0} \approx \frac{xdx+ydy-zdz}{0}$$

$$ydx + xdy - dz = 0 \text{ and } xdx + ydy - zdz = 0$$

$$\int d(xy) - \int dz = \int 0$$

$$xy - z = C_1$$

$$\int (xdx + ydy - zdz) = 0$$

$$x^2 + y^2 - z^2 = C_2$$

$$\phi(C_1, C_2) = 0$$

or $\quad \phi(xy - z,\ x^2 + y^2 - z^2) = 0$

End of Solution

70. Suppose the random variable X has distribution function $F(x) = \begin{cases} 0 & x \le 0 \\ 1 - \exp(-x^2) & x > 0 \end{cases}$.

What is the probability that X exceed 1?

(a) e^{-2} (b) e^{-1}

(c) e^{-3} (d) e^{-4}

Ans. (b)

$$F(x) = 0 : x \le 0$$

$$1 - e^{-x^2};\ x > 0$$

$$P(X > 1) = 1 - P(X \le 1)$$

$$= 1 - F_x(1) = 1 - \{1 - e^{-1}\}$$

$$= e^{-1}$$

End of Solution

71. A total of 28 percent of American males smoke cigarettes, 7 percent smoke cigars, and 5 percent smoke both cigars and cigarettes. What percentage of males smoke neither cigars nor cigarettes?

(a) 30 percent (b) 20 percent

(c) 80 percent (d) 70 percent

Ans. (d)

End of Solution

72. If the average number of claims handled daily by an insurance company is 5, what proportion of days have less than 3 claims? Assume that the number of claims on different days is independent.

(a) $\frac{37e^{-5}}{2}$ (b) $\frac{31e^{-5}}{2}$

(c) $\frac{35e^{-5}}{2}$ (d) $\frac{39e^{-5}}{2}$

Ans. (a)

X = {Number of claims per day}

$$\lambda = 5/\text{day}$$

By using Poissions distribution

$$P(X < 3) = P(X \le 2)$$
$$= P(X = 0) + P(X = 1) + P(X = 2)$$
$$= e^{-\lambda}\left(\lambda^0 + \frac{\lambda^1}{1!} + \frac{\lambda^2}{2!}\right)$$
$$= \frac{37e^{-5}}{2}$$

End of Solution

73. A negative feedback system has a forward path gain of 18 and a feedback path gain of 0.15. What is the overall gain of the system?

(a) 4.86 (b) 10.66

(c) 3.26 (d) 2.86

Ans. (a)

Given : $G = 18$

$H = 0.15$

$$\text{Overall gain} = \frac{G}{1+GH}$$
$$= \frac{18}{1+18\times 0.15} = 4.86$$

End of Solution

74. Consider the following conditions for a second order system when subject to a unit step input :

1. With critical damping, there are no oscillations.
2. With no damping, the system output oscillates with constant frequency and variable amplitude.
3. With overdamping, the output takes longer time to reach the steady-state value.

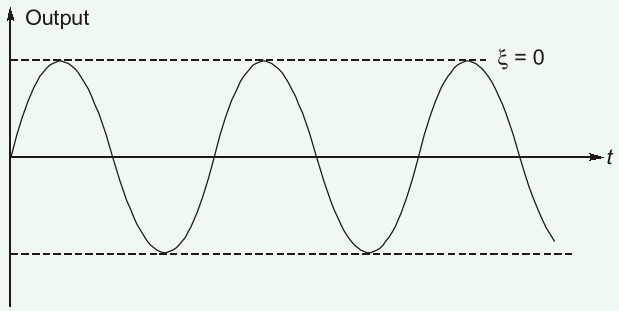
Which of the above conditions is/are **not** correct?

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

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

Ans. (c)

With no damping, the system output oscillate with constant frequency and constant amplitude.

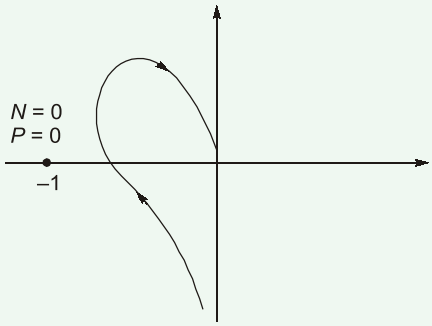


End of Solution

75. In Nyquist stability criterion, the closed-loop systems whose open-loop frequency response $G(j\omega)H(j\omega)$ loci, as ω goes from 0 to ∞, do not encircle the –1 point, will be

(a) unstable
(b) marginally stable
(c) marginally unstable
(d) stable

Ans. (d)

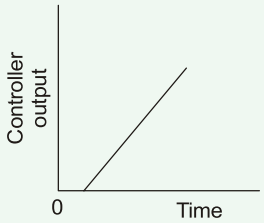


$N = P$

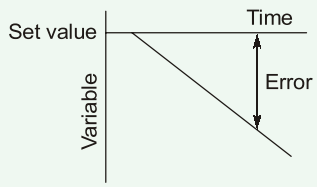
So, system is stable

End of Solution

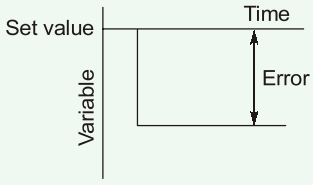
76. Which error-time graph is relevant to the following integral mode controller output?



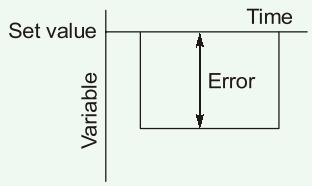
(a)



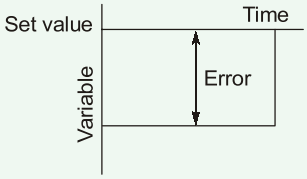
(b)



(c)

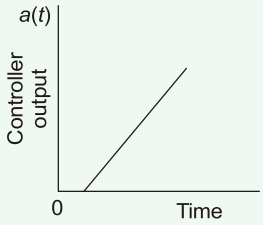


(d)



Ans. **(b)**

Given output:



The output, $a(t) = K_i \int_0^t e(t)\,dt$

So, $e(t) = \frac{1}{K_i}\frac{d}{dt}(a(t))$

$e(t) = \frac{1}{K_i}\frac{d}{dt}(\text{ramp})$

$e(t) = \text{step}$

So, option (b) has step input.

End of Solution

77. For the given transfer function, $G(s) = K/(1 + Ts)$, what is the phase of frequency response?

(a) $\arctan(-\omega T)$
(b) $\arctan(-\omega T/2)$
(c) $\arctan(-2\omega T)$
(d) $\arctan(\omega T)$

Ans. **(a)**

$$G(s) = \frac{K}{1+Ts}$$

$$G(j\omega) = \frac{K}{1+j\omega T}$$

$$\text{Phase, } \phi = -\tan^{-1}(\omega T)$$

End of Solution

78. Which one of the following steps is correct while plottting an open-loop bode diagram?

(a) Transfer an open-loop TF into a constant frequency form.
(b) For the low-frequency asymptote, if there is only the proportion link, one should plot a horizontal one with the amplitude value –20 log K (dB).

(c) For the high-frequency asymptote, one should change the slope of the asymptote in every break frequency ωT for every link.
(d) Compensate the asymptote to get the precise constant time characteristics diagram.

Ans. (c)

- Transfer an open-loop TF into a constant time form.
- For the low-frequency asymptote, if there is only the proportion link, one should plot a horizontal line with the amplitude value 20 logk (dB).
- Compensate the asymptote to get the precise frequency characteristics diagram.

End of Solution

79. For the closed-loop transfer function as part of necessary conditions for the stability of linear feedback system, the characteristic roots must satisfy the following conditions :
1. No nil solution
2. No conjugate pure complex roots
3. All the real roots must be negative

Which of the above conditions are correct ?
(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Ans. (a)

End of Solution

80. The Routh array of an open-loop transfer function of unit negative feedback control system is us under:

s^3	1	12
s^2	6	$8(1+k)$
s^1	$(32-4k)/3$	0
s^0	$8(1+k)$	

The system is stable and unstable when the values of 'k' respectively are
(a) 15 and 16 (b) 6 and 12
(c) 12 and 6 (d) 6 and 15

Ans. (b, d)

For stable system,

$$\frac{(32-4k)}{3} > 0 \text{ and } 8(1+K) > 0$$

For stable $-1 < K < 8$

So correct answer is (b, d)

End of Solution

81. Consider the following table wherein three typical acceleration input signals are fed to various system types where 'R' represents the amplitude of the input (note the situation of acceleration input) and 'K' is the open-loop gain of the time constant type, What are the steady-state errors in place of A, B and C respectively in the table?

System type	Typical input signal		
	Step	Ramp	Acceleration
	$x(t) = R$	$x(t) = Rt$	$x(t) = \frac{R}{2}t^2$
0	$\frac{R}{1+K}$	∞	A
I	0	B	∞
II	C	0	$\frac{R}{K}$

(a) ∞, R/K and 0
(b) ∞, $R/1 + K$ and 0
(c) 0, R/K and ∞
(d) 0, $R/1 + K$ and ∞

Ans. (a)

$$A = \infty$$
$$B = \frac{R}{K}$$
$$C = 0$$

End of Solution

82. Which one of the following is ***not*** a method to reduce steady-state error of system?
(a) Increase open-loop gain
(b) Limiting system types
(c) Feed forward control
(d) Compound control

Ans. (b)
The steady-state error of a system can not reduced by using limiting system types.

End of Solution

83. Consider the following statements related to root locus:
1. The number of branches of the root locus equals the number of closed-loop poles.
2. The root locus is symmetrical about the real axis.
3. The root locus approaches straight lines as asymptotes as the locus approaches infinity.

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

Ans. (d)

End of Solution

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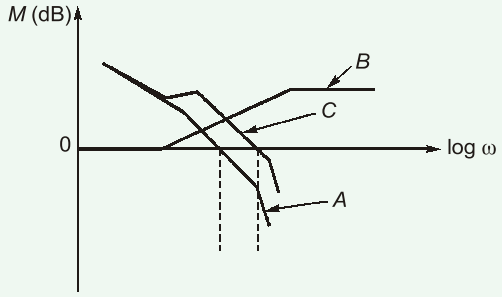
84. Consider the following visualizing lead compensation representation frequency versus gain crossover frequency:



Which of the above curves is/are a compensator?

(a) A only
(b) B only
(c) C only
(d) Both A and B

Ans. (b)

- Curve B is lead compensator.
- Curve A is uncompensated system.
- Curve C is compensated system.

End of Solution

85. Isolating transformers are commonly used in many types of electric circuits for the purpose of

(a) blocking alternating current signal between the circuits
(b) blocking alternating current signals while maintaining direct current continuity between the circuits
(c) blocking direct current signals while maintaining alternating current continuity between the circuits
(d) blocking direct current signal between the circuits

Ans. (c)

End of Solution

86. When there is no ferromagnetic material but only air present in between the coils, such a transformer is called

(a) Iron-core type transformer
(b) Steel-core type transformer
(c) Wet type transformer
(d) Dry type transformer

Ans. (d)

End of Solution

87. The objectionable audible humming sound in the core of the transformer due to magnetostriction is minimized by

(a) decreasing flux density
(b) increasing flux density
(c) use of stacking laminations
(d) use of silicon-steel sheets

Ans. (c)

End of Solution

88. The ideal two-winding transformer primary and secondary windings has $N_1 = 100$ turns and $N_2 = 200$ turns with a natural coupling flux described by the parabolic function $\phi_m(t) = -0.05(t^2 - 2t)$ Wb. The primary terminal voltage is

(a) $10(t - 1)$ Volts
(b) $-10(t - 1)$ Volts
(c) $20(t - 1)$ Volts
(d) $-20(t - 1)$ Volts

Ans. (b)

$$E = N\frac{d\phi}{dt} = 100\frac{d}{dt}\left[-0.05(t^2 - 2t)\right]$$

$$= -100\frac{d}{dt}\left[0.05(t^2 - 2t)\right]$$

$$= -5(2t - 2)$$

$$= -10(t - 1)$$

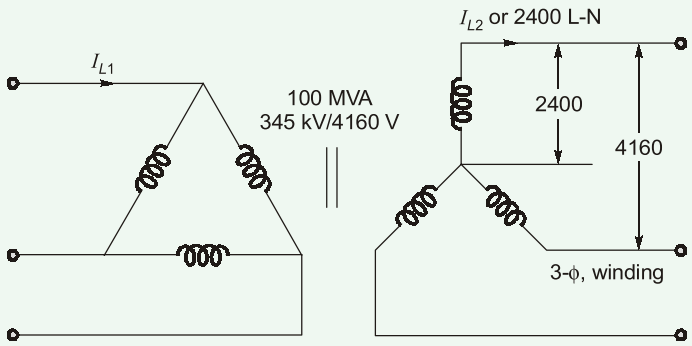
End of Solution

89. A 345-kV transmission line feeds a distribution substation that in turn has radial feeds to a 4160/2400-V, four-wire distribution network and the turns ratio of the Δ-Y connected 100-MVA transformer in this substation. Its line current (I_{L1}) at Δ side is

(a) 167.35 A
(b) 96.62 A
(c) 58.79 A
(d) 138.79 A

Ans. (a)

Transformer stepping down 345 kV to 4160 V



$$\sqrt{3}V_L I_L = 100 \text{ MVA}$$

$$I_L = \frac{100 \times 10^6}{\sqrt{3} \times 345 \times 10^3} = 167.35 \text{ A}$$

End of Solution

90. A four-pole lap-wound DC machine armature has 54 slots with single-turn coils. How many armature conductors are required if there are two coil sides per slot ?

(a) 27 (b) 54
(c) 81 (d) 108

Ans. (d)

$P = 4,\ A = P = 4$

54 slots single turn coil

coilsides = $54 \times 2 = 108$

End of Solution

91. The magnetic cores of large transformers are built in stepped cores to

(a) minimize the hysteresis loss
(b) minimize the magnetizing loss
(c) minimize the use of copper and decrease copper loss
(d) minimize the eddy current loss

Ans. (c)

End of Solution

92. An autotransformer has an advantage over the equivalent two-winding transformer, which is

(a) no electrical isolation (b) greater short-circuit current
(c) higher excitation current (d) lower leakage reactance

Ans. (d)

End of Solution

93. The stator and rotor slots of an asynchronous motor are designed to traverse the axial length of the magnetic core at an angle from the true axial direction. The average value of the mmf wave over the axial length of the magnetic core is

(a) step transition (b) ramped transition
(c) steep transition (d) triangular transition

Ans. (a)

End of Solution

94. A 4-pole, 50-Hz, three-phase asynchronous motor is operating at a shaft speed of 1750 rpm. What is the speed of the stator air gap mmf wave?

(a) 188.49 rad/sec (b) 157.07 rad/sec
(c) 127.23 rad/sec (d) 87.64 rad/sec

Ans. (b)

Asynchronous motor,

Rotor speed = 1750 rpm

So, synchronous speed will be higher than rotor speed.

Hence, option (a) is correct, i.e., machine is excited with 60 Hz supply.
Speed of stator air gap mmf wave =

$$\frac{120\times 60}{4}\times\frac{2\pi}{60} = 188.49 \text{ rad/sec}$$

End of Solution

95. Prior to placing a three-phase, Y-connected synchronous generator in service on the Y-connected electric utility grid, three lamps are connected across the open contractors served as indicators to assure synchronization conditions if the lamps will blink OFF and ON which indicates

(a) the voltage magnitudes of the oncoming synchronous generator and the electric utility are not matched
(b) the frequency of the oncoming synchronous generator and the electric utility are not equal
(c) the phase sequence of the oncoming synchronous generator and the electric utility are not matched
(d) the voltage magnitudes, frequency and phase sequence of the oncoming synchronous generator and the electric utility are matched

Ans. (b)

Fliccesing frequency = $|f_i - f_r|$

End of Solution

96. A primitive stepper motor and its digital driver circuit is furnished with a train of *f* pulses per second, That the input of the controller is divided so that the output is sent in sequence to one phase winding at a time with 2*p* as the number of phases and k number of teeth. Then the rotor angular motion per pulse is a step of

(a) π/p radians
(b) *p*/π radians
(c) π/k2p radians
(d) π/kp radians

Ans. (d)

End of Solution

97. Which one of the following statements is **not** correct ?

(a) The corona loss on the middle conductor is more as compared with the two outer conductors.
(b) The corona loss is less in hilly areas than in plain areas.
(c) The rains increase the corona loss in transmission lines.
(d) The height of the conductors from the ground has its effect on corona loss.

Ans. (b)

The Corona loss, $P_c \propto (V_C - V_{ph})^2$
Where, V_C = critical voltage,
V_{ph} = Phase voltage of line

The voltage, $V_C = m_0 g r \delta \ln\left(\frac{d}{r}\right)$

Here, $V_c \propto \delta \propto b$

Where, b = At m. perssure

In hilly area b is low, so V_C will be lower

If V_C is lower than P_C will be increased.

So the Coronaloss is more in hilly areas than in plain area. So option (b) is correct.

Other statements are correct.

End of Solution

98. For economic size the ratio of outer diameter to the conductor diameter should be 'e'. What is the economic overall diameter of 1-core cable metal sheathed for a working voltage of 85 kV if the dielectric strength of the insulating materials is 65 kV/cm?

(a) 1.6e cm (b) 2.6e cm

(c) 3.6e cm (d) 4.6e cm

Ans. (b)

$$E_{max} = \frac{V}{r \ln\left(\frac{R}{r}\right)}$$

For most economic size of cable

$$\frac{R}{r} = e$$

So, $$E = \frac{V}{r}$$

$$r = \frac{V}{E}$$

Given, $E = 65$ kV/cm

$V = 85$ kV

So, overall diameter, $D = 2R = 2e\left(\frac{V}{E}\right) = 2 \times e \times \left(\frac{85}{65}\right)$

$D = 2.6e$ cm

End of Solution

99. When impedance is being calculated for an alternator, which measurement of parameter requires the series connection of windings in stator windings?

(a) Positive sequence impedance (b) Negative sequence impedance

(c) Zero sequence impedance (d) Sub-transient reactance

Ans. (c)

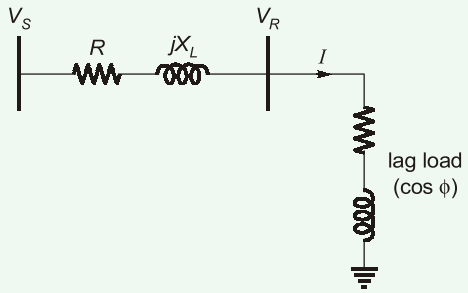
End of Solution

100. What is the percentage increase of busbar voltage required to compensate for the reactance drop when the feeder having a reactance of 5% carriers a full load current at a p.f. 0.8 lagging?

(a) 3% (b) 4%

(c) 1.5% (d) 2%

Ans. (a)



$V_S - V_R = I(R\cos\phi + X_L \sin\phi)$

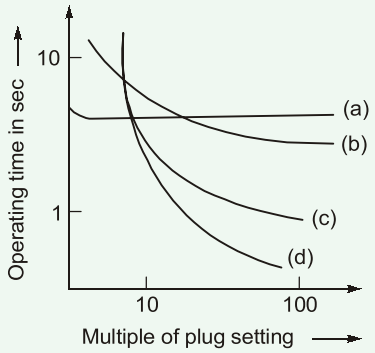
$V_S - V_R = I(X_L \sin\phi)$

% change in voltage = 5 × 0.6 = 3%

So, 3% compesnsation is required.

End of Solution

101. The over current relays are categoried by obtaining their characteristics as under:

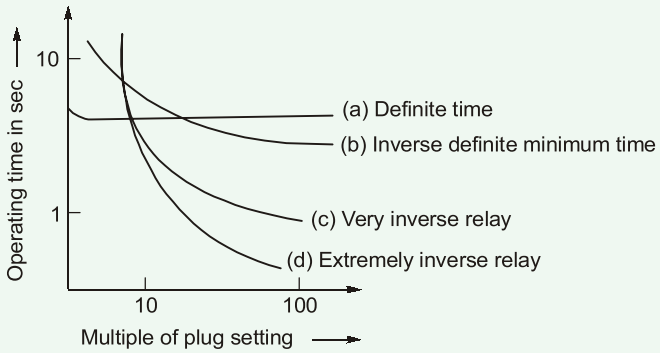


The curve (b) in the characteristics is pertaining to the which category of current relay?

(a) Extremely inverse relay (b) Very inverse relay

(c) Inverse time (d) Inverse definite minimum time

Ans. (d)



End of Solution

102. Consider the following statements:

1. The arcing time of arc controlled circuit breaker varies considerably depending upon the breaking current.
2. Except for a certain medium range of voltages, air circuit breakers are widely used for the low voltage circuits as well as the highest transmission voltages.
3. The resistance switching reduces help to distribute the transient recovery voltage more uniformly across recovery the several gaps.
4. With the use of better insulating materials for the arching chambers, the oil C.Bs are able to meet the increased fault levels of the systems easily.
5. The resistance switching reduces transient voltages during switching out inductive load but enhances for capacitive loads.

Which of the above statements is/are **not** correct?

(a) 1 and 2 only
(b) 2 and 3 only
(c) 4 only
(d) 5 only

Ans. (a)

End of Solution

103. Consider the table below for different types of buses where each set may consist of any parameters '*V*' is voltage magnitude, '*P*' is real power injection, '*Q*' is reactive power and 'δ' is phase angle.

Bus type	Set of quantities to be Specified for bus	Set of quantities to be obtained for bus
Load bus	Set A	Set D
Slack	Set B	Set E
Generator bus	Set C	Set F

Select the correct answer using the above table:

(a) Set A and E are same, but Set C and D are different
(b) Set B and F are same, but Set C and E are different
(c) Set C and D are same, but Set A and F are different
(d) Set C and E are same, but Set D and B are different

Ans. (a)

Bus type	Set of quantities to be Specified for bus	Set of quantities to be obtained for bus
Load bus	P,Q Set A	$\|V\|,\delta$ Set D
Slack	$\|V\|,\delta$ Set B	P,Q Set E
Generator bus	$P,\|V\|$ Set C	Q,δ Set F

Set A and E are same, but set C and D are different.

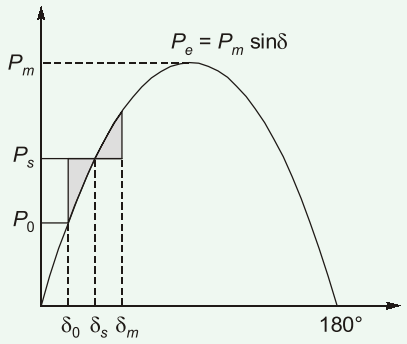
End of Solution

104. While the load flow equations are nonlinear and they are solved by using Gauss-Seidel Iterative Method by including PV buses, what would be the reason for the violation of reactive power limit?
(a) Too low specified voltage level only
(b) Too high specified voltage level only
(c) Either too low or too high specified voltage level
(d) Neither too low nor too high specified voltage level

Ans. (c)

End of Solution

105. Consider a system consisting of a synchronous machine connected to an infinite bus bar. The below power single curve is obtained using equal area criterion when sudden increase in mechanical load on that motor occurs:



What is the condition of power at point '*b*' if P_e is electromagnetic power and P_s is shaft power?
(a) $P_e = P_s$
(b) $P_e < P_s$
(c) $P_e > P_s$
(d) $P_m = P_s$

Ans. (a)
At *b* point, $P_e = P_s$

End of Solution

106. If T_s represents the shaft torque and T_e the electromagnetic torque and if these are assumed positive for a generator, the net torque causing acceleration T_a is

(a) $T_a = T_s - T_e$ (b) $T_a = T_s + T_e$

(c) $T_a = 2T_s - T_e$ (d) $T_a = T_s + 2T_e$

Ans. (a)

$$T_a = T_s - T_e$$

End of Solution

107. Consider the following conditions :

In HVDC transmission, high power factor of the system is maintained for the following reason(s):

1. For a given current and voltage of the thyristor and transformers, the power rating of the converters is equal.
2. The stresses on the thyristors and damping circuits are reduced.
3. For the same power to be transmitted the current rating of the system is reduced and also the copper losses in the ac lines are reduced.

Which of the above conditions is/are correct?

(a) 1 only (b) 2 only

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

Ans. (d)

- The load current, $I = \dfrac{P}{V\cos\phi}$
- If $\cos\phi$ is higher than I will be lower, so copper loss $P_L (P_L = I^2R)$ in the line will be less.
- The stress on the thyristors and damping circuits are reduced because reactive power requirement is less.

End of Solution

108. Which type of hydro turbine is totally embedded in the fluid and powered from the pressure drop across the device?

(a) Impulse turbine only (b) Reaction turbine only

(c) Squirrel cage turbine only (d) Both impulse turbine and reaction turbine

Ans. (b)

End of Solution

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109. By considering the standard notations, reverse recovery time (t_{rr}) of a power diode is

(a) $t_{rr} = \sqrt{\frac{2Q_R}{di/dt}}$ (b) $t_{rr} = \sqrt{\frac{2Q_R}{dv/dt}}$

(c) $t_{rr} = \sqrt{\frac{2dv/dt}{Q_R}}$ (d) $t_{rr} = \sqrt{\frac{2dI/dt}{Q_R}}$

Ans. (a)

End of Solution

110. The overdrive factor (ODF) of a power transistor can be expressed as

(a) $\frac{\text{base current required to operate in saturation } (I_{BS})}{\text{base current } (I_B)}$ (b) $\frac{\text{base current } (I_B)}{\text{base current required to operate in saturation } (I_{BS})}$

(c) $\frac{\text{base current required to operate in saturation } (I_{BS})}{\text{collector current } (I_C)}$ (d) $\frac{\text{collector current } (I_C)}{\text{base current } (I_B)}$

Ans. (b)

End of Solution

111. When the amplitude of the gate pulse to thyristor is increased,

(a) the delay time would decrease, but the rise time would increase.
(b) both delay time and rise time would increase.
(c) the delay time would decrease, but the rise time remains unaffected.
(d) the delay time would increase, but the rise time would decrease.

Ans. (c)

End of Solution

112. A single-phase full-wave bridge rectifier circuit is fed from a 220 V, 50 Hz supply. It consists of four diodes, a load resistance 20 Ω and a very large inductance so that the load current is constant. What is the average or dc output voltage?

(a) 78.135 V (b) 140.125 V
(c) 198.165 V (d) 311.025 V

Ans. (c)

$$V_0 = \frac{2V_m}{\pi} = \frac{2\sqrt{2} \times 220}{\pi}$$
$$= 198.165 \text{ V}$$

End of Solution

113. In a single-phase full-wave controlled bridge rectifier with source inductance and R-L load, the output voltage during overlap is equal to
(a) source voltage
(b) difference of source voltage and voltage drop in inductance
(c) zero
(d) addition of source voltage and voltage drop in inductance.

Ans. (c)

End of Solution

114. If a step-down chopper operates in the continuous conduction mode with a duty cycle D, the ripple factor is

(a) $\frac{\sqrt{D-D^2}}{D}$ (b) $\frac{\sqrt{D^2+D}}{D}$

(c) $\frac{D}{\sqrt{D^2-D}}$ (d) $\frac{D}{\sqrt{D^2+D}}$

Ans. (a)

$$FF = \frac{V_{0r}}{V_0} = \frac{\sqrt{\alpha}\,V_s}{\alpha V_s}$$

$$FF = \frac{1}{\sqrt{\alpha}}$$

$$\alpha = D = \frac{T_{ON}}{T}$$

$$VRF = \sqrt{FF^2 - 1}$$

$$= \sqrt{\frac{1}{\alpha} - 1} = \sqrt{\frac{1-\alpha}{\alpha}} = \sqrt{\frac{\alpha-\alpha^2}{\alpha^2}}$$

$$= \frac{\sqrt{\alpha-\alpha^2}}{\alpha} = \frac{\sqrt{D-D^2}}{D}$$

End of Solution

115. When a separately excited dc motor is. to be controlled from a 3-phase source for operation in the first quadrant only, which one of the following converters is used?
(a) Three-phase dual converter
(b) Three-phase semi converter
(c) Three-phase full converter
(d) Three-phase half-wave converter

Ans. (b)

End of Solution

116. A wound rotor or slip-ring asynchronous motor is commonly used as drive in overhead cranes and load equalization. Which of the following speed controls is adopted ?
(a) Stator current control
(b) Static rotor resistance control
(c) Stator voltage control
(d) Stator voltage and frequency control

Ans. (b)

End of Solution

117. Which one of the following statements is correct in a series resonant converter ?
(a) The load current is a square waveform.
(b) The output voltage waveform depends on the damping factor of load impedance.
(c) The trigger frequency is higher than the damped resonant frequency.
(d) The output voltage waveform does not depend on the damping factor of load impedance.

Ans. (d)

End of Solution

118. Which of the following switching techniques is commonly opted in resonant converters?
(a) Frequency switching
(b) Voltage switching
(c) Zero voltage switching or zero current switching
(d) Current switching

Ans. (c)

End of Solution

119. The function of static transfer switch in a multimodular Uninterruptible Power Supply (UPS) system is to change over
(a) the power supply to the critical load from the UPS to power line
(b) the battery bank to the critical load
(c) the power supply to UPS
(d) the battery bank to the UPS from the power line

Ans. (a)

End of Solution

120. Static VAR Compensator (SVC) is usually designed to operate at
(a) slightly lagging power factor
(b) leading power factor
(c) unity power factor
(d) zero power factor lagging

Ans. (c)
Static VAR compensator (SVC) is usaully designed to operate at unity power factor.

End of Solution

121. What is the spectral efficiency of 16-QAM?

(a) 1 bps/Hz (b) 2 bps/Hz

(c) 3 bps/Hz (d) 4 bps/Hz

Ans. **(d)**

$$\text{Spectral efficiency} = \frac{R_b}{\text{B.W.}}$$

For 16-QAM, $\text{BW} = \frac{R_b}{\log_2 M}$

$$\text{Spectral efficiency} = \log_2 M$$
$$= \log_2 16 = 4 \text{ bps/Hz}$$

End of Solution

122. A continuous-time signal is given below :

$$x(t) = 8 \cos 200\pi t$$

What is the minimum sampling rate required to avoid aliasing?

(a) 100 Hz (b) 200 Hz

(c) 50 Hz (d) 150 Hz

Ans. **(b)**

$$x(t) = 8 \cos 200\pi t$$
$$\text{Min sampling rate} = 2f_m$$
$$= 2 \times 100$$
$$= 200 \text{ Hz}$$

End of Solution

123. By considering the standard notations, in DACs, a glitch due to the switch associated with the most significant Jutcan have an amplitude almost equal to

(a) $2\ V_{ref}$ (b) $\frac{1}{2}V_{ref}$

(c) $3\ V_{ref}$ (d) $\frac{1}{3}V_{ref}$

Ans. **(b)**

End of Solution

124. What is the value of Q factor if the band pass filter is having frequencies from 800 Hz to 1200 Hz

(a) 1.30 (b) 2.45

(c) 3.40 (d) 4.35

Ans. **(b)**

$$Q = \frac{\text{Centre frequency}}{\text{BW}} = \frac{\sqrt{f_{c1} \cdot f_{c2}}}{\text{BW}}$$

$$= \frac{\sqrt{800 \times 1200}}{400} = 2.45$$

Alternate Solution:

$f_L = 800$ Hz

$f_H = 1200$ Hz

$BW = f_H - f_L = 1200 - 800 = 400$ Hz

$$\frac{f_H}{f_L} \geq 1.1$$

$$f_C = \sqrt{f_L f_H} = \sqrt{1200 \times 800} = 979 \text{ Hz}$$

Quality factor, $$Q = \frac{f_C}{BW} = \frac{979\text{Hz}}{400\text{Hz}} = 2.45$$

End of Solution

125. An AM broadcast radio transfer radiates 10 k Watts of power if modulation percentage is 60. What is the carrier power?

(a) 6.25 kW (b) 8.47 kW

(c) 13.60 kW (d) 10.00 kW

Ans. (b)

$$P_t = P_c\left[1 + \frac{\mu^2}{2}\right]$$

$$10\text{k} = P_c\left[1 + \frac{(0.6)^2}{2}\right]$$

$$P_C = 8.47 \text{ kW}$$

End of Solution

126. A PLL FM detector uses a VCO with $k_f = 100$ kHz/V. If it receives an FM signal with a deviation of 75 kHz and sine-wave modulation, what is the RMS output voltage from the detector ?

(a) 3.57 V (b) 2.54 V

(c) 1.55 V (d) 0.53 V

Ans. (d)

$K_f = 100$ kHz/Volt

$\Delta f = 75$ kHz

$$\Delta f = K_f A_m \rightarrow A_m = \frac{75\text{k}}{100\text{k}} = 0.75 \text{ V}$$

$$V_{rms} = \frac{V_{peak}}{\sqrt{2}} = \frac{0.75}{\sqrt{2}} = 0.53 \text{ V}$$

End of Solution

127. The signal power and noise power measured at the input of an amplifier are 150 μW. and 1.5 μW respectively. If the signal power at the output 1.5 W and noise power is 40 mW, what is the amplifier noise factor?

(a) 2.666 (b) 3.750
(c) 4.266 (d) 5.625

Ans. (a)

$$S_i = 150\ \mu W$$
$$N_i = 1.5\ \mu W$$
$$S_0 = 1.5\ W$$
$$N_0 = 40\ mW$$

$$\text{Noise factor} = \frac{\left(\frac{S_i}{N_i}\right)}{\left(\frac{S_0}{N_0}\right)}$$

$$\frac{S_i}{N_i} = \frac{150\mu W}{1.5\mu W} = 100$$

$$\frac{S_0}{N_0} = \frac{1.5}{40\times 10^{-3}} = 37.5$$

$$\text{N.F} = \frac{100}{37.5} = 2.666$$

End of Solution

128. A discrete source emits one of five symbols once every millisecond with probabilities $\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \frac{1}{16}$ and $\frac{1}{16}$ respectively. What is the source entropy?

(a) 0.875 bits/symbol (b) 1.875 bits/symbol
(c) 2.875 bits/symbol (d) 3.875 bits/symbol

Ans. (b)

$$P_1 = \frac{1}{2},\ P_2 = \frac{1}{4},\ P_3 = \frac{1}{8};\ P_4 = P_5 = \frac{1}{16}$$

$$H = \sum_{i=1}^{5} P_i \log_2 \frac{1}{P_i}$$

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

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

$$= 1.875 \text{ bits/symbol}$$

End of Solution

129. According to the description of the AND instruction of 8086 microprocessor, what are the essential conditions to be satisfied while executing it?

1. The source can be a register or a memory location.
2. The destination can be a register or a memory location.
3. The source and destination must both be bytes or be words.
4. The source and the destination cannot both be memory locations in an instruction.

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

Ans. (c)

8086 is a 16-bit μP

- AND instructions can work with source as a Register/Memory and destination can also be Register/Memory but both operands can't be memory.
- AND can also be with immediate data.
- AND logic can be implemented for bytes/words as it is a bit-wise operation.

So all are correct (c).

End of Solution

130. What is the modulation index, if the E_{max} = 150 mV and E_{min} = 70 mV?

(a) 40%
(b) 30%
(c) 36.4%
(d) 44.6%

Ans. (c)

$$E_{max} = 150 \text{ mV}$$
$$E_{min} = 70 \text{ mV}$$
$$\mu = \frac{E_{max} - E_{min}}{E_{max} + E_{min}} = \frac{80}{220} = 36.4\%$$

End of Solution

131. A receiver has a noise power bandwidth of 12 kHz. A resistor which matches with the receiver input impedance is conducted across the antenna terminals. What is the noise power contributed by this resistor in the receiver bandwidth ?
(Take temperature as 30°C)

(a) 2.581×10^{-17} W
(b) 3.181×10^{-17} W
(c) 4.636×10^{-17} W
(d) 5.017×10^{-17} W

Ans. (d)

R_x has noise power BW = 12 kHz

$$T = 30°C + 273 = 303 \text{ k}$$
$$\text{Noise power} = kTB$$
$$= [1.38 \times 10^{-23}] [303] [12 \times 10^{3}]$$
$$= 5017.68 \times 10^{-20}$$
$$= 5.017 \times 10^{-17} \text{ W}$$

End of Solution

132. An amplifier has a bandwidth of 4 MHz with 10 kΩ as the input resistor. What is the rms noise voltage at the input to this amplifier if the room temperature is 25°C ?

(a) 35.23 μV (b) 40.55 μV
(c) 25.65 μV (d) 14.62 μV

Ans. (c)

$BW = 4$ MHz
$R = 10\ k\Omega$
$T = 25°C + 273 = 298°$ K

RMS noise voltage?

$$V_n = \sqrt{4kTBR}$$

$$= \sqrt{4 \times 1.38 \times 10^{-23} \times 298 \times 4 \times 10^6 \times 10 \times 10^3}$$

$$= \sqrt{6579.84 \times 10^{-13}} = \sqrt{657.98} \times 10^{-6}$$

$$= 25.65\ \mu V$$

End of Solution

133. How many numbers of multiplications is needed in the calculation of FFT with 64 point sequence ?

(a) 160 (b) 172
(c) 192 (d) 200

Ans. (c)

$$\text{No. of multiplication} = \frac{N}{2}\log_2 N = \frac{64}{2}\log_2 64 = 192$$

End of Solution

134. Which one of the following is the correct Butterworth polynomial for second order filter?

(a) $s^2 + s + 1$ (b) $s^2 + \sqrt{2}s + 1$
(c) $s^2 + 2s + 1$ (d) $s^2 + s + 2$

Ans. (b)

End of Solution

135. Which one of the following is the correct relation of mapping from the '*s*-plane' to the '*z*-plane' in bilinear transformation ?

(a) $s = \frac{2}{T}\left[\frac{1+z^{-1}}{1-z^{-1}}\right]$ (b) $s = \frac{T}{2}\left[\frac{1-z^{-1}}{1+z^{-1}}\right]$

(c) $s = \frac{T}{2}\left[\frac{1+z^{-1}}{1-z^{-1}}\right]$ (d) $s = \frac{T}{2}\left[\frac{1-z^{-1}}{1+z^{-1}}\right]$

Ans. (d)

End of Solution

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136. The fundamental period of complex signal $x(t) = e^{j\omega_0 t}$ is

(a) $\frac{2\pi}{\omega_0}$ (b) $\frac{\pi}{\omega_0}$

(c) $2\pi\omega_0$ (d) $\pi\omega_0$

Ans. (a)

End of Solution

137. The energy contained of the signal $x(t) = e^{-2t}\,u(t)$ is

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

(c) $\frac{1}{4}$ (d) 4

Ans. (c)

The energy contained by $e^{-at}u(t)$ is $\frac{1}{2a}$

Put $a = 2$,

$$e^{-2t}u(t) \rightarrow \text{energy} = \frac{1}{4}$$

End of Solution

138. Which one of the following is a useful property of the unity impulse signal $\delta(t)$?

(a) $\delta(at) = a\,\delta(t)$ (b) $\delta(at) = \delta(t)$

(c) $\delta(at) = [\delta(t)]^{-a}$ (d) $\delta(at) = \frac{1}{|a|}\delta(t)$

Ans. (d)

End of Solution

139. Which one of the following is correct for the system represented by the relation $y(t) = x \sin(t)$, where $x(t)$ and $y(t)$ are input and output respectively?

(a) It is causal and linear. (b) It is non-causal linear.

(c) It is casual and non-linear. (d) It is non-causal and non-linear.

Ans. (b)

End of Solution

140. The Fourier series representations are based on using

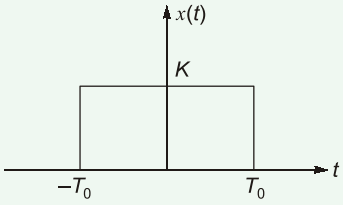
(a) constant coefficients (b) cosine functions only

(c) sine functions only (d) orthogonal functions

Ans. (d)

End of Solution

141. What is the Fourier transform of rectangular pulse as shown in the figure below?



(a) $2KT_0 \sin c\left(\frac{\omega T_0}{\pi}\right)$

(b) $2KT_0 \sin c\left(\frac{\omega T_0}{2\pi}\right)$

(c) $KT_0 \sin c\left(\frac{\omega T_0}{\pi}\right)$

(d) $KT_0 \sin c\left(\frac{\omega T_0}{2\pi}\right)$

Ans. (a)

End of Solution

142. What is the Fourier transform of the function $f(t) = te^{-|t|}$?

(a) $\frac{4j\omega}{(1+\omega^2)^2}$

(b) $\frac{-4j\omega}{(1+\omega^2)^2}$

(c) $\frac{4j\omega}{(1+\omega)^2}$

(d) $\frac{-4j\omega}{(1+\omega)^2}$

Ans. (b)

End of Solution

143. What is the signal $x(t)$, based on the following facts:

1. $x(t)$ is periodic with period $T_0 = 4$ and has Fourier series coefficient $c[k]$.
2. $x(t)$ is real-valued.
3. $c[k] = 0$ for $|k| > 1$.
4. The signal $y(t)$, whose Fourier series coefficients are $d[k] = e^{-j\pi K/2}c[k]$, odd.
5. $\frac{1}{4}\int_{-2}^{2} |x(t)|^2\, dt = \frac{1}{2}$.

(a) $(2)^m \cos(\omega_0 t)$

(b) $(-1)^m \cos(\omega_0 t)$

(c) $(-1)^m \cos(2\omega_0 t)$

(d) $(-2)^m \cos(\omega_0/2t)$

Ans. (b)

$$y(t) \Longleftrightarrow d_k = e^{-j\frac{\pi}{2}k} \cdot C_k$$

By time shifting properly,

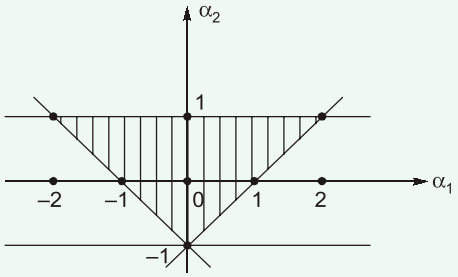
$$y(t) = x(t-1)$$

To satisfy facts (4) and (5),

$$x(t) = (-1)^m \cos(\omega_0 t)$$

End of Solution

144. From the plot shown below, what are the necessary and sufficient conditions for a second order causal LTI discrete time system to be stable?



(a) $|\alpha_1| < 1 \text{ and } |\alpha_2| < 1 + \alpha_1$

(b) $|\alpha_2| < 1 \text{ and } |\alpha_1| < 1 + \alpha_2$

(c) $|\alpha_1| > 1 \text{ and } |\alpha_2| > 1 + \alpha_1$

(d) $|\alpha_2| > 1 \text{ and } |\alpha_2| > 1 + \alpha_2$

Ans. (b)

End of Solution

Directions: Each of the next six (06) items consist of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the codes given below:

Codes:

(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 true, but Statement (II) is false.

(d) Statement (I) is false, but Statement (II) is true.

145. **Statement (I):** Diodes designed expressly to operate in the forward biased region are called zener diodes.

Statement (II): The principal operating region for a zener diode is negative in terms of both voltage and current.

Ans. (d)

- Zener didoe will operate in reverse bias region not in forward bias.
- Zener diode in negative in terms of voltage and current because the region will be in 3rd quantrunt.

End of Solution

146. **Statement (I):** A small-signal equivalent circuit of a BJT that applies to both *n-p-n* and *p-n-p* transistors is valid at lower frequencies by ignoring capacitance effects.

Statement (II): Despite the structural similarities, a p-n-p BJT has higher current gain than a comparable *n-p-n* BJT because holes are less mobile than electrons.

Ans. (c)

Statement (I): Small signal equivalent model for BJT will not have junction capacitances.

Statement (II): *p-n-p* current gain will be less than *n-p-n* because $\mu_n > \mu_p$.

End of Solution

147. **Statement (I):** MOSFETs are preferred over JFETs for digital integrated circuits, either p-channel metal-oxide semiconductor or n-channel metal-oxide semiconductor logic circuits can be constructed.

Statement (II): The usage of a p-channel MOSFET as the active load for an n-channel MOSFET leads to a logic family known as complementary-symmetry MOS or 7 CMOS.

Ans. (b)

Statement (I): MOSFETs are preferred over JFET for digital interrated circuits.

Statement (II): CMOS is constructed by NMOS and PMOS where PMOS will behave as a active load.

End of Solution

148. **Statement (I):** A system is LTI if and only if the exists a signal, called the system impulse response.

Statement (II): The output of a discrete-time LTI system is equal to the convolution sum between the input signal and its unit impulse response.

Ans. (a)

End of Solution

149. **Statement (I):** The root locus is the path of the roots of the characteristic equation traced out in the s-plane as a system parameter varies from zero to infinity.

Statement (II): The frequency response of a system is defined as the steady-state response of the system to a non-sinusoidal unique input signal, and the resulting output signal for a linear system is sinusoidal in the steady-state; it differs from the input only in amplitude and phase angle.

Ans. (c)

End of Solution

150. **Statement (I):** Transformers take advantage of the high magnetic energy density of ferromagnetic material to allow economical device design, however, the non-linear nature of ferromagnetic material leads to introduction of harmonics in current or voltage.

Statement (II): The non-linear nature of the transformer magnetizing inductance can lead to a transient inrush current significantly greater than the rated value of current upon energizing a transformer.

Ans. (b)

End of Solution

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