ESE 2022

Preliminary Examination

Detailed Solution of

ELECTRICAL ENGINEERING

Set-A

Scroll down

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Electrical Engineering Paper Analysis of ESE 2022 Prelims Exam		
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UPSC ESE Prelims 2022
Electrical Engineering Analysis

by **MADE EASY faculties**

https://www.youtube.com/watch?v=UbhEo8pGnGk

1. A transistor has $\beta = 105$ and $I_C = 840\ \mu A$. What is the value of I_B?

(a) 0.008 μA (b) 0.08 μA

(c) 0.8 μA (d) 8 μA

Ans. **(d)**

Given, $\beta = 105$

$I_C = 840\ \mu A$

$I_B = ?$

$I_C = \beta I_B$

$$I_B = \frac{I_C}{\beta} = \frac{840\ \mu A}{105} = 8\ \mu A$$

End of Solution

2. What is the power gain of transistor amplifier, if its current gain is 40 and voltage gain is 25?

(a) 100 (b) 1200

(c) 1000 (d) 950

Ans. **(c)**

Given data, $A_I = 40$

$A_V = 25$

$P_{gain} = A_V \cdot A_I$

$= 40 \times 25 = 1000$

End of Solution

3. Which one of the following statements is not correct regarding common-base amplifier?

(a) The output is in the same phase as the input alternating signal.

(b) It cannot operate at higher frequency as compared to CE amplifier.

(c) The current gain is less than unity.

(d) Impedance matching is needed when cascading because there is very large difference in the input and output impedance, the input impedance is low and the output high.

Ans. **(b)**

In common base amplifier,

"It can not operate at higher frequency as compared to CE amplifier" is wrong statement.

∴ (b) option is right choice.

End of Solution

4. When the quiescent point of an amplifier is biased just at the cut-off axis, so that only the positive half of the signal input is amplified and the negative half of the signal is cut off, it is referred as

(a) class AB amplification (b) class A amplification

(c) class B amplification (d) class C amplification

Ans. (c)

When the operating or quiescent point of an amplifier is biased at cut-off
Then it is class B amplification.

End of Solution

5. Which one of the following is a disadvantages of CE amplifier?
   (a) It provides good current as well as voltage gain.
   (b) It provides the maximum power gain of the three configuration.
   (c) It has medium both input and output impedances.
   (d) Its frequency response bandwidth is lower than the amplifiers of the other two configurations.

Ans. (d)

The disadvantages of CE amplifier is its frequency response bandwidth is lower.

End of Solution

6. Which one of the following consists of op-amp in inverting mode and network of R-C components, and the op-amp being in inverting mode it serves two purpose of amplifying and at its output 180° shifted phase is obtained?
   (a) Wien's bridge oscillator
   (b) R-C phase-shift oscillator
   (c) Triangular wave generator
   (d) Charging capacitor

Ans. (b)

Opamp in inverting mode and network of RC components.
RC phase shift oscillator.

End of Solution

7. Which one of the following statements is not correct related to oscillators?
   (a) The frequency of a sinusoidal oscillator is determined by the condition that the loop-gain phase shift is zero.
   (b) In every practical oscillator, the loop gain is slightly larger than unity and the amplitude of the oscillations is limited by onset of non-linearity.
   (c) The condition of unity loop gain $-A\beta = 1$ is called the Barkhausen criterion.
   (d) Oscillations will be sustained if, at the oscillator frequency, the magnitude of the product of the transfer gain of the amplifier and the magnitude of the feedback factor the feedback network are less than unity.

Ans. (d)

In relation to oscillators

$$A\beta < 1 \text{ is not correct}$$

$\therefore$ (d) option is right choice.

End of Solution

8. Which one of the following statements is not correct for a transistor?
(a) The region at the centre is always base region.
(b) Emitter region is more heavily doped and based region is very lightly doped.
(c) Collector region is very lightly doped compared to base region.
(d) Low power input can be converted to a large power output with the half of a small piece of semi conductor without any hassles of preheating and handling of large heat dissipation.

Ans. (c)
Collector region is very lightly doped compared to base region is wrong statement.
Theoretical transistor has
Emitter - heavily doped, Collector - moderate
Base - lightly-doped

End of Solution

9. For certain of the reverse voltage in a transistor, the effective base width may reduce to zero resulting into the voltage breakdown. This phenomenon is called
(a) early effect
(b) avalanche multiplication
(c) punch through
(d) zones breakdown

Ans. (c)
For certain of reverse voltage in transistor, the effective base width may reduce to zero. This phenomena is known as punch through.

End of Solution

10. An *n*-type semiconductor specimen has a Hall coefficient of 300 cm^3/C and its resistivity is 0.1 Ω-cm. Its electron mobility is
(a) 300 cm^2/V-sec
(b) 30 cm^2/V-sec
(c) 3000 cm^2/V-sec
(d) 3 cm^2/V-sec

Ans. (c)

$$R_H = \frac{1}{ne} \text{ (Hall coefficient)}$$

$$\sigma = n \times e \times \mu = \frac{1}{\rho}$$

$$\sigma = \frac{\mu}{R_H} = \frac{1}{\rho}$$

$$\mu = \frac{R_H}{\rho} = \frac{300}{0.1} = 3000 \text{ cm}^2\text{/V-sec}$$

End of Solution

11. Which of the following motors are commonly used in power electronic systems?
1. Synchronous motors
2. d.c. motors
3. d.c. motors with brushes

Select the correct answer using the code given below:
(a) 1 and 3 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

12. In P-N junction diode, the reverse saturation current increases by 7.2% by a degree rise in junction temperature (in Celsius) and gets
(a) halved for every 10° C rise in temperature
(b) doubled for every 10° C rise in temperature
(c) halved for every 20° C rise in temperature
(d) doubled for every 20° C rise in temperature

Ans. (b)
It double for every 10° C rise in temperature.

End of Solution

13. Which one of the following controllers is to check the status of each device and inform the centre processing unit of the status of each?
(a) Programmable I/O interrupt controller
(b) DMA controller
(c) Disk controller
(d) Pipeline controller

Ans. (a)
Programmable I/O interrupt controller monitors the devices and checks which device has interrupted the CPU.

End of Solution

14. Which one of the following bus architectures is used to maximize throughput of video graphics memory?
(a) EISA bus (b) VESA bus
(c) PCI bus (d) MCA bus

Ans. (c)
Peripheral component interconnect bus replaced other slow speed slots and also VESA bus which was under ISA (Industry Standard Association).
It has more data rate and can be used for general applications including video graphic applications.

End of Solution

15. Which one of the following bus architectures is having maximum data rate (MB/s)?
(a) VESA bus
(b) PCI-64 bus
(c) MCA bus
(d) EISA bus

Ans. (b)
PCI-64 bus.
Remaining were slow as compared to PCI-64 bus in data rate.

End of Solution

16. Which one of the following functions is not performed by the USB host controller?
(a) Configure the scheduling algorithms
(b) Packet generation
(c) Serializer/Deserializer
(d) Process request from device and host

Ans. (a)
Configuration the scheduling algorithms not performed by the USB host controller but other operations are performed in the USB host controller.

End of Solution

17. Which one of the following layers in PCI express protocol architecture is used for compatibility with PCI, initialization and enumeration of the devices connected to the PCI express?
(a) PCI express physical layer
(b) Software layer
(c) Data link layer
(d) Hardware layer

Ans. (a)
Peripheral component inter connect, initialization are done in physical layer.

End of Solution

18. Which one of the following tools is used to protect critical sections and prevent race conditions?
(a) Mutex lock
(b) Semaphore lock
(c) Spooling lock
(d) Livelock

Ans. (a)
Critical section means shared resources, this will be protected by mutex lock.

End of Solution

19. To arise a deadlock situation, which of the following conditions hold simultaneously in a system?
1. Mutual exclusion
2. Hold and wait
3. Preemption

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Select the correct answer using the code given below:

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

Ans. (b)

To arise the deadlock four different conditions are necessary

mutual exclusion

hold and wait

no pre-emption

circular wait

Only two conditions are matching from given points: Mutual exclusion and hold and wait.

End of Solution

20. Which of the following issues are addressed by redundant arrays of independent disks?

(a) Performance and reliability
(b) Performance and stability
(c) Performance and process
(d) Performance and storage space

Ans. (a)

The main purpose of maintaining RAID is for performance and reliability.

End of Solution

21. Stack-oriented machine

(a) contains any accumulator or general purpose registers.
(b) does not contain only a stack pointer which points to the stack top.
(c) requires any operand address for arithmetic, logical and comparison instructions
(d) does not contain any accumulator or general purpose registers.

Ans. (a)

In stack oriented machine CPU, data must be pushed onto stack first, then operated but ACC and other registers also required.

Stack pointer is must.

$\therefore$ b, c, d are incorrect.

ALU instructions are operated on data at top of stack.

End of Solution

22. Virtual memory implements the translation of a program's address space to

(a) virtual addresses
(b) physical addresses
(c) mapping addresses
(d) page addresses

Ans. (b)

Virtual memory implements the translation of a program's address space to physical addresses.

CPU always generates virtual address but actual programs resides in physical address, so it should translate to physical address in order to access any instruction of the program.

End of Solution

23. Which one of the following provides an interface to which a client can send a request to perform an action, in response, the server executes the action and sends back results to the client?

(a) File server system
(b) Open-source system
(c) Compute server system
(d) Peer to peer system

Ans. (c)

What ever the request sent by the client will be sent to server system and request will be processed in the several system and processed result will be sent back to client system. This is generally known as client server system and it is also known as computer server system.

End of Solution

24. Which of the following statements are correct regarding multiprocessing architecture?

1. It can cause a system to change its memory access model from uniform memory access to non-uniform memory access.
2. There are two types of systems such a asymmetric multiprocessing and symmetric multiprocessing.
3. It adds CPUs to decrease computing power.

Select the correct answer using the code given below:

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

Ans. (b)

Main advantages of multiprocessor systems is to change its memory access model from uniform memory access to non uniform memory access.

There two types of systems:

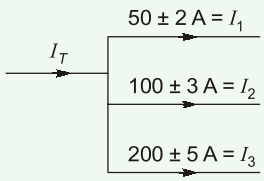
1. Symmetric multiprocessing
2. Asymmetric multiprocessing

End of Solution

25. Consider a parallel circuit having three branches the current in first branch is 50 ± 2 A, in the second branch is 100 ± 3 A and in the third branch is 200 ± 5 A. What is the value of the total current, assuming the errors as standard deviations?

(a) 350 ± 10 A
(b) 350 ± 3.16 A
(c) 350 ± 6.16 A
(d) 350 ± 5 A

Ans. (c)



$$I_T = I_1 + I_2 + I_3$$

$$\frac{\delta I_T}{\delta I_1} = 1 = \frac{\delta I_T}{\delta I_2} = \frac{\delta I_T}{\delta I_3}$$

$$\sigma_{IT} = \sqrt{\left(\frac{\delta I_T}{\delta I_1}\right)^2 \sigma_1^2 + \left(\frac{\partial I_T}{\partial I_2}\right)^2 \sigma_2^2 + \left(\frac{\delta I_T}{\delta I_3}\right)^2 \sigma_3^2}$$

$$= \sqrt{1^2 \times 2^2 + 1^2 \times 3^2 + 1^2 \times 5^2} = 6.16 \text{ A}$$

$$I_T = (50 + 100 + 200) \pm 6.16$$

$$= 350 \pm 6.16 \text{ A}$$

End of Solution

26. Which one of the following is not a self-generating type of transducer?

(a) Bourdon gauge for the measurement of pressure
(b) Pitot tube for the measurement of fluid flow velocity
(c) Thermistor for the measurement of temperature
(d) Photovoltaic cell

Ans. (c)

End of Solution

27. The approximate range of gauge factor for a semiconductor strain gauge is

(a) 2 - 3
(b) 50 - 90
(c) 10 - 20
(d) 100 - 200

Ans. (d)

End of Solution

28. The approximate pressure range for ionization gauge measuring device is

(a) 10^{-8} to 10^{-3} torr
(b) 10^{-3} to 10^{-2} torr
(c) 10^{-10} to 10^{-8} torr
(d) 10^{-2} to 10^{-1} torr

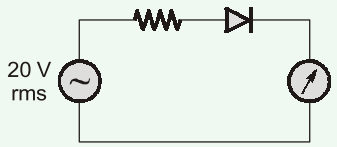
Ans. (a)

End of Solution

29. A half-wave rectifier type a.c. voltmeter is fed with a 20 V rms signal. What is the equivalent d.c. output voltage?

(a) 6.4 V
(b) 9 V
(c) 12.8 V
(d) 18 V

Ans. (b)

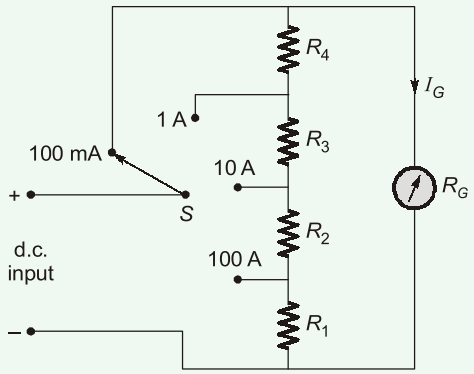


$$V_{DC} = 0.45\ V_{rms}$$

$$= 0.45 \times 20 = 9 \text{ V}$$

End of Solution

30. A D'Arsonval movement has a resistance of 100 Ω and full deflection current of 2 mA and is used for construction of multirange ammeter as shown in the figure:



What are the values of resistances R_1 , R_2 , R_3 and R_4, if the shunt resistances are connected as shown in the figure?

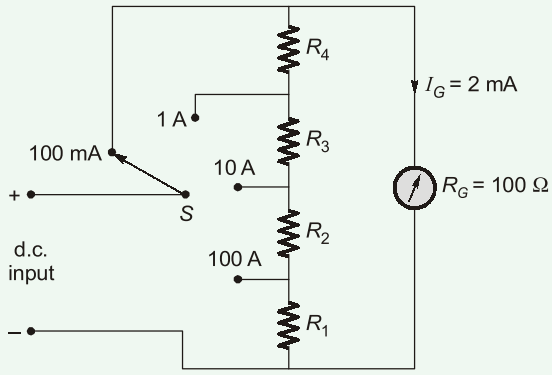
(a) $R_1 = 0.002\ \Omega$, $R_2 = 0.018\ \Omega$, $R_3 = 0.18\ \Omega$ and $R_4 = 1.836\ \Omega$.

(b) $R_1 = 0.002\ \Omega$, $R_2 = 0.18\ \Omega$, $R_3 = 0.018\ \Omega$ and $R_4 = 1.836\ \Omega$.

(c) $R_1 = 1.836\ \Omega$, $R_2 = 0.18\ \Omega$, $R_3 = 0.018\ \Omega$ and $R_4 = 0.002\ \Omega$.

(d) $R_1 = 1.836\ \Omega$, $R_2 = 0.018\ \Omega$, $R_3 = 0.18\ \Omega$ and $R_4 = 0.02\ \Omega$.

Ans. (a)



For 100 mA:

$$R_{sh} = R_1 + R_2 + R_3 + R_4 = \frac{R_m}{\left(\frac{I}{I_m} - 1\right)} = \frac{100}{\left(\frac{100}{2} - 1\right)}$$

$$R_1 + R_2 + R_3 + R_4 = 2.0408\ \Omega \qquad \text{...(i)}$$

For 1 A:

$$R_2 + R_3 + R_1 = \frac{100 + R_4}{\left(\frac{1}{2 \times 10^{-3}} - 1\right)} = \frac{100 + R_4}{499} \qquad \text{...(ii)}$$

For 10 A:

$$R_2 + R_1 = \frac{100 + R_3 + R_4}{\left(\frac{10}{2\times10^{-3}} - 1\right)} = \frac{100 + R_3 + R_4}{4999} \quad \text{...(iii)}$$

Switched at 100 A:

$$R_{sh} = R_1 = \frac{R_2 + R_3 + R_4 + 100}{\left(\frac{100}{2\times10^{-3}} - 1\right)} = \frac{R_2 + R_3 + R_4 + 100}{49999} \quad \text{...(iv)}$$

By solving equation (i), (ii), (iii) and (iv)

$R_1 = 0.002\ \Omega$; $R_2 = 0.018\ \Omega$

$R_3 = 0.18\ \Omega$

and $R_4 = 1.836\ \Omega$

End of Solution

31. The torque generated in the aluminium disc of induction type energy meter is maximum when the phase difference between the magnetic fields of shunt and series electromagnets is equal to

(a) 180° (b) 90°

(c) 45° (d) 0°

Ans. **(b)**

For energy meter

$\tau_d \propto \phi_{sh}\ \phi_{se} \times \sin(\angle\phi_{sh} - \angle\phi_{se})$; τ_d is maximum when $\sin(\angle\phi_{sh} - \angle\phi_{se}) = 1$.

So angle between $\angle\phi_{sh}$ and $\angle\phi_{se}$ should be 90°.

∴ (b) option is correct.

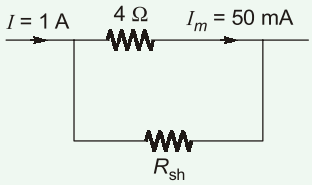
End of Solution

32. A d.c. galvanometer of 4 Ω resistance reads up to 50 mA. What is the value of the resistance in parallel to enable the instrument to read up to 1 A?

(a) 0.21053 Ω (b) 0.26316 Ω

(c) 0.31285 Ω (d) 0.37347 Ω

Ans. **(a)**



$$R_{sh} = \frac{R_m}{(m-1)},$$

$$m = \frac{I}{I_m} = \frac{4}{\left(\frac{1}{50\times10^{-3}} - 1\right)} = 0.21053\ \Omega$$

End of Solution

33. Which one of the following is correct in the feedback circuit, having three resistance and capacitance elements with conditions as $R_1 = R_2 = R_3 = \bar{R}$ and $C_1 = C_2 = C_3 = \bar{C}$ for phase-shift oscillator?

(a) $f = \dfrac{0.065}{\bar{R}\bar{C}}$ (b) $f = \dfrac{0.078}{\bar{R}\bar{C}}$

(c) $f = \dfrac{0.045}{\bar{R}\bar{C}}$ (d) $f = \dfrac{0.038}{\bar{R}\bar{C}}$

Ans. (a)

$$R_1 = R_2 = R_3 = \bar{R}$$

$$C_1 = C_2 = C_3 = \bar{C}$$

RC phase shift oscillator

$$f = \frac{1}{2\pi RC\sqrt{6}} = \frac{1}{2\times 3.14\times 2.44\times \bar{R}\bar{C}}$$

$$= \frac{1}{15.32\bar{R}\bar{C}} = \frac{0.065}{\bar{R}\bar{C}}$$

End of Solution

34. Which one of the following statements is not correct for electrodynamometer type instrument?

(a) It can measure a range of currents and voltages up to 10 A and 600 V respectively.
(b) The deflecting torque is inversely proportional to the square of the current.
(c) It can be used for both a.c. and d.c. systems.
(d) It has the same calibration for d.c. instruments as well as a.c. measurements.

Ans. (b)

In electrodynamometer type instrument deflection torque,

$$\tau_d \propto I^2$$

$\therefore$ (b) option is right choice.

End of Solution

35. The controlling torque of a gravity-controlled measuring instrument is directly proportional to

(a) θ (b) $\cos\theta$

(c) θ^2 (d) $\sin\theta$

Ans. (d)

$T_d = (mgl)\sin\theta \Rightarrow$ For gravity control

End of Solution

36. The arms of a four-arm bridge abcd, supplied with sinusoidal voltage, have the following values:

Arm *ab* : A resistance of 200 Ω in parallel with a capacitance of 1 μF.

Arm *bc* : 400 Ω resistance

Arm *cd* : 1000 Ω resistance

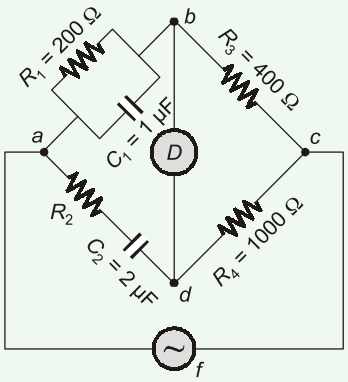
Arm *da* : A resistance R_2 in series with a 2 μF capacitances.

What are the values of R_2 and the frequency respectively at which the bridge will balance?

(a) 200 Ω, 456 Hz (b) 400 Ω, 398 Hz

(c) 200 Ω, 398 Hz (d) 400 Ω, 456 Hz

Ans. (b)



For Wien bridge under balance condition:

$$\frac{R_4}{R_3} = \frac{R_2}{R_1} + \frac{C_1}{C_2}$$

$$\frac{1000}{400} = \frac{R_2}{200} + \frac{1}{2}$$

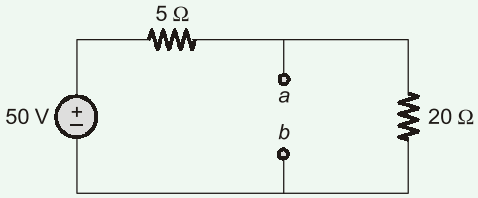
$$R_2 = 400\ \Omega$$

$$f = \frac{1}{2\pi\sqrt{R_1 R_2 C_1 C_2}}$$

$$= \frac{1}{2\pi\sqrt{200 \times 400 \times 1 \times 2 \times 10^{-12}}} = 398\ \text{Hz}$$

End of Solution

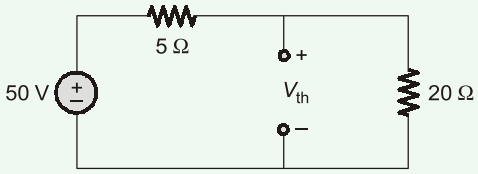
37. The Thevenin voltage and resistance across the terminal *a-b* of the circuit in the figure respectively are



(a) 40 V, 4 Ω
(b) 20 V, 8 Ω
(c) 40 V, 8 Ω
(d) 20 V, 4 Ω

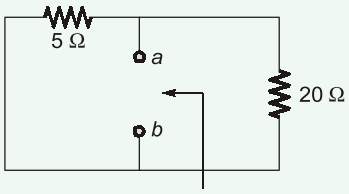
Ans. (a)

Case-I : V_{th}



$$V_{th} = 50 \times \frac{20}{20+5} = 40 \text{ V}$$

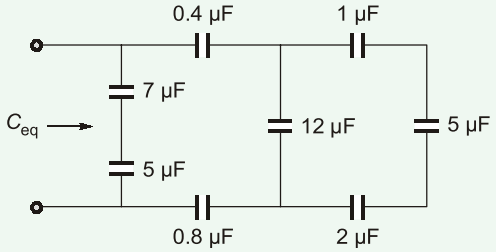
Case-II : R_{th}



$$R_{th} = \frac{5 \times 20}{5+20} = 4\ \Omega$$

End of Solution

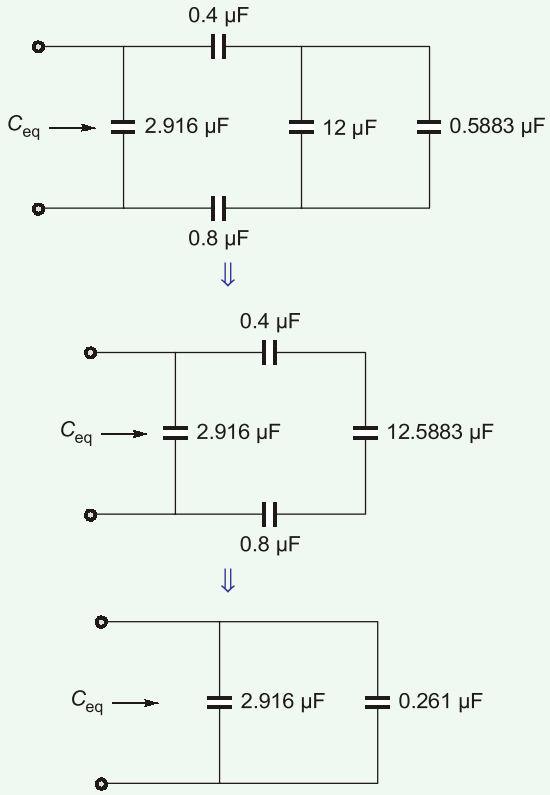
38. What is C_{eq} for the given circuit?



(a) 6.18 μF
(b) 3.18 μF
(c) 8.23 μF
(d) 12.67 μF

Ans. (b)

Given circuit can be simplified as,



$\therefore \quad C_{eq} = 3.177\ \mu F = 3.18\ \mu F$

(b) option is correct.

End of Solution

39. Consider the following statements with respect to Kirchhoff's laws for a circuit comprising of resistances and independent sources:

1. The number of independent element volt-ampere equations is equal to the number of resistances.
2. The number of independent KVL equations is equal to one more than the number of nodes.
3. The number of independent KVL equations is equal to the number of independent loops.

Which of the above statements is /are not correct?

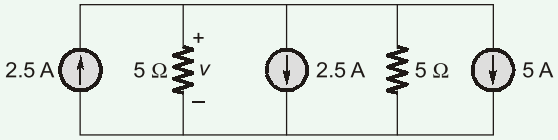
(a) 1 only (b) 2 only

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

Ans. (b)

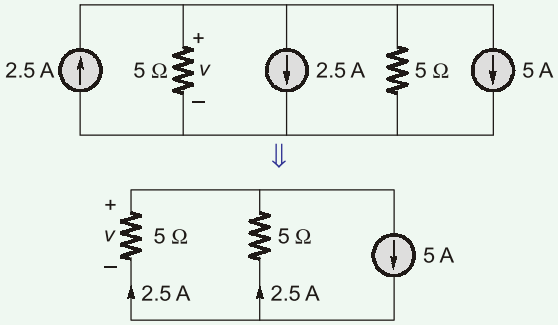
End of Solution

40. What is the voltage v in the circuit diagram?



(a) 7.5 V
(b) 16.5 V
(c) 12.5 V
(d) 14.4 V

Ans. (c)



$v = -2.5 \times 5 = -12.5$

$|v| = 12.5$

End of Solution

41. When angular frequency for d.c. sources is zero, capacitor and inductor will act like respectively

(a) short circuited, open circuited
(b) open circuited, short circuited
(c) open circuited, open circuited
(d) short circuited, short circuited

Ans. (b)

When angular frequency is zero,

$$\omega = 0$$

$\therefore$ $X_L = \omega L = 0$ or inductor behaves as short circuit

Similarly, $X_C = \dfrac{1}{\omega C} = \dfrac{1}{0} = \infty$ capacitor behaves as open circuit.

Option (b) is correct

End of Solution

42. Which one of the following statements is not correct regarding potential due to a point charge?

(a) It is directly proportional to the magnitude of the charge.
(b) It is inversely proportional to the distance from the charge.
(c) It is inversely proportional to the relative permittivity of the medium in which the charge is placed.
(d) It is directly proportional to the electric field intensity.

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Ans. (d)

Potential due to point charge,

$$V_Q = \frac{KQ}{r} \; ; \quad K = \frac{1}{4\pi \in}$$

$$\Rightarrow \quad V_Q = \frac{Q}{4\pi \in r}$$

Here, $V \propto Q$

$$V \propto \frac{1}{r}$$

$$V \propto \frac{1}{\in}$$

End of Solution

43. The relation between electric flux density (D) and field intensity (E) with absolute and relative permittivity is expressed as

(a) $E = \frac{\varepsilon_0 \varepsilon_r}{D}$ (b) $E = \frac{D}{\varepsilon_0 \varepsilon_r}$

(c) $E = \frac{D\varepsilon_0}{\varepsilon_r}$ (d) $E = \frac{D\varepsilon_r}{\varepsilon_0}$

Ans. (b)

As we know, $D = \varepsilon E$

$$\Rightarrow \quad D = \varepsilon_0 \varepsilon_r E$$

$$\Rightarrow \quad E = \frac{D}{\varepsilon_0 \varepsilon_r}$$

End of Solution

44. If L is self-inductance, I is current, λ is flux linkage of a magnetic field, then the energy stored in the magnetic field is

(a) $\frac{0.5\lambda^2}{L}$ (b) $\frac{2\lambda^2}{L}$

(c) $\frac{0.5\lambda}{L^2}$ (d) $\frac{2\lambda}{L^2}$

Ans. (a)

As we know that, $\lambda \propto I$

$$\Rightarrow \quad \lambda = LI$$

$$\Rightarrow \quad I = \frac{\lambda}{L}$$

$\therefore$ Magnetic energy, $w_m = \frac{1}{2} LI^2$

$$w_m = \frac{1}{2} \cdot L \cdot \frac{\lambda^2}{L^2}$$

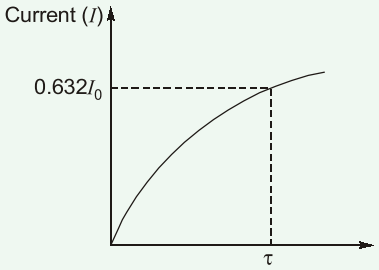
$$w_m = \frac{\lambda^2}{2L} = \frac{0.5\lambda^2}{L}$$

End of Solution

45. The time constant of R-L series circuit may be defined as the time at which the current through the R-L series circuit rises to

(a) 36.8% of steady-state value
(b) 63.2% of steady-state value
(c) 23.2% of initial value
(d) 46.8% of initial value

Ans. (b)



where, τ = time constant

I_0 is the steady state value or final value.

∴ Time constant of *R-L* series circuit, τ is the time when current through *R-L* series circuit rises to 63.2% of steady state value.

∴ (b) option is correct.

End of Solution

46. Transient disturbance is produced in a circuit whenever

(a) currents in electrical circuit are associated with resistors
(b) circuit is suddenly connected to or disconnected from the supply
(c) the source is overdamped
(d) the source is underdamped

Ans. (b)

Transient disturbance is produced in circuit whenever circuit is suddenly connected to or disconnected from the supply.

∴ (b) option is correct.

End of Solution

47. Choke coils are made of iron core, because

(a) it has less loss in iron cores
(b) large-valued flux densities can be produced in iron cores
(c) it is easily available in the market
(d) it has laminated core with high resistance

Ans. (b)

For iron core, reluctance is low, flux value is high and hence flux density also high.

∴ (b) option is correct.

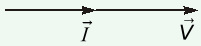
End of Solution

48. At off-resonance frequencies in parallel resonant circuit, the phase angle is greater than

(a) 0°
(b) 30°
(c) 60°
(d) 90°

Ans. (a)

At resonance condition the current $\vec{I}$ and $\vec{V}$ are in phase with each other



angle is 0°

∴ At off resonance condition means not in resonance means angle between voltage and current is greater than 0°.

(a) option is correct.

End of Solution

49. Which one of the following defects might be thought of as being formed by a cation leaving its normal position and moving into an interstitial site?

(a) Schottky defect
(b) Frenkel defect
(c) Crystallographic defect
(d) Stoichiometric defect

Ans. (b)

Frenkel defect is formed when a cation leaves its normal position and occupies an interstitial position.

End of Solution

50. Which of the following classifications are correct with reference to the various types of imperfections in a semiconductor?

1. Substitutional
2. Vacancies
3. Interstitial

Select the correct answer using the code given below:

(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

51. Which one of the following statements is not correct regarding superconductivity of material?
(a) Superconducting compounds and , alloys do not necessarily have compounds which are themselves superconducting.
(b) The metals which are very good conductors at room temperature do not exhibit superconducting properties.
(c) The metals and compounds which are superconducting are rather bad conductors at ordinary temperature.
(d) Monovalent metals, ferromagnetic and antiferromagnetic metals are superconducting.

Ans. (d)
Fe is ferromagnetic but it does not exhibit superconductivity.

End of Solution

52. According to Bragg's law, if an electromagnetic wave is diffracted when it is passed through a series of small slits spaced a distance d apart and order of diffraction is n and if the angle between the diffracted beam and incident beam is 2θ, then the relationship between the wavelength λ and this angle of diffraction is
(a) $n\lambda = 2d \sin\theta$ (b) $\lambda = 2dn \sin\theta$
(c) $\lambda d = n \sin 2\theta$ (d) $n\lambda = d \sin 2\theta$

Ans. (a)
Bragg's law $n\lambda = 2d \sin\theta$

End of Solution

53. What is the approximate diameter of a copper wire of length 100 m, if it is to be used as winding material in a transformer such that the resistance of the whole winding is 2 Ω? (Take resistivity of copper as 1.7×10^{-8} Ω-m)
(a) 0.25 mm (b) 1.05 mm
(c) 2.25 mm (d) 3.05 mm

Ans. (b)

$$l = 100 \text{ m}$$
$$R = 2\ \Omega$$
$$\rho = 1.7 \times 10^{-8}\ \Omega\text{-m}$$
$$R = \frac{\rho l}{A}$$
$$\Rightarrow \quad A = \frac{\rho l}{A} = \frac{1.7\times10^{-8}\times100}{2}$$
$$\Rightarrow \quad A = \frac{\pi d^2}{4} = \frac{1.7\times10^{-6}}{2}$$

$$d = \sqrt{\frac{2 \times 1.7 \times 10^{-6}}{\pi}}$$

$$\Rightarrow \quad d = 1.04 \times 10^{-3} \text{ m}$$

End of Solution

54. The temperature above which the ferromagnetic materials lose their magnetic properties is called

(a) saturation point
(b) breakdown point
(c) Curie point
(d) peak point

Ans. **(c)**

Above curie temperature ferromagnetic materials become paramagnetic.

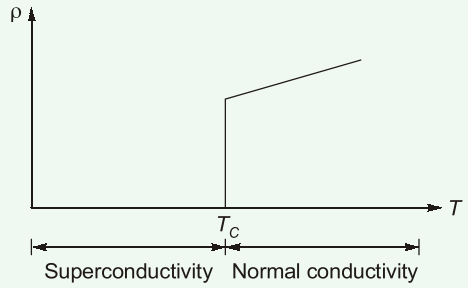
End of Solution

55. There are some metals and chemical compounds whose resistivity becomes zero when their temperature is brought near 0 K (-273 °C). Such metals or compounds are said to have attained

(a) piezoelectricity
(b) superconductivity
(c) semiconductivity
(d) electromagnetism

Ans. **(b)**

Superconductivity is the state of material when its resistivity becomes zero below certain critical temperature



End of Solution

56. A blue lamp emits light of mean wavelength of $4500\,\dot{A}$. The lamp is rated at 150 W and 8% of the energy appears as emitted light. How many photons are emitted by the lamp per second?

(Take $h = 6.625 \times 10^{-34}$ J-sec and $c = 3 \times 10^{8}$ m/sec)

(a) 10.55×10^{18}
(b) 13.62×10^{18}
(c) 27.15×10^{18}
(d) 33.25×10^{18}

Ans. (c)

Energy of emitted photon,

$$E = \frac{hc}{\lambda} = \frac{6.625\times10^{-34}\times3\times10^{8}}{4500\times10^{-10}} = 4.42\times10^{-19}\text{ J}$$

Energy emitted by lamp = 8% of (150 W × 1 sec) = 8% of 150 J

($\because$ time, t = 1 sec)

$$E_{\text{total}} = \frac{8\times150}{100}\text{J/s} = 12\text{ J/s}$$

$$\therefore \text{No. of photon emitted} = \frac{E_{\text{total}}}{E} = \frac{12}{4.42\times10^{-19}} = 2.72\times10^{19} = 27.2\times10^{18}$$

End of Solution

57. What is the energy lost per hour in a specimen of iron subjected to magnetization at 50 c/s, if the specimen weighs 50 kg and the hysteresis loop is equivalent in area to 250 J/m^3 and the density of iron is 7500 kg/m^3?

(a) 3×10^5 J (b) 4×10^5 J

(c) 5×10^5 J (d) 6×10^5 J

Ans. (a)

$$\text{The energy loss} = \frac{250}{7500}\times50\times50\times60\times60$$

$$= 3\times10^5\text{ J}$$

End of Solution

58. A good insulating material should possess which of the following characteristics?

1. High dielectric strength
2. Low permittivity
3. Low thermal strength

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

Ans. (a)

A good insulating material should have-

- High dielectric strength
- Low permittivity
- High thermal strength

End of Solution

59. Most substances are not magnets, because
(a) they do not have sufficient energy to produce magnetic behavior
(b) their electrons do not move truly
(c) the electrons usually pair up with their spins opposite to each other, so that their fields cancel each other
(d) their electrons strongly bind to the nucleus as they have more number of protons than electrons

Ans. (c)
Because of the pairing net electron spin dipole moments get cancelled and hence material becomes nonmagnetic.

End of Solution

60. Whenever a particle has angular momentum, it will contribute to permanent dipole moment. Which one of the following does not contribute to the angular momentum of an atom?
(a) Orbital angular momentum of electron
(b) Proton spin angular momentum
(c) Electron spin angular momentum
(d) Nuclear spin angular momentum

Ans. (b)
Permanent magnetic dipole moment of an atom is due to-
- Orbital angular momentum of electron
- Electron spin angular momentum.
- Nuclear spin angular momentum.

End of Solution

61. A workshop has several machines. During a typical month, two machines will break down. The probability of more than two machines will breakdown in a month is
(a) $1 - 3e^{-2}$ (b) $1 - 4e^{-2}$
(c) $1 - 5e^{-2}$ (d) $1 - 6e^{-2}$

Ans. (c)

X = no. of machines breakdown in a mount

and $\lambda = 2$ in a month

$\therefore \quad P(X > 2) = 1 - P(X \le 2)$

$$= 1 - [P[X = 0] + P(X = 1) + P(X = 2)]$$

$$= 1 - \left[\frac{e^{-\lambda}\lambda^0}{\lfloor 0} + \frac{e^{-\lambda}\lambda^1}{\lfloor 1} + \frac{e^{-\lambda}\lambda^2}{\lfloor 2}\right]$$

$$= 1 - [e^{-2} + e^{-2}(2) + e^{-2}(2)]$$

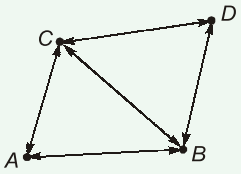
$$= 1 - 5e^{-2}$$

End of Solution

62. Villagers A, B, C and D are connected by overhead telephone lines joining AB, AC, BC, BD and CD. As a result of severe gales, there is a probability p (the same for each link) that any particular link is broken. Then the probability that a call can be made from A and B is

(a) $1 - p^2 - 2p^3 + 3p^4 - p^5$
(b) $1 + 2p^2 - 2p^3 + 4p^4 - 2p^5$
(c) $1 - 3p^2 + 2p^3 - 3p^4 - p^5$
(d) $1 + 4p^2 + 2p^3 - 4p^4 + 2p^5$

Ans. (a)



(Here $\overline{AB}$ = complement of AB)

$$\text{Probability} = \overline{AB}\,\overline{AC} + (\overline{AB}\,AC\,\overline{CB}\,CD\,\overline{DB}) + (\overline{AB}\,AC\,\overline{CB}\,\overline{CD})$$

$$= p \times p + p(1-p)\,(1-p)p + p(1-p)p \times p$$
$$= p^2 + p^3(1-p)^2 + p^3(1-p)$$
$$= p^2 + p^3(1 + p^2 - 2p) + p^3 - p^4$$
$$= p^2 + p^3 + p^5 - 2p^4 + p^3 - p^4$$
$$= p^2 + 2p^3 - 3p^4 + p^5$$

Hence, $1 - p^2 - 2p^3 + 3p^4 - p^5$

End of Solution

63. What is regression line of Y and X for the following six pairs of observations?

i	1	2	3	4	5	6
x_i	1	3	4	5	7	8
y_i	2	8	9	10	14	19

(a) $Y = 1.18X - 0.49$
(b) $Y = 1.18X - 0.16$
(c) $Y = 2.18X + 0.49$
(d) $Y = 2.18X + 0.16$

Ans. (d)

X	Y	X^2	XY
1	2	1	2
3	8	9	24
4	9	16	36
5	10	25	50
7	14	49	98
8	19	64	152
$\Sigma X = 28$	$\Sigma Y = 62$	$\Sigma X^2 = 164$	$\Sigma XY = 362$

Let linear regression is $y = a + bx$
Where normal equation are,

$$\Sigma Y = na + b\Sigma X$$
$$\Sigma XY = a\Sigma X + b\Sigma X^2$$
$$62 = 6a + 28b \quad ...(i)$$
$$362 = 28a + 164b \quad ...(ii)$$

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

$$a = 0.16 \text{ and } b = 2.18$$

Hence regression line is $y = 0.16 + 2.18x$
So option (d) is correct.

End of Solution

64. A bag contains 50 balls of which 10 are red and the remainder black. If two balls are drawn successively from the bag at random, what is the probability of selecting one red and one black ball?

(a) $\frac{9}{245}$ (b) $\frac{156}{245}$

(c) $\frac{16}{49}$ (d) $\frac{156}{49}$

Ans. (c)

$$P(E) = P(1 \text{ red and } 1 \text{ black})$$
$$= \frac{{}^{10}C_1 \times {}^{40}C_1}{{}^{50}C_2} = \frac{400}{\frac{50 \times 49}{2}} = \frac{16}{49}$$

End of Solution

65. A random variable y has a known probability distribution given by

y	2	4	6	8	10
$P(y)$	0.17	0.23	0.2	0.3	0.1

Then the expected value of y is

(a) 7.67 (b) 6.88

(c) 5.86 (d) 4.89

Ans. (c)

$$E(Y) = \sum_i Y_i P(Y_i)$$
$$= 2 \times 0.17 + 4 \times 0.23 + (6 \times 0.2) + (8 \times 0.3) + (10 \times 0.1)$$
$$= 0.34 + 0.92 + 1.2 + 2.4 + 1$$
$$= 5.86$$

End of Solution

66. The Fourier series for $f(x) = \sin^2 x$ defined over the range $-\pi \le x \le \pi$ is

(a) $\frac{1}{2} - \frac{\cos 2x}{2}$ (b) $1 + \cos 2x$

(c) $\frac{1}{2} - \frac{\cos x}{2}$ (d) $\frac{\cos 2x}{2} + \frac{1}{2}$

Ans. **(a)**

$$\sin^2 x = \frac{1-\cos 2x}{2}$$

End of Solution

67. What is the general solution of the partial differential equation

$\frac{\partial \psi}{\partial x} + 2\frac{\partial \psi}{\partial y} + (2x - y)\psi = 0$?

(a) $\psi(x,y) = f(2x-y)e^{-(2x^2+2y^2-3xy)/5}$ (b) $\psi(x,y) = f(2x-y)e^{-(2x^2-2y^2+3xy)/5}$

(c) $\psi(x,y) = f(2x-y)e^{-(-2x^2+2y^2+3xy)/5}$ (d) $\psi(x,y) = f(2x-y)e^{-(2x^2-2y^2+3xy)/5}$

Ans. **(d)**

End of Solution

68. The functions $f(x, t)$ and $F(x)$ are defined by $f(x, t) = e^{-xt}$ and $F(x) = \int_0^x f(x,t)\,dt$.

Then $\frac{dF}{dx} =$

(a) $f(x,t) + \int_0^x \frac{\partial f(x,t)}{\partial x}\,dt$ (b) $f(x,x) + \int_0^x \frac{\partial f(x,t)}{\partial x}\,dt$

(c) $f(0,0) + \int_0^x \frac{\partial f(x,t)}{\partial x}\,dt$ (d) $f(t,t) + \int_0^x \frac{\partial f(x,t)}{\partial x}\,dt$

Ans. **(b)**

$$F(x) = \int_0^x f(x,t)dt \rightarrow \text{Linear volerra internal equation of first kind}$$

$$\frac{dF(x)}{dx} = \frac{d}{dx}\int_0^x f(x,t)dt$$

By Leibnitz rule,

$$= f(x,x)\frac{d}{dx}(x) - f(x,0)\frac{d}{dx}(0) + \frac{\partial}{\partial x}\int_0^x f(x,t)dt$$

$$= f(x,x) + \int_0^x \frac{\partial f(x,t)}{\partial x}\,dt$$

End of Solution

69. The distances of the variable point P, which has coordinates x, y, z from the fixed points (0, 0, 1) and (0, 0, –1) are denoted by u and v respectively. New variables ξ, η, ϕ are defined by $\xi = \frac{1}{2}(u+v)$, $\eta = \frac{1}{2}(u-v)$ and ϕ is the angle between the plane $y = 0$ and the plane containing the three points, i.e., $\phi = \tan^{-1}\left(\frac{y}{x}\right)$ over $1 \le \xi < \infty$, $-1 \le \eta < 1$, $0 \le \phi < 2\pi$. The Jacobian of $\frac{\partial(\xi,\eta,\phi)}{\partial(x,y,z)}$ has the value $(\xi^2 - \eta^2)^{-1}$, then

$$\iiint_{\text{all space}} \frac{(u-v)^2}{uv}\exp\left(-\frac{u+v}{2}\right)dx\,dy\,dz =$$

(a) $\frac{16\pi}{e}$ (b) $\frac{8\pi}{3e}$

(c) $\frac{16\pi}{3e}$ (d) $\frac{8\pi}{e}$

Ans. (c)

$$\xi = \frac{1}{2}[u+v], \qquad 1 < \xi < \infty$$

$$\eta = \frac{1}{2}[u-v], \qquad -1 < \eta < 1$$

$$J = \xi^2 - \eta^2 = \frac{1}{4}[4uv] = uv, \qquad \phi : 0 \text{ to } 2\pi$$

$$\therefore \quad = \iiint \frac{(u-v)^2}{uv} e^{-\left(\frac{u+v}{2}\right)} dx\,dy\,dz$$

$$= \int_1^{\infty}\int_{-1}^{1}\int_{\phi=0}^{2\pi} \frac{4\eta^2}{uv} e^{-\xi}(uv)\,d\xi\,d\eta\,d\phi$$

$$= \int_1^{\infty} e^{-\xi}d\xi \int_{-1}^{1} 4\eta^2 d\eta \int_0^{2\pi} d\phi$$

$$= \frac{e^{-\xi}}{-1}\Big]_1^{\infty}\left[\frac{4\eta^3}{3}\right]_{-1}^{1}(\phi)_0^{2\pi}$$

$$= \frac{1}{e}\times\frac{4}{3}(2)\times 2\pi = \frac{16\pi}{3e}$$

End of Solution

70. The function $f(x, y) = x^3 - 12xy + 48x + by^2$, $b \neq 0$ has two, one or zero stationary points, according to whether $|b|$ is

(a) less than, equal to or greater than 3
(b) less than, equal to or greater than 4
(c) less than, equal to or greater than 8
(d) less than, equal to or greater than 2

Ans. **(a)**

Stationary given by

$$p = 3x^2 - 12y + 48 = 0 \quad ...(i)$$

$$q = -12x + 2by = 0 \quad ...(ii)$$

$$\Rightarrow \quad y = \frac{6x}{b}$$

Sub. in equation (i),

$$3x^2 - \frac{72}{b}x + 48 = 0$$

To have the one (or) two stationary pts

$$B^2 - 4AC \geq 0$$

$$\Rightarrow \quad \left(\frac{-72}{b}\right)^2 - 4(3)(48) \geq 0$$

$$\Rightarrow \quad \frac{(72)^2}{b^2} \geq 12 \times 48$$

$$\Rightarrow \quad b^2 \leq \frac{72 \times 72}{12 \times 48} = 9$$

$$\Rightarrow \quad b \leq \pm 3$$

and $\quad |b| \leq 3$

For zero stationary pts :

$$B^2 - 4AC < 0$$

$$\Rightarrow \quad |b| > 3$$

End of Solution

71. What are the values of α and β that make $dF(x, y) = \left(\frac{1}{x^2+2} + \frac{\alpha}{y}\right)dx + (xy^{\beta} + 1)dy$ an exact differential equations?

(a) $\alpha = -1, \beta = -2$
(b) $\alpha = 1, \beta = -2$
(c) $\alpha = -1, \beta = 2$
(d) $\alpha = -2, \beta = -1$

Ans. (a)

D.E. is exact differential equation

$$\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$$

$$\frac{-\alpha}{y^2} = y^{\beta}$$

$$\Rightarrow \quad \beta = -2,\ \alpha = -1$$

End of Solution

72. A and B are real non-zero 3×3 matrices and satisfy the equation $(AB)^T + B^{-1} A = 0$. If B is orthogonal, then A is

(a) symmetric
(b) antisymmetric
(c) Hermitian
(d) anti-Hermitian

Ans. (b)

Given $(AB)^T + B^{-1} A = 0$ and $BB^T = I$

Pre-multiply by B on both sides

$$\Rightarrow \quad B(B^T A^T) + B(B^{-1}A) = 0$$

$$\Rightarrow \quad (BB^T)A^T + (BB^{-1})A = 0$$

$$\Rightarrow \quad I\,A^T + IA = 0$$

$$\Rightarrow \quad A^T = -A$$

$\therefore$ A is skew-symetric.

End of Solution

73. Consider a buck converter with the controlled switch as MOSFET and the uncontrolled switch as diode, the input to the buck converter is- 60 V. The MOSFET is turned on for 20 µsec and turned off for 10 µ/sec periodically. Assuming ideal components, the output voltage of the buck converter is

(a) 20 V
(b) 30 V
(c) 40 V
(d) 50

Ans. (c)

$$\alpha = \frac{T_{ON}}{T} = \frac{20\mu s}{30\mu s} = \frac{2}{3}$$

$$V_0 = \alpha V_s = \frac{2}{3} \times 60 = 40 \text{ V}$$

End of Solution

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74. Consider the following statements related to dc - dc converters:

1. The polarity of output voltage and input voltage of a single-ended primary inductance converter is opposite.
2. The polarity of output voltage and input voltage of a Cuk converter is opposite.
3. The polarity of output voltage and input voltage of a buck-boost converter is same.
4. The polarity of output voltage and input voltage of a boosts converter is same.

Which of the above statements are correct?

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

Ans. (d)

End of Solution

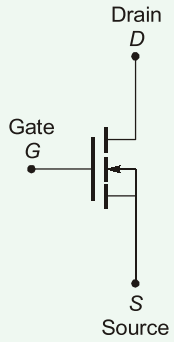
75. In d.c. power supplies, the switching frequency is much greater than

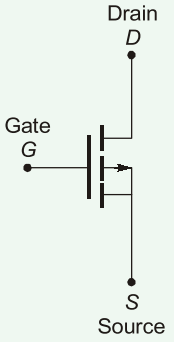
(a) the d.c. power source frequency, enabling the transformer to be small.
(b) the d.c. power source frequency, enabling the transformer to be large.
(c) the a.c. power source frequency, enabling the transformer to be large.
(d) the a.c. power source frequency, enabling the transformer to be small.

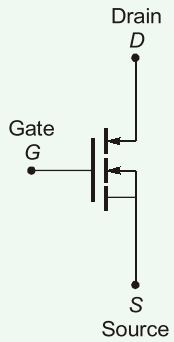
Ans. (d)

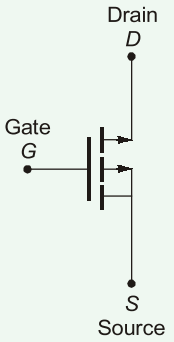
End of Solution

76. Which one of the following is the circuit symbol of *p*-channel IGBT?

(a)


(b)


(c)


(d)


Ans. (d)

End of Solution

77. The regenerative action does not take place in which type of triggering method to turn on the SCR?
(a) Thermal triggering
(b) High forward voltage triggering
(c) Light triggering
(d) Gate triggering

Ans. (b)

End of Solution

78. Which one of the following is also known as resonant commutation?
(a) Class A commutation
(b) Class C commutation
(c) Class D commutation
(d) Class E commutation

Ans. (a)

End of Solution

79. Which one of the following is a current-controlled device?
(a) MOSFET
(b) SIT
(c) MCT
(d) GTO

Ans. (d)

End of Solution

80. In line frequency phase-controlled converters and single-quadrant step-down switch-mode d.c.-d.c. converters, the output current can become
(a) discontinuous at light loads on the motor
(b) zero current
(c) higher than the rated speed of the motor
(d) to match the motor load inertia

Ans. (a)

End of Solution

81. When a separately excited d.c. motor is to be controlled from a three-phase supply fed from controlled rectifier in only first quadrant, which one of the following converters is used to serve the purpose?
(a) Half-wave converter
(b) Full converter
(c) Semiconverter
(d) Dual converter

Ans. (c)

End of Solution

82. In case of a squirrel-cage induction motor using three-phase bridge inverter, which one of the following statements is correct for speed control?
(a) If frequency increases, then starting torque decreases with constant supply voltage.
(b) If frequency increases, then starting torque increases with constant supply voltage.
(c) If frequency decreases, then starting torque decreases with constant supply voltage.
(d) If frequency decreases, then starting torque increases with constant supply voltage.

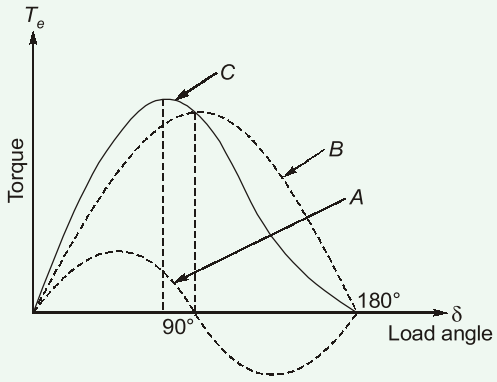
Ans. (a)

$$T_{st} \propto \frac{V^2}{f^3}$$

As f increases, T_{st} decreases on keeping constant supply voltage.
When supply voltage is constant, we cannot decrease the frequency otherwise core of machine will goes in saturation region.

End of Solution

83. The following characteristics are drawn for salient-pole synchronous motor :



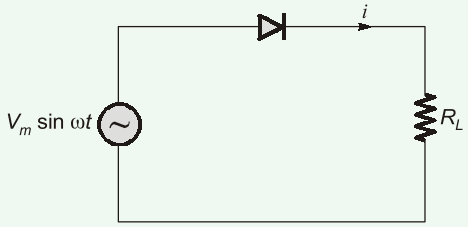
The curve B denotes
(a) output torque
(b) electromagnetic torque
(c) reluctance torque
(d) breakdown torque

Ans. (b)
Curve A denote the reluctance torque.
Curve B denote the electromagnetic torque.
Curve C denote the net output torque.

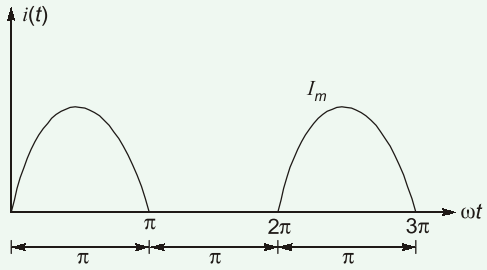
End of Solution

84. While finding various factors of single-phase diode rectifiers, the transformer utilization factor of a half-wave rectifier is
(a) 0.482
(b) 0.572
(c) 0.286
(d) 1.11

Ans. (c)



$\therefore$ $$V_{rms} = \frac{V_m}{\sqrt{2}}$$



$$I_m = \frac{V_m}{R_L}$$

$$I_{dc} = \frac{I_m}{\pi}$$

$$I_{rms} = \frac{I_m}{2}$$

$$\text{TUF} = \frac{P_{dc}}{V_{rms} \cdot I_{rms}} = \frac{I_{dc}^2 \times R_L}{V_{rms} \cdot I_{rms}}$$

$$= \frac{\left(\frac{I_m}{\pi}\right)^2 \cdot R_L}{\frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{2}}$$

$$= \frac{2\sqrt{2}}{\pi^2}$$

$$= 0.286$$

End of Solution

85. The positive sequence impedance component of three unequal impedances Z_a, Z_b and Z_c is

(a) $\frac{1}{3}(Z_a + aZ_b + a^2Z_c)$ (b) $\frac{1}{3}(Z_a + a^2Z_b + aZ_c)$

(c) $\frac{1}{3}(Z_a + Z_b + a^2Z_c)$ (d) $\frac{1}{3}(Z_a + aZ_b + Z_c)$

Ans. **(a)**

$$\begin{bmatrix} Z_0 \\ Z_1 \\ Z_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & a & a^2 \\ 1 & a^2 & a \end{bmatrix}\begin{bmatrix} Z_a \\ Z_b \\ Z_c \end{bmatrix}$$

Positive sequence network,

$$Z_1 = \frac{1}{3}[Z_a + aZ_b + a^2Z_c]$$

End of Solution

86. Which one of the following wiring systems is commonly used for light/fan load in domestic and commercial buildings?

(a) Lead sheathed wiring
(b) Conduit wiring
(c) PVC wiring
(d) Cleat wiring

Ans. (b)

End of Solution

87. Which one of the following is not an advantage in using bundle conductors?

(a) Reduced corona loss
(b) Reduced radio interference
(c) Increased voltage gradient
(d) Reduced surge impedance

Ans. (c)

End of Solution

88. Which one of the following is not a method of voltage control in power systems?

(a) Booster transformer
(b) Tap-changing transformer
(c) Series capacitor
(d) Shunt inductor

Ans. (c)

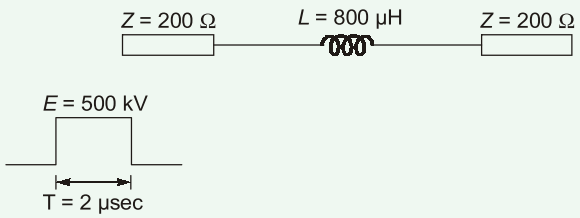
Series capacitor is not the method of voltage control in power system. In fact series capacitor is used to improve the steady state stability of system.

End of Solution

89. An inductance of 800 μH connects two sections of a transmission line each having a surge impedance of 200 Ω. A 500 kV, 2 μsec rectangular surge travels along the line towards the inductance. What is the maximum value of the transmitted wave?

(a) $500 \times \left[\frac{e-1}{e}\right]$ kV
(b) $500 \times \left[\frac{e+1}{e}\right]$ kV
(c) $250 \times \left[\frac{e-1}{e}\right]$ kV
(d) $250 \times \left[\frac{e+1}{e}\right]$ kV

Ans. (a)



Max voltage transmitted

$$= E\left[1 - e^{\frac{-2Z}{L}T}\right]$$

$$= 500\left[1 - e^{\frac{-2\times200}{800}\times2}\right]$$

$$= 500(1 - e^{-1}) = 500\left(\frac{e-1}{e}\right) \text{ kV}$$

End of Solution

90. The faults on power systems are analyzed easily by making use of

(a) superposition theorem (b) substitution theorem

(c) Thevenin's theorem (d) Millman's theorem

Ans. **(c)**

Thevenin's theorem is used for analysis of faults in power system.

End of Solution

91. Which one of the following is not a basic functional characteristic of a protective relay?

(a) Reliability (b) Sensitivity

(c) Speed (d) Linearity

Ans. **(d)**

Linearity is not a basic functional characteristics of a protective relay.

End of Solution

92. In a system of 132 kV, the line-to-ground capacitance is 0.01 μF and the inductance is 4 H. What is the voltage appearing across the pole of a circuit breaker if the instantaneous value of magnetizing current of 5 A is interrupted?

(a) 50 kV (b) $\frac{100}{\sqrt{2}}$ kV

(c) 100 kV (d) $100\sqrt{2}$ kV

Ans. **(c)**

$$V_{CB} = I_a\sqrt{\frac{L}{C}}$$

$$= 5\sqrt{\frac{4}{0.01\times10^{-6}}}$$

$$= 100 \text{ kV}$$

End of Solution

93. Which one of the following tests does not come under the testing types of circuit breaker?

(a) Short-circuit test (b) Open-circuit test
(c) Dielectric test (d) Thermal test

Ans. **(b)**

Open-circuit test is not come under the testing types of circuit breaker.

End of Solution

94. In a power system, the maximum power can be transferred from one end to another end when the reactance of the line is

(a) $\sqrt{3}$ times of the resistance (b) $\sqrt{2}$ times of the resistance
(c) triple the resistance (d) double the resistance

Ans. **(a)**

Maximum power can be transferred from one end to another when

$$X = \sqrt{3}R$$

End of Solution

95. A 50 Hz, four-pole turbogenerator rated at 30 MVA, 13.2 kV has an inertia constant of H = 9.0 kW-sec/kVA. What is the KE stored in the rotor at synchronous speed?

(a) 135 MJ (b) 180 MJ
(c) 270 MJ (d) 360 MJ

Ans. **(c)**

$$\text{K.E.} = H \times S$$
$$= 9 \times 30$$
$$= 270 \text{ MJ}$$

End of Solution

96. Which one of the following is not an example of renewable energy?

(a) Solar (b) Wind
(c) Geothermal (d) Nuclear

Ans. **(d)**

Nuclear power plant is not an example of renewable energy.

End of Solution

97. There are additional losses that arise from the non-uniform current distribution in the conductors and the core losses generated in the iron due to the distortion of the magnetic flux distribution from the load currents. Such losses are known as

(a) steel losses (b) frictional losses
(c) stray load losses (d) windage losses

Ans. **(c)**

Stray losses are those losses which occurs on loading of machine.

End of Solution

98. If the magnetic core has a constant permeability by making air as media for a coil current and the resultant flux linkage, then
(a) the energy and coenergy are equal
(b) the energy is greater than the coenergy
(c) the energy is less than the coenergy
(d) the coenergy is not developed

Ans. (a)
For $\mu_r = 1$, $B \propto H$ so for linear characteristics of B-H curve, field energy and coenergy are equal.

End of Solution

99. The structure of d.c. commutator machine is generally designed with
(a) non-salient stator and salient rotor (b) salient stator and non-salient rotor
(c) salient stator and salient rotor (d) non-salient stator and non-salient rotor

Ans. (b)

End of Solution

100. The steady-state external performance characteristic of a d.c. generator has the relationship between
(a) generated e.m.f. and field current at constant speed
(b) terminal voltage and field current, with constant armature current and speed
(c) generated e.m.f. and field current, with constant armature current and speed
(d) terminal voltage and load current at constant speed

Ans. (d)
External characteristics of dc generator has relationship between terminal voltage and load current at constant speed.

End of Solution

101. A 250 V, 50 kW, short-shunt compound d.c. generator has the following data : armature resistance = 0.05 Ω, series field resistance = 0.05 Ω, shunt field resistance = 130 Ω and 2 V is the total brush contact drop. What is the value of the total current supplied by the generator?
(a) 0.2 A (b) 2 A
(c) 0.2 kA (d) 2 kA

Ans. (c)

$$I_L = \frac{50 \times 10^3}{250} = 0.2 \text{ kA}$$

End of Solution

102. In generating mode, an induction machine operates as a generator with a shaft speed which is greater than the synchronous speed, if the slip is

(a) zero (b) unity

(c) greater than unity (d) less than zero

Ans. (d)

End of Solution

103. A three-phase, 60 Hz, 25 HP, wye-connected induction motor operates at a shaft speed of almost 1800 r.p.m. at no load and 1650 r.p.m. at full load. The number of poles of the motor is

(a) 2 (b) 3.33

(c) 4 (d) 6.66

Ans. (c)

$$P = \frac{120 \times f}{N_s} = \frac{120 \times 60}{1800} = 4$$

End of Solution

104. A three-phase, 13.2 kV, 60 Hz, 50 MVA, wye-connected cylindrical rotor synchronous generator has an armature reactance of 2.19 Ω per phase. The leakage reactance is 0.137 times the armature reactance. The armature resistance is small enough to be negligible. Also ignore the saturation. Assume that the generator delivers full-load current at the rated voltage and 0.8 lagging power factor. The synchronous reactance per phase is

(a) 0.32 Ω (b) 2.32 Ω

(c) 2.73 Ω (d) 2.49 Ω

Ans. (d)

$$X_s = X_{ar} + X_L$$
$$= 2.19 + (0.137 \times 2.19) = 2.49\ \Omega$$

End of Solution

105. For the commutated d.c. machine stator, it has riverted poles and the ends of the poles are called

(a) pole shoe (b) pole face

(c) pole arc (d) pole gap

Ans. (b)

End of Solution

106. In a lap winding, there are always as many paths in parallel through the armature winding as there are a number of poles. In such a lap winding, the current in each armature coil is

(a) one and one-half of the armature terminal current.
(b) half of the armature terminal current.
(c) equal to the armature terminal current divided by the number of poles.
(d) equal to the number of poles divided by the armature terminal current.

Ans. **(c)**

For lap winding, current in each armature coil

$$I_{coil} = \frac{I_a}{A} = \frac{I_a}{P} \qquad (A = P)$$

So, current in each armature coil is equal to the armature terminal current divided by the number of poles.

End of Solution

107. A four-pole d.c. machine armature has 54 slots. It is lap-wound with single-turn coils. How many armature coils are required?

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

Ans. **(b)**

Given : Lap-wound with signle turn coil.

Number of coils = Number of slots (in double layer winding) = 54

So, Number of coils = 54

End of Solution

108. A shunt d.c. motor is rated for 230 V, 1350 r.p.m., 10 HP, the line current I_L = 37.5 A and the field current I_f = 0.75 A. It is known that the armature resistance R_a = 0.35 Ω and the power dissipated across field winding P_{fw} = 519 W at rated speed. The shunt d.c. motor is to be equipped with the manually operated variable resistor starter. What is the maximum allowable armature current in starting resistance R_{st} to assure that the initial armature current does not exceed 150 percent of the rated value?

(a) 18.125 A (b) 27.125 A
(c) 36.125 A (d) 55.125 A

Ans. **(d)**

The armature current, $I_a = I_L - I_F$

$I_a = 37.5 - 0.75 = 36.75$ A

So, maximum allowable current = 150% of I_a rated

$I_L = 1.50 I_a$

$I_L = 1.50 \times 36.75$

$I_L = 55.125$ Amp

End of Solution

109. Which one of the following statements is correct regarding lead or lag compensation?
(a) The lag compensator improves the steady-state performance of the system.
(b) The lead compensation becomes effective when the phase angle of uncompensated system decreases rapidly near the gain crossover frequency.
(c) Choose the lead compensator when reduced noise level is required.
(d) The combination of decreased open-loop gain and lead compensator improves steady-state error and phase margin.

Ans. (a)
The lag compensator improves the steady state performance of the system.

End of Solution

110. Consider the following statements for phase margin :
1. Phase margin is defined as the amount of additional phase lag at the gain crossover frequency required to bring the system to the verge of instability.
2. The phase margin is always positive for stable feedback systems.
3. The phase margin is always negative for stable feedback systems.

Which of the above statements is/are correct?
(a) 1 and 2 (b) 1 and 3
(c) 1 only (d) 3 only

Ans. (a)
The phase margin is always positive for stable feedback systems.
So, statement (3) is wrong.

End of Solution

111. Consider the following statements for minimum and non-minimum phase systems :
1. Non-minimum phase systems have poles and/or zeros in the right half of the *s*-plane (RHP) of their transfer functions.
2. Minimum phase systems have no poles or zeros in the right half of the *s*-plane (RHP) of their transfer functions.
3. The modulus of the phase response for a non-minimum phase system is always larger than that for a system with minium phase behaviour, though both may have the same amplitude response.

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)
All three statements are true.

End of Solution

112. Consider a system described by

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}1 & 1\\ -2 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}0\\ 1\end{bmatrix}u$$

$$y = \begin{bmatrix}1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

Which one of the following is correct?

(a) The system is controllable only

(b) The system is observable only

(c) The system is controllable and observable

(d) The system is neither controllable nor observable

Ans. **(c)**

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

$$B = \begin{bmatrix}0\\ 1\end{bmatrix}$$

$$C = \begin{bmatrix}1 & 0\end{bmatrix}$$

$$Q_C = [B : AB]$$

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

$$Q_C = \begin{bmatrix}0 & 1\\ 1 & -1\end{bmatrix} \Rightarrow |Q_C| \neq 0$$

$$Q_0 = \begin{bmatrix}C\\ CA\end{bmatrix} = \begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}$$

$$|Q_0| \neq 0$$

So, system is controllable and observable.

End of Solution

113. What is the state-transition matrix $\Phi(t)$ of the following system?

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

(a) $\Phi(t) = \begin{bmatrix}e^{-t}-e^{-2t} & e^{-t}-e^{-2t}\\ -2e^{-t}+2e^{-2t} & -e^{-t}+2e^{-2t}\end{bmatrix}$ (b) $\Phi(t) = \begin{bmatrix}2e^{-t}-e^{-2t} & e^{-t}-e^{-2t}\\ -2e^{-t}+2e^{-2t} & -e^{-t}+2e^{-2t}\end{bmatrix}$

(c) $\Phi(t) = \begin{bmatrix}2e^{-t}-e^{-2t} & e^{-t}-e^{-2t}\\ -e^{-t}+e^{-2t} & -e^{-t}+e^{-2t}\end{bmatrix}$ (d) $\Phi(t) = \begin{bmatrix}2e^{-t}-2e^{-2t} & 2e^{-t}-e^{-2t}\\ -2e^{-t}+2e^{-2t} & -2e^{-t}+2e^{-2t}\end{bmatrix}$

Ans. **(b)**

We know the property of state-transition matrix

$$\phi(0) = I = \begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$$

From option (a), $\phi(0) = \begin{bmatrix}0 & 0\\ 0 & 1\end{bmatrix}$

Option (b), $\phi(0) = \begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$

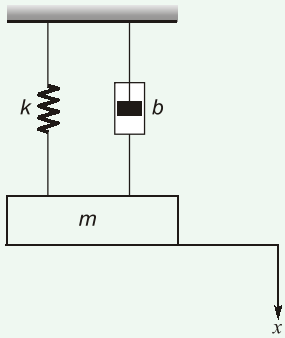
Option (c), $\phi(0) = \begin{bmatrix}1 & 0\\ 0 & 0\end{bmatrix}$

Option (d), $\phi(0) = \begin{bmatrix}0 & 1\\ 0 & 0\end{bmatrix}$

So, answer is option (b).

End of Solution

114. In the system shown in the figure, the numerical values of m, b and k are given as $m = 1$ kg, $b = 2$ N-sec/m and $k = 100$ N/m. The mass is displaced 0.05 m and released without initial velocity. What is the frequency observed in the vibration, if the displacement x is measured from the equilibrium position?



(a) 6.23 rad/sec (b) 7.76 rad/sec
(c) 9.95 rad/sec (d) 8.78 rad/sec

Ans. (c)

The natural frequency, $\omega_n = \sqrt{\frac{k}{m}} = \sqrt{\frac{100}{1}} = 10$

The damping coefficient, $\xi = \frac{B}{2\sqrt{km}}$

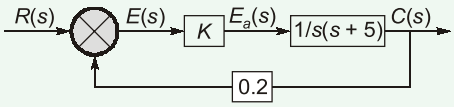
$$\xi = \frac{2}{2\sqrt{100 \times 1}} = 0.1$$

So, $\omega_d = \omega_n\sqrt{1-\xi^2} = 10\sqrt{1-0.1^2}$

$= 9.95$ rad/sec

End of Solution

115. A feedback control system is shown in the figure. What is the value of K for unit ramp input so that the system will have damping ratio of 0.5?



(a) 50 (b) 150
(c) 125 (d) 25

Ans. (c)

The closed loop transfer function

$$\frac{C(s)}{R(s)} = \frac{k}{s(s+5)+0.2k} = \frac{k}{s^2+5s+0.2k}$$

Here, $\omega_n = \sqrt{0.2k}$

$2 \times \xi\omega_n = 5$

$2 \times 0.5 \times \sqrt{0.2k} = 5$

$$k = \frac{25}{0.2} = 125$$

End of Solution

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LIVE-ONLINE & **OFFLINE** COURSES

NST-1

22nd Feb, 2022

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116. Consider the following network :

$$G(s) = \frac{s + \frac{1}{T_1}}{s + \frac{1}{T_2}}$$

Which of the following conditions is/are correct?
1. If $T_1 > T_2$, then the network is a lead network.
2. If $T_1 < T_2$, then the network is a lag network.
3. If $T_1 > T_2$, then the network is a lag network.
4. If $T_1 < T_2$, then the network is a lead network.

Select the correct answer using the code given below :

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

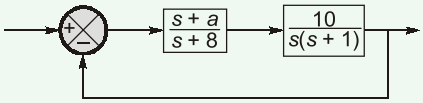
Ans. **(c)**

$$G(s) = \frac{(sT_1 + 1)}{(sT_2 + 1)}$$

The angle, $\phi = \tan^{-1}(\omega T_1) - \tan^{-1}(\omega T_2)$
For lead network, $\phi > 0$
So, $T_1 - T_2 > 0$
$T_1 > T_2$
Similarly for lag network, $T_1 < T_2$
So, option (c) is correct.

End of Solution

117. Consider the system shown in the figure. What is the value of *a* such that the damping ratio of the dominant closed poles is 0.5?



(a) 0.6 (b) 1.4
(c) 1.2 (d) 2.8

Ans. **(d)**

The characteristics equation can be given

$$q = (s + 8)s(s + 1) + (s + a)10$$
$$q(s) = s^3 + 9s^2 + 8s + 10s + 10a$$
$$q(s) = s^3 + 9s^2 + 18s + 10a \quad \ldots(1)$$

Given : $\xi = 0.5$

$$q(s) = (s + \alpha)(s^2 + 2\xi\omega_n s + \omega_n^2)$$
$$q(s) = (s + \alpha)(s^2 + 2 \times 0.5\omega_n s + \omega_n^2)$$

$$q(s) = (s + \alpha)(s^2 + \omega_n s + \omega_n^2)$$
$$q(s) = s^3 + \omega_n s^2 + \omega_n^2 s + \alpha_s^2 + \omega_n \alpha s + \alpha\omega_n^2$$
$$q(s) = s^3 + (\omega_n + \alpha)s^2 + (\omega_n^2 + \omega_n\alpha)s + \alpha\omega_n^2$$

Comparing $\omega_n + \alpha = 9$ $\quad \omega_n^2 + \omega_n\alpha = 18$

$$\alpha = 9 - \omega_n$$

So, $\omega_n^2 + \omega_n(9 - \omega_n) = 18$

$$\omega_n^2 + 9\omega_n - \omega_n^2 = 18$$

$$\omega_n = \frac{18}{9} = 2$$

So, $10a = \alpha\omega_n^2$

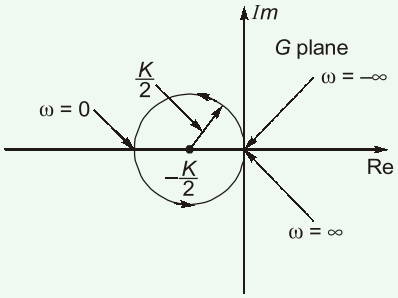
$$10 \times a = (9 - \omega_n)\omega_n^2$$
$$10 \times a = (9 - 2)(2)^2 = 28$$

$$a = \frac{28}{10} = 2.8$$

So, option (d) is correct.

End of Solution

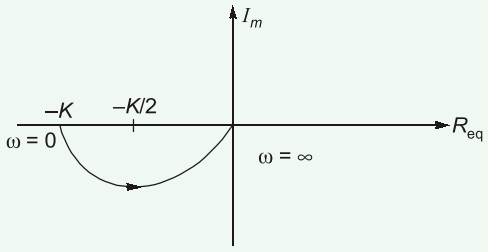
118. Consider the closed-loop system shown in the figure. What is the ciritical value of K for stability by the use of the Nyquist stability criterion?



(a) 0.1 (b) 0.2
(c) 1 (d) 0.5

Ans. **(c)**

For stable system,

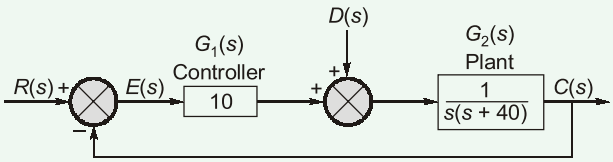


$$-K < -1$$
$$K > 1$$

So, limiting value of $K = 1$.

End of Solution

119. In the feedback control system shown in the figure, $D(s)$ is step disturbance, $R(s)$ is input and $C(s)$ is output :



The steady state error component due to a step disturbance for the system is

(a) –0.10 (b) –0.25

(c) 10 (d) 25

Ans. **(a)**

For $R(s) = 0$

$$\frac{E(s)}{D(s)} = \frac{-G_2(s)}{1+G_1(s)G_2(s)} = \frac{-\dfrac{1}{s(s+40)}}{1+\dfrac{10}{s(s+40)}}$$

$$\frac{E(s)}{D(s)} = \frac{-1}{s(s+40)+10}$$

$$E(s) = \frac{-1}{s(s+40)+10}D(s)$$

For $D(s) = \dfrac{1}{s}$

The steady state error,

$$e = \lim_{s\to 0} sE(s) = \lim_{s\to 0} \frac{-1}{s(s+40)+10}\cdot\frac{1}{s}(s)$$

$$e_{ss} = \frac{-1}{0+10} = -0.10$$

$$e_{ss} = -0.10$$

End of Solution

120. Consider the following statements related to steady-state error for a control system :

1. Steady-state error can be calculated from a system's closed-loop transfer function for a unity feedback system.
2. Steady-state error can be calculated from a system's open-loop transfer function for a unity feedback system.
3. Steady-state error is the difference between the input and the output for a prescribed test input as time tends to infinity.
4. Many steady-state errors in control systems can arise from non-linear sources.

Which of the above statements are correct?

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

Ans. (d)

All statements are correct.

End of Solution

121. What is the z-transform of discrete-time unit step signal $u(n)$?

(a) $\frac{z}{z+1}, |z|>1$
(b) $\frac{1}{z+1}, |z|>1$
(c) $\frac{z}{z-1}, |z|>1$
(d) $\frac{1}{z-1}, |z|>1$

Ans. (c)

$$u(n) \rightleftharpoons \frac{z}{z-1}, |z|>1$$

End of Solution

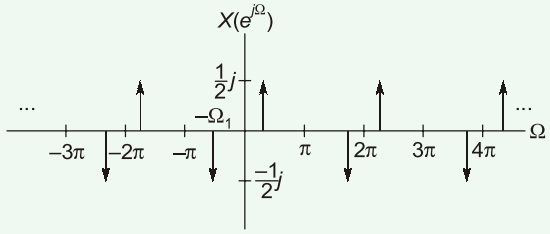
122. Consider the following statements for quarter-wave symmetry :
A periodic function possesses a quarter-wave symmetry, if
1. it has either odd or even symmetry
2. it has half-wave symmetry
Which of the above statements is/are correct?

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

Ans. (a)

End of Solution

123. What is the inverse discrete-time Fourier transform of the frequency domain representation shown in the figure?



(a) $x[n] = \frac{\pi}{2}\sin(\Omega_1 n)$
(b) $x[n] = \frac{3}{2\pi}\sin(\Omega_1 n)$
(c) $x[n] = \frac{1}{\pi}\sin(\Omega_1 n)$
(d) $x[n] = \frac{1}{2\pi}\sin(\Omega_1 n)$

Ans. (d)

$$X(e^{j\Omega}) = \frac{-j}{2}\delta(\Omega+\Omega_1)+\frac{j}{2}\delta(\Omega-\Omega_1) \quad ...(1)$$

As we know, $\frac{1}{2\pi} \rightleftharpoons \delta(\Omega)$

$$\frac{1}{2\pi}e^{-j\Omega_1 n} \rightleftharpoons \delta(\Omega+\Omega_1)$$

$$\frac{1}{2\pi}e^{j\Omega_1 n} \rightleftharpoons \delta(\Omega-\Omega_1)$$

By applying inverse DTFT on (1),

$$x(n) = \frac{-j}{2}\cdot\frac{1}{2\pi}\cdot e^{-j\Omega_1 n}+\frac{j}{2}\cdot\frac{1}{2\pi}\cdot e^{j\Omega_1 n}$$

$$= \frac{1}{2\pi}\left[\frac{-j}{2}e^{-j\Omega_1 n}+\frac{j}{2}e^{j\Omega_1 n}\right]\times\frac{j}{j}$$

$$= \frac{1}{2\pi}\left[\frac{1}{2j}e^{-j\Omega_1 n}-\frac{1}{2j}e^{j\Omega_1 n}\right]$$

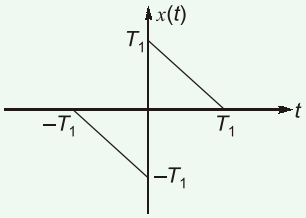
$$= -\frac{1}{2\pi}\left[\frac{e^{j\Omega_1 n}-e^{-j\Omega_1 n}}{2j}\right]$$

$$= -\frac{1}{2\pi}\sin(\Omega_1 n)$$

Closest answer is option (d).

End of Solution

124. What is the solution for aperiodic signal $x(t)$ as shown in the figure?



(a) $j\left(\frac{3\sin(\omega T_1)}{\omega^2}-\frac{2T_1}{\omega}\right)$

(b) $j\left(\frac{3\sin(\omega T_1)}{\omega}-\frac{3T_1}{\omega^2}\right)$

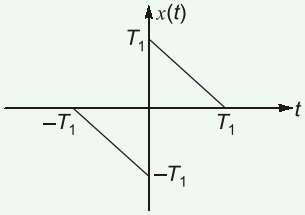
(c) $j\left(\frac{2\sin(\omega T_1)}{\omega^2}-\frac{2T_1}{\omega}\right)$

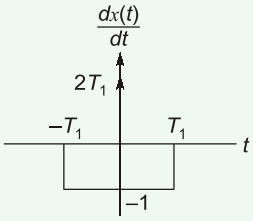
(d) $j\left(\frac{2\sin(\omega T_1)}{\omega}-\frac{3T_1}{\omega^2}\right)$

Ans. (c)

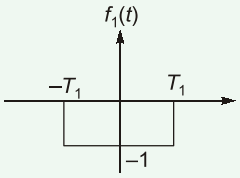
We can write,

$$\frac{dx(t)}{dt} = f_1(t) + 2T_1\delta(t) \qquad ...(1)$$





where,



$$\rightleftharpoons F_1(\omega) = -2T_1\sin(\omega T_1)$$

$$= -2T_1\frac{\sin(\omega T_1)}{\omega T_1}$$

$$= -\frac{2}{\omega}\sin(\omega T_1)$$

By applying FT on (1),

$$j\omega X(\omega) = F_1(\omega) + 2T_1$$

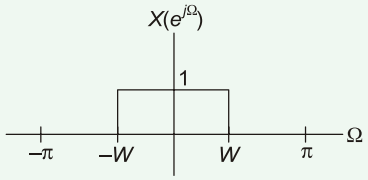
$$\Rightarrow \quad X(\omega) = \frac{-\frac{2}{\omega}\sin(\omega T_1) + 2T_1}{j\omega}$$

$$= \frac{-j}{\omega}\left[\frac{-2}{\omega}\sin(\omega T_1) + 2T_1\right]$$

$$= j\left[\frac{2\sin(\omega T_1)}{\omega^2} - \frac{2T_1}{\omega}\right]$$

End of Solution

125. For discrete-time sinc function, what is the inverse discrete-time Fourier transform of the function as shown in the figure?



(a) $x[n]=\frac{W}{\pi}\text{sinc}\left(\frac{Wn}{2\pi}\right)$ (b) $x[n]=\frac{W}{2\pi}\text{sinc}\left(\frac{Wn}{\pi}\right)$

(c) $x[n]=\frac{W}{\pi}\text{sinc}\left(\frac{Wn}{\pi}\right)$ (d) $x[n]=\frac{2W}{\pi}\text{sinc}\left(\frac{Wn}{2\pi}\right)$

Ans. (c)

End of Solution

126. What is the Fourier transform $G(\omega)$ of the signal of $g(t)=\frac{1}{1+jt}$?

(a) $2\pi e^{\omega}u(-\omega)$ (b) $\pi e^{\omega}u(-\omega)$

(c) $0.5\pi e^{\omega}u(-\omega)$ (d) $3\pi e^{\omega}u(-\omega)$

Ans. (a)

$$e^{-t}u(t)\rightleftharpoons\frac{1}{1+j\omega}$$

Duality property

$$\frac{1}{1+jt}\rightleftharpoons 2\pi e^{\omega}u(-\omega)$$

End of Solution

127. What is the convolution of the following two signals?

$$x(t)=\begin{cases}1, & -1<t<1\\ 0, & \text{elsewhere}\end{cases} \text{ and } h(t)=\delta(t+1)+2\delta(t+2)$$

(a) $y(t)=x(t+1)+2x(t-2)$ (b) $y(t)=x(t-1)+2x(t+2)$

(c) $y(t)=x(t+1)+2x(t+2)$ (d) $y(t)=x(t-1)+2x(t-2)$

Ans. (c)

$$\begin{aligned}y(t)&=x(t)*h(t)\\&=x(t)*[\delta(t+1)+2\delta(t+2)]\\&=x(t+1)+2x(t+2)\end{aligned}$$

End of Solution

128. What is the bilateral z-transform of the signal $x(n)=a^{n+1}u(n+1)$?

(a) $\frac{z}{1-az^{-1}},|z|>|a|$ (b) $\frac{z}{1+az^{-1}},|z|>|a|$

(c) $\frac{1}{1-az^{-1}},|z|>|a|$ (d) $\frac{1}{1+az^{-1}},|z|>|a|$

Ans. (a)

$$x(n) = a^{n+1}u(n+1)$$

We know $$a^n u(n) \rightleftharpoons \frac{1}{1-az^{-1}}; |z|>|a|$$

$$a^{n+1}u(n+1) \rightleftharpoons \frac{z}{1-az^{-1}}; |z|>|a|$$

End of Solution

129. Which one of the following statements is NOT correct for convolution?
(a) The convolution of an odd and an even function is an odd function.
(b) The convolution of two odd functions is an even function.
(c) The convolution of two even functions is an even function.
(d) The convolution of two odd functions is an odd function.

Ans. (d)

End of Solution

130. The sampling frequency of the signal $g(t) = \text{sinc}^2(200t)$ is
(a) 100 Hz (b) 200 Hz
(c) 400 Hz (d) 800 Hz

Ans. (c)

$$g(t) = \text{sinc}^2(200t) = Sa^2(200\pi t)$$
$$\omega_m = 2 \times 200\pi = 400\pi \text{ rad/sec}$$
$$f_m = \frac{\omega_m}{2\pi} = 200 \text{ Hz}$$
Sampling frequency, $$f_s = 2f_m = 400 \text{ Hz}$$

End of Solution

131. What is the final value of the function $f(t) = e^{-2t} \sin 5tu(t)$?
(a) 0 (b) 1
(c) 5 (d) ∞

Ans. (a)

$$f(t) = e^{-2t} \sin 5t.u(t)$$
$$f(\infty) = \text{final value} = 0$$

End of Solution

132. If a discrete signal represented by $x(n) = \alpha^n u(n)$, then what is the value of the signal $g(n) = x(n) - \alpha x(n-1)$?
(a) $g(n) = \delta(n)$ (b) $g(n) = \delta(n-1)$
(c) $g(n) = \alpha\delta(n-1)$ (d) $g(n) = \delta(n-\alpha)$

Ans. (a)

Given : $x(n) = a^n u(n) \rightleftharpoons X(z) = \dfrac{1}{1-az^{-1}}$

and $g(n) = x(n) - ax(n-1)$

$G(z) = X(z) - az^{-1}X(z)$

$= (1 - az^{-1}) \times (z)$

$= (1-az^{-1})\left(\dfrac{1}{1-az^{-1}}\right)$

$= 1$

By taking inverse ZT,

$g(n) = \delta(n)$

End of Solution

133. For an amplitude modulated double sideband full carrier wave, a peak unmodulated carrier voltage $V_c = 10V_p$, a load resistance $R_L = 10\ \Omega$ and a modulation coefficient $m = 1$. What is the total power of the modulated wave?

(a) 7.5 W (b) 2.5 W

(c) 1.25 W (d) 5.0 W

Ans. (a)

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

$$= \frac{(10V_P)^2}{2\times 10}\left[1+\frac{1}{2}\right]$$

Let $V_P = 1$ V

$$P_t = \frac{100}{2\times 10}\left[1+\frac{1}{2}\right]$$

$$= 5\left[1+\frac{1}{2}\right] = 7.5 \text{ W}$$

End of Solution

134. For a Citizens band receiver using high-side injection with an RF carrier of 27 MHz and an IF centre frequency of 455 kHz, what is the image frequency?

(a) 24.55 MHz (b) 27.91 MHz

(c) 28.45 MHz (d) 29.65 MHz

Ans. (b)

$f_s = 27$ MHz

$IF = 455$ MHz

$f_{si} = f_s + 2I_F = 27 \text{ MHz} + 0.91 \text{ MHz}$

$= 27.91$ MHz

End of Solution

135. Which of the following statements are correct to improve the nosie figure of a receiver?
1. The devices used for the amplifiers and mixer stages must produce low noise.
2. The receiver can be operated at low temperatures.
3. High-gain amplifiers are used to improve the noise figure.
4. The diodes and FETs are preferred to improve the noise figure.

Select the correct answer using the code given below :
(a) 1 and 2 only
(b) 3 and 4 only
(c) 1, 3 and 4 only
(d) 1, 2, 3 and 4

Ans. (d)

End of Solution

136. Any device or circuit whose output is not a linear variation with the input can be used as
(a) an RF amplifier
(b) a mixer
(c) an IF amplifier
(d) a local oscillator

Ans. (b)

End of Solution

137. In the receiver parameter, fidelity is a measure of
(a) the ability of the receiver to accept a given band of frequencies and reject all other frequencies.
(b) the minimum radio frequency signal level that can be detected at the input to the receiver and still produces a usable demodulated signal.
(c) the ability of a communication system to produce, at the output of the receiver, an exact replica of the original source information.
(d) the difference in decibles between the minimum input level necessary to discern a signal and the inoput level that will overdrive the receive and produce distorition.

Ans. (c)

Fidelity is the ability of a communication system to produce, at the output of the receiver, an exact replica of the original source information.

End of Solution

138. Which one of the following statements is correct regarding tuned radio frequency receiver?
(a) The bandwidth is inconsistent and varies with centre frequency when tuned over a wide range of input frequencies.
(b) It is stable due to the large number of RF amplifiers all tuned to the same centre frequency.
(c) The gain is uniform over a very wide frequency range.
(d) It has a very low sensitivity.

Ans. (a)

End of Solution

139. Which one of the following is a figure of merit used to indicate how much the signal-to-noise ratio deteriorates as a signal passes through a circuit or series of circuits?

(a) Impulse noise
(b) Noise figure
(c) Correlated noise
(d) Noise temperature

Ans. (b)

End of Solution

140. Consider the following statements related to the source coding :

1. A conversion of the output of a discrete memoryless source (DMS) into a sequence of binary symbols is called source coding.
2. The source code efficiency (η) is defined as $\eta = \frac{L_{min}}{L}$, where L_{min} is the minimum possible value of L, and L is the average codeword length.
3. The code redundance (γ) is defined as $\gamma = 1 + \eta$.

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. (a)

The statement (3) is wrong because the code redundancy

$$\gamma = 1 - \eta$$

End of Solution

141. Consider the following statements regarding differential pulse-code modulator :

1. The differential pulse-code modulator system employs a predictor.
2. It needs far fewer bits per each error sample than what would have been needed for the original samples themselves.
3. It will have larger dynamic range than the original message itself.

Select the correct statements using the code given below:

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

Ans. (c)

The differential pulse-code modulator will have smaller dynamic range than the original message itself.

So, statement (3) is wrong.

End of Solution

142. How many minimum number of samples are required to exactly describe the following signal?

$$x(t) = 10\cos(6\pi t) + 4\sin(8\pi t)$$

(a) 4 samples per second
(b) 6 samples per second
(c) 8 samples per second
(d) 2 samples per second

Ans. (c)

$$f_{s,min} = 2f_{max}$$
$$f_{s,min} = 2 \times 4 \text{ Hz}$$
$$= 8 \text{ samples/sec}$$

End of Solution

143. Which one of the following is not a property of a Gaussian random process?

(a) A Gaussian process is completely described by its mean and auto-correlation.

(b) If a Gaussian process is wide-sense stationary, then it is stationary in the strict sense too.

(c) If a Gaussian process is given as input to an LTI system, the output process is also Gaussian.

(d) If two processes which are jointly Gaussian are uncorrelated, then they are statistically dependent.

Ans. (d)

End of Solution

144. A PCM system uses a uniform quantizer followed by a 7-bit binary encoder. The bit rate of the system is equal to 50×10^6 bits/sec. What is the maximum message signal bandwidth for which the system operates satisfactorily?

(a) 3.57 MHz (b) 4.55 MHz

(c) 7.55 MHz (d) 8.57 MHz

Ans. (a)

$$R_b = nf_s$$
$$50 \times 10^6 = f \times f_s$$
$$f_s = \frac{50 \times 10^6}{7}$$
$$f_s \geq 2f_m$$
$$2f_m \leq \frac{50 \times 10^6}{7}$$
$$f_m \leq \frac{50 \times 10^6}{7 \times 2}$$
$$f_m \leq 3.57 \text{ MHz}$$
$$(f_m)_{max} = 3.57 \text{ MHz}$$

End of Solution

Directions : Each of the next six (6) items consists of two statements, one labelled as the 'Statement (I) and the other labelled 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) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are individually true, but Statement (II) is not the correct explantion 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) :** Aluminium oxidizes quickly in normal atmospheric conditions and acquires a thin film of oxide Al_2O_3.

Statement (II) : The high melting point of aluminium oxide coating and the rapidity with which a freely exposed aluminium surface becomes oxidized, make soldering difficult through conventional means.

Ans. (b)

End of Solution

146. **Statement (I) :** When the signal is of the form of current, then series input devices are used.

Statement (II) : An ammeter, which is a series device, thus should be designed with a low input impedance so that the current is correctly measured.

Ans. (b)

End of Solution

147. **Statement (I) :** If the gain margin is negative, this gives the decibel rise in open-loop gain, which is theoretically permissible without oscillation.
Statement (II) : For a multistage amplifier, if the open-loop gain $|\beta A|$ is unity when the phase shift is 180°, then the closed-loop amplifier will oscillate.

Ans. (c)

Gain margin = –[Open loop gain] dB

Statement I : $A\beta \geq 1$ or 0 dB (True)

Gain margin < 1 or 0 dB

Statement II : Multistage amp. if $A\beta = 1$ and phase shift is 180° closed loop amp. will oscillate. (False)

End of Solution

148. **Statement (I) :** When negative feedback is applied to the ideal amplifier, the differential input voltage is zero.

Statement (II) : There is no current flow into either input terminal of the ideal op-amp.

Ans. (b)

Statement I : When negative feedback is applied to ideal amp, the differential i/p voltage is zero (virtual short) (true).

Statement II : There is no current flow into either input terminal or ideal op amp : $Z_i = \infty$ (True)

End of Solution

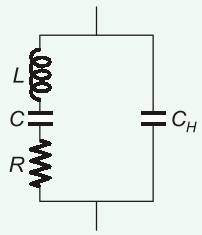
149. **Statement (I) :** When the carrier is generated by a crystal oscillator, the frequency is fixed by the crystal.

Statement (II) : The equivalent circuit of a crystal is an L-C-R circuit with both series and parallel resonant points.

Ans. (b)

Statement I : When carrier is generated by crystal oscillator, the frequency is fixed by crystal : frequency depends on crystal. (True)

Statement II : The equivalent circuit of crystal is an LCR circuit with both series and parallel resonant points. (True).



End of Solution

150. **Statement (I) :** In FDM transmitter, if the signals which are to be multiplexed will each modulate a separate carrier, then the type of modulation can be AM, SSB, FM or PM.

Statement (II) : In FDM transmitter, the modulator outputs will contain the sidebands of the corresponding signals.

Ans. (a)

End of Solution

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