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TSPSC - 2022

Assistant Executive Engineer Examination (AEE)

Questions With Detailed Solutions

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SUBJECTWISE WEIGHTAGE

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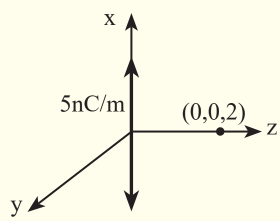
01. Consider an infinite uniform line charge of 5 nC/m along the x axis in free space. Calculate the electric field at a distance of 2m from the line charge along the z axis.

(a) $45\,\hat{z}$ V/m (b) $90\,\hat{z}$ V/m
(c) $22.5\,\hat{z}$ V/m (b) $11.25\,\hat{z}$ V/m

01. Ans: (a)

Sol:



$$\bar{E} = \frac{\rho_\ell}{2\pi\varepsilon_o}\frac{\hat{\rho}}{\rho} = \frac{\rho_\ell}{2\pi\varepsilon_o}\left[\frac{\bar{\rho}}{\rho^2}\right]$$

$$= \frac{5\times10^{-9}}{2\pi\times\dfrac{1}{36\pi\times10^9}}\left[\frac{2\hat{z}}{(2)^2}\right]$$

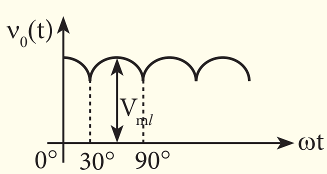
$$= \frac{5\times18}{2}\hat{z} = 45\hat{z}\ \text{V/m}$$

02. A three-phase diode bridge rectifier supplied from a three-phase, 400V, 50Hz ac supply delivers power to a resistive load of 50Ω. The peak value of the instantaneous load voltage would be

(a) $400\sqrt{(2/3)}$ (b) $400/\sqrt{3}$
(c) $400\sqrt{2}$ V (d) 400V

02. Ans: (c)

Sol:



$v_0(t)$ = Instantaneous output voltage of 3-ϕ FW uncontrolled rectifier.

$v_0(t) = v_{A0} - v_{B0}$ = line voltage

Peak or maximum value of $v_0(t) = V_{ml}$

$= \sqrt{2}\times V_{\ell\,rms}$

$= \sqrt{2}\times 400$ V

$= 400\sqrt{2}$ V

03. In a single-phase transformer supplied from a constant input voltage, the magnitude of the load current is kept constant while the power factor is varied. Under this condition

(a) the maximum efficiency occurs at unity power factor
(b) the power factor where maximum efficiency occurs depends on the leakage inductance values
(c) the maximum efficiency occurs at power factor of 0.5(lead)
(d) the maximum efficiency occurs at power factor of 0.5 (lag)

03. Ans: (a)

Sol: Efficiency is maximum at UPF.

04. A synchronous generator rated 11kV, 50MVA has a per unit impedance of 0.2pu on its own base. Then its impedance referred to a 22kV, 150MVA base would be

(a) 0.15pu (b) 0.133pu
(c) 0.2pu (d) 0.1pu

04. Ans: (a)

Sol: $X_{pu(new)} = X_{pu(old)}\dfrac{S_{B(new)}}{S_{B(old)}}\cdot\left(\dfrac{V_{B(old)}}{V_{B(new)}}\right)^2$

$X_{pu(new)} = 0.2\times\left(\dfrac{150}{50}\right)\left(\dfrac{11}{22}\right)^2 = 0.15$ pu

05. Consider the following statements about a linear system that has a transfer function given as $G(s) = \frac{1-s}{1+s}$:

A. G(s) is a minimum-phase system

B. The system is BIBO stable

C. It is an all pass system

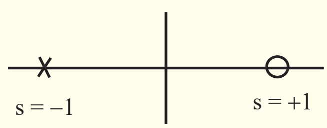
Which of the above statements is/are true?

(a) A, B and C (b) B only

(c) A and B only (d) B and C only

05. Ans: (d)

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



Pole is in the left half of s-plane hence stable

Pole and zero symmetrical w.r.t origin hence it is an all pass system.

06. The dynamics of a system is defined by the relation $\ddot{x} + 6\dot{x} + 5x = 10(1 - e^{-t})$. What will be the steady state value of the system output x(t)?

(a) 3/2 (b) 5/3

(c) 1 (d) 2

06. Ans: (d)

Sol: Given $\ddot{x} + 6\dot{x} + 5x = 10\,[1 - e^{-t}]$

Apply Laplace Transform on both side.

$$s^2x(s)+6sx(s)+5x(s) = 10\left[\frac{1}{s} - \frac{1}{s+1}\right]$$

$$x(s)\,[s^2 + 6s + 5] = 10\left[\frac{s+1-s}{s(s+1)}\right]$$

$$x(s) = \frac{10}{s(s+1)(s^2+6s+5)}$$

Steady state value = $Lt_{s\to 0}\, s\,x(s) = \frac{10}{5} = 2$

07. Two synchronous generators G1 and G2 rated 200MW and 400MW respectively are operated in parallel to supply a total load of 300MW. If the governors in both the machines are set to a droop of 4%, what would be the individual power supplied by each generator?

(a) G1 = 100 MW, G2 = 200MW

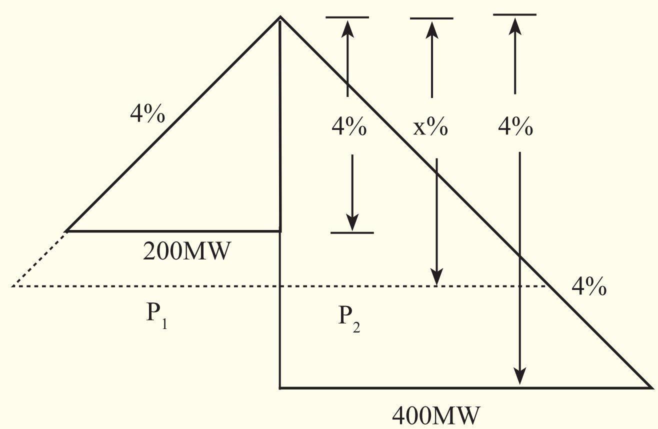
(b) G1 = 50 MW, G2 = 250MW

(c) G1 = 200 MW, G2 = 100MW

(d) G1 = 150 MW, G2 = 150MW

07. Ans: (a)

Sol:



$$\frac{P_1}{200} = \frac{x}{4} \Rightarrow P_1 = 50\,x \quad \text{.................... (1)}$$

$$\frac{P_2}{400} = \frac{x}{4} \Rightarrow P_2 = 100x \quad \text{.................. (2)}$$

$P_1 + P_2 = 300$

$50x + 100x = 300$

$\Rightarrow x = 2$

$P_1 = 50x = 50 \times 2 = 100$ MW

$P_2 = 100x = 100 \times 2 = 200$ MW

$G_1 = 100$ MW

$G_2 = 200$ MW

Method - II:

As both generators are having same dropping, so they share the load proportional to their rating.

$$P_1 = \frac{200}{200+400} \times 300 = 100 \text{ MW}$$

$$P_2 = \frac{400}{200+400} \times 300 = 200 \text{ MW}$$

08. Which of the following machines is most suitable for installation as a generator in a coal-fired thermal power plant?
(a) Squirrel cage induction generator
(b) Wound rotor induction generator
(c) Salient pole synchronous generator
(d) Cylindrical rotor synchronous generator

08. Ans: (d)

Sol: The cylindrical rotor synchronous generator (turbo alternator) is most suitable for installation as generator in a cool-fired thermal power plant.

09. Which of the following relays used for transmission line distance protection has the property of being inherently directional?
(a) Impedance relay (b) Reactance relay
(c) MHO relay (d) OHM relay

09. Ans: (c)

Sol: MHO Relay is the voltage restrained directional relay.

10. A bucholz relay is commonly used for the protection of which of the following?
(a) Busbars (b) Generators
(c) Transformers (d) Transmission lines

10. Ans: (c)

Sol: A Buchholz relay is commonly used for the protection of transformers from all internal faults.

11. Which of the following is the purpose of using harmonic restraint function in power transformers?
(a) to prevent false tripping due to magnetising inrush current
(b) to reduce the harmonic power loss in the transformer
(c) to reduce the harmonic content in the transformer voltage
(d) to reduce the harmonic content in transformer current

11. Ans: (a)

12. In an alternator, field current of 20A results in an armature current of 400A when the terminals are short-circuited. The same field current also creates a terminal voltage of 2000V in open circuit. What would be the magnitude of the internal voltage drop within the machine at a load current of 200A?
(a) 100V (b) 1000V
(c) 1V (d) 10V

12. Ans: (b)

Sol: $I_{SC} = 400$ A $\Rightarrow I_f = 20$ A

$E_{OC} = 2000$ V $\Rightarrow I_f = 20$ A

Internal voltage drop $= I_a Z_S = ?$ at $I_a = 200$ A

$$Z_S = \frac{E_{OC}}{I_{SC}} = \frac{2000}{400} = 5\Omega$$

drop $= I_a Z_S = 200 \times 5 = 1000$ V

13. DC voltage of 54.6V is applied across an electric bulb which draws 3.76 A current. What is the power consumed by the bulb?

(a) 771.91W (b) 502.296W
(c) 205.296W (d) 792.86W

13. Ans: (c)

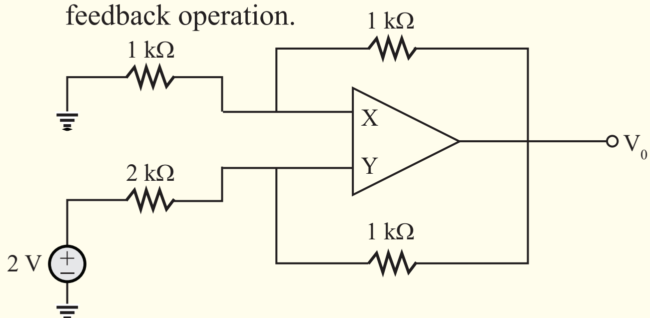
Sol: Power consumed by the bulb

$P = VI$

$= (54.6)(3.76)$

$P = 205.296$ W

14. In the circuit below, find the V_o for negative feedback operation.

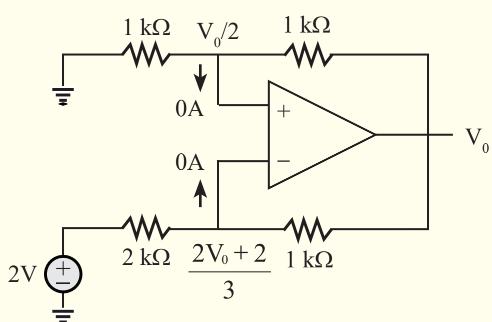


(a) 3V (b) –4V
(c) 1V (d) 2V

14. Ans: (b)

Sol: If X = positive ; Y = negative

output voltage $(V_0) = -4V$



$V_+ = V_-$ (Virtual short concept)

$$\frac{2V_0+2}{3} = \frac{V_0}{2}$$

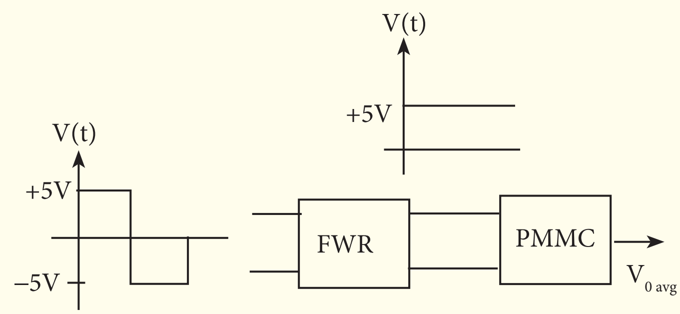
$4V_0 + 4 = 3V_0$

$V_0 = -4$

15. A average-reading multimeter reads 5V when fed with a square wave symmetric about the time-axis. For the same input an rms-reading meter will read

(a) 5V (b) 10V
(c) $5/\sqrt{2}$V (d) $5/\sqrt{3}$V

15. Ans: (a)



$V_{0\,avg} = V_m = 5V$

$V_{rms} = V_m = 5V$

Output scale = FF × PMMC scale

$$FF = \frac{V_{rms}}{V_{avg}} = \frac{V_m}{V_m} = 1$$

Output scale = 1 × PMMC scale

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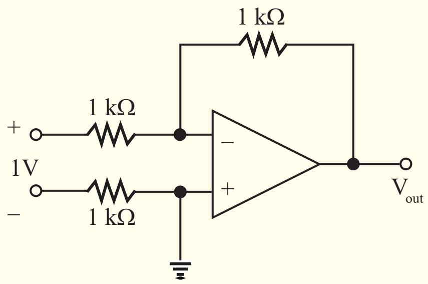
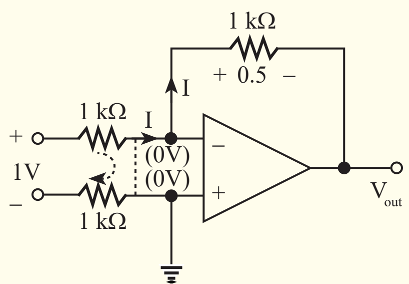
16. Find V_{out} in the below circuit. Assume opamp to be ideal.



(a) −1V (b) −2V
(c) 0V (d) 1V

16. Ans: (a)

Sol:



$$I = \frac{1V}{2} = 0.5 \text{ mA}$$

$$V_0 = 0.5 \text{ mA} \times 1k\Omega = -0.5 \text{ V}$$

Nearest option (a) is correct

17. An ammeter has a range of 0 – 10A with an internal resistance of 0.1Ω. In order to increase its range to 0 – 30A, we need to add a resistance of
(a) 0.05Ω in shunt with the meter
(b) 0.1Ω in shunt with the meter
(c) 0.05Ω in series with the meter
(d) 0.1Ω in series with the meter

17. Ans: (a)

Sol: $I_m = 10$ A, $R_m = 0.1\ \Omega$
$I = 30$ A; $R_{sh} = ?$

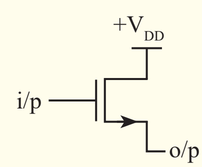
To increase the range of an ammeter, the shunt resistance is used.

$$R_{sh} = \frac{R_m}{\left(\frac{I}{I_m} - 1\right)} = \frac{0.}{\left(\frac{30}{10} - 1\right)} = \frac{0.1}{2} = 0.05\ \Omega$$

18. A MOSFET biased in common-drain configuration is best suited for designing a
(a) transresistance amplifier
(b) transconductance amplifier
(c) current buffer
(d) voltage buffer

18. Ans: (d)

Sol:



MOSFET in CD (common drain) source follower

Voltage gain $A_v \cong 1$

∴ Voltage buffer

19. What is the condition to achieve regenerative braking of induction motor?
(a) synchronous speed should be doubled
(b) synchronous speed should be increased by a factor of 1.5
(c) synchronous speed should be a little higher than the rotor speed
(d) synchronous speed should be a little lower than the rotor speed

19. Ans: (d)

Sol: For regenerative mode $N > N_s$

20. What is the low order ripple frequency of the output voltage of a three phase fully controlled bridge converter, if the AC input supply frequency is f ?
(a) 3f (b) 6f
(c) f (d) 2f

20. Ans: (b)

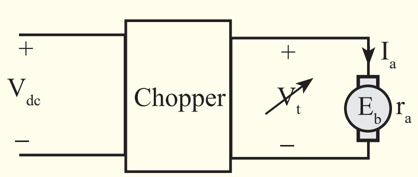
Sol: In 3-ϕ fully controlled bridge converter, the output voltage wave form consists of six pulses for every one cycle of input voltage wave form then it is also called 3-ϕ six pulse controlled converter.

$f_0 = 6$ f.

21. Which of the following armature voltage control method is employed when the supply is dc?
(a) Chopper control
(b) Static Ward - Leonard schemes
(c) Ward-Leonard schemes
(d) Transformers with taps and an uncontrolled rectifier bridge

21. Ans: (a)

Sol:



$$N \propto \frac{V_t - I_a r_a}{\phi}$$

Fo the speed control of DC motor, it input supply is dc then the chopper converter is used in armature voltage (V_t) control method.

22. What is the unit of illumination?
(a) coulomb (b) lux
(c) decibel (d) henry

22. Ans: (b)

Sol: The unit of illumination is lux

23. Which bridge is used to measure frequency?
(a) Wien's bridge (b) Anderson bridge
(c) Maxwell's bridge (d) Schering bridge

23. Ans: (a)

Sol: Wien's bridge is usd to measure the frequency.

24. A constant V/f controlled induction motor is fed from a variable voltage variable frequency three phase voltage source inverter. The motor is operated within the base speed. Which of the following is true in torque-speed characteristics of this motor?
(a) starting torque increases with decrease in frequency and maximum torque decreases
(b) starting torque decreases with decrease in frequency and maximum torque decreases
(c) starting torque increases with decrease in frequency and maximum torque remains unchanged
(d) starting torque decreases with decrease in frequency and maximum torque remains unchanged.

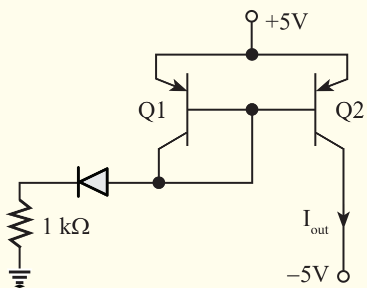
24. Ans: (c)

Sol: Starting torque $T_{st} \propto \frac{1}{f}\left(\frac{V}{f}\right)^2$

Maximum torque $T_{max} \propto \left(\frac{V}{f}\right)^2$

With constant $\frac{V}{f}$, maximum torque is constant and starting torque is inversely proportional to frequency.

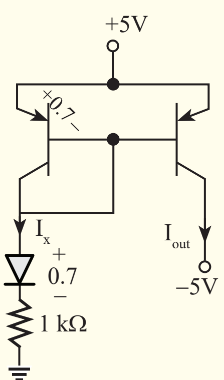
25. Q1 and Q2 are perfectly matched BJTs. Assuming beta to be infinite and forward bias voltage drop in diode to be 0.7V, find the current I_{out}.



(a) 4.3mA (b) 5.7mA
(c) 0mA (d) 3.6mA

25. Ans: (d)

Sol:



$\beta \Rightarrow \infty$

$I_B \to 0$

Current mirror

$$I_{out} = I_x = \frac{5-0.7-0.7}{1k}$$

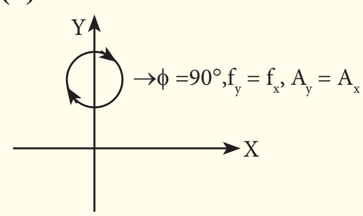
$$= \frac{3.6}{1k} = 3.6\text{ mA}$$

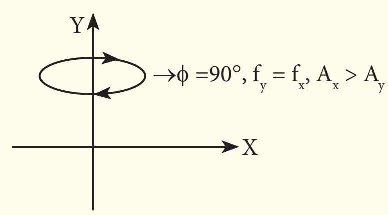
26. Two channels of a CRO are fed with two signals. In the X-Y mode, an ellipse with major axis aligned along the Y axis is observed. The following inference can be made from this

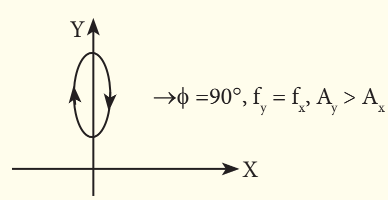
(a) Two signals are periodic with same amplitude but different frequency
(b) Two signals are periodic with same frequency but different phase and amplitude
(c) Two signals are periodic with same frequency and amplitude but different phase
(d) Two signals are periodic with same frequency and phase but different amplitude

26. Ans: (b)

Sol:







In the X-Y mode, an ellipse with major axis aligned along the Y axis is obsorbed then the two signals are periodic with same frequency but different phase and amplitude.

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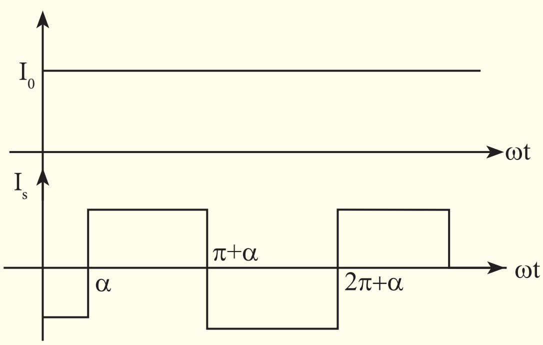
27. A single-phase diode bridge rectifier is used to supply a highly inductive load. If the load current is assumed to be ripple free, then the input current at the ac side of the rectifier will be
(a) Triangular wave
(b) Square wave
(c) Purely sinusoidal
(d) Pure DC

27. Ans: (b)

Sol: 1-ϕ FWR,



In a single phase diode bridge rectifier (1-ϕ FWR) is used to supply a highly inductive load. If load current (I_0) is assumed to be ripple free (I_0= constant) then the input current at the AC side of the rectifier will be square wave (I_s).

28. A three-phase 33kV, oil-circuit breaker is rated 1500A, 2000MVA, 2s. The symmetrical breaking current for this breaker would be
(a) 50 kA (b) 40 kA
(c) 25 kA (d) 35 kA

28. Ans: (d)

Sol: The symmetrical breaking capacity $= \sqrt{3}\,V_L \times I_{sym}$

$$\therefore I_{sym} = \frac{2000 \times 10^6}{\sqrt{3} \times 33 \times 10^3} = 34.99\text{kA}$$

29. Consider the following lists regarding compensation techniques in power systems:
A. Reduce the Ferranti effect
B. Improve power factor
C. Increase power flow capability of line
D. Reduce current ripple
1. Series capacitor
2. Shunt reactor
3. Shunt capacitor
4. Series reactor
Choose the option in which all items are correctly matched.
(a) A–4, B–2, C–1, D–3
(b) A–2, B–3, C–1, D–4
(c) A–2, B–1, C–3, D–4
(d) A–1, B–3, C–2, D–4

29. Ans: (b)

Sol: Shunt Capacitor → Improves Power factor
Series Capacitor → Improves Power flow capability
Shunt reactor → reduces the ferranti Effect
Series reactor → reduces the current ripples

30. The surge impedance of a 300 km long overhead line is 180 ohms. For a 150 km length of the same line, the surge impedance in ohms would be
(a) 90 Ohms (b) 270 Ohms
(c) 180 Ohms (d) 360 Ohms

30. Ans: (c)

Sol: Surge impedance never depends on the length of the line.

31. The transfer function given as $G(s)=\dfrac{s+\alpha}{s+\beta}$ could represent that of a lead compensator, if

(a) $\alpha=-3, \beta=-1$ (b) $\alpha=3, \beta=1$

(c) $\alpha=1, \beta=2$ (d) $\alpha=3, \beta=2$

31. Ans: (c)

Sol: Given T.F. = $\dfrac{s+\alpha}{s+\beta}$

For LEAD compensator Both α & β should be positive and $\alpha<\beta$

Hence suitable option is $\alpha = 1$ and $\beta = 2$

32. A unity feedback closed loop system has an output given as $y(t) = e^{-2t}\,u(t)$ when the input to the system is a unit impulse. Which of the following denotes the transfer function of the open loop system?

(a) $1/(s + 1)$ (b) $s/(s + 1)$

(c) $1/(s + 3)$ (d) $1/(s + 2)$

32. Ans: (a)

Sol: Given closed loop output = $y(t) = e^{-2t}\,u(t)$

r(t) input = Impulse

$$\text{C.L.T.F.} = \frac{Y(s)}{R(s)} = \frac{\text{L.T.}\{e^{-2t}u(t)\}}{\text{L.T.}\{\text{Impulse}\}} = \frac{\frac{1}{s+2}}{1}$$

$$\text{C.L.T.F.} = \frac{1}{s+2}$$

$$\text{O.L.T.F.} = \frac{\text{C.L.T.F}}{1-\text{C.L.T.F}} = \frac{1}{s+1}$$

33. Consider the following statements made about short-pitched windings in ac rotating machines:

A. short-pitching the windings results in reduced fundamental emf compared to full-pitched windings

B short-pitching increases the harmonic voltage content in the induced emf.

C. short-pitched coils have smaller length for the overhang portion

Which of the above statements is/are true?

(a) A only (b) C only

(c) A and C only (d) A and B only

33. Ans: (c)

Sol: A and C both are correct.

34. The speed of an induction motor is increases by increasing the frequency by 20%. If the magnetising current of the machine is to remain constant, then

(a) supply voltage must be increaesed by 10%

(b) slip must be increased by 20%

(c) supply voltage must be increased by 20%

(d) supply voltage must be decreased by 20%

34. Ans: (c)

Sol: $B \propto \dfrac{V_1}{f}$ = constant

To maintain the same magnetizing current, $\dfrac{V}{f}$ should be constant. As frequency is increased by 20%, supply voltage must be increased by 20%

35. Which of the following is the reason behind the inability of an ideal synchronous motor to develop any starting torque?

(a) the rotor winding has a very high reactance

(b) the stator winding are concentrated windings

(c) the rotor is extremely heavy in these machines

(d) the relative velocity between stator and rotor mmf is large at starting

35. Ans: (d)

Sol: During starting the stator field (poles or MMF) will ace online

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rotating at synchronous speed, but the rotor is at stationary, therefore the rotor field (or poles or MMF) will be at zero speed. The relative speed between stator MMF & rotor MMF is equal to synchronous speed. But for the production of unidirectional torque both must be stationary with respect to each other.

36. Consider the following statements about three-phase voltage source inverters:

A. they require voltage-bidirectional two quadrant devices to realise the switches

B. PWM techniques are used to reduce the frequency of the harmonics in the output

C. in the 180° conduction mode, a new switch is gated in every 60° duration.

Which of the above statements is/are true?

(a) A only (b) C only

(c) A and B only (d) B and C only

36. Ans: (d)

Sol:
- Voltage source inverter (VSI) require unipolar and bidirectional switch like MOSFET, IGBT with body diodes.
- Objectives of PWM techniques are to control rms value of the output voltage and to eliminate (or) minimise the lower order harmonic content to this possible extent.
- In the 180° conduction mode, a new switch is gated in every 60° duration.

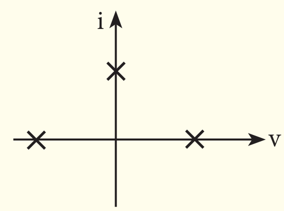
37. Which among the following is an example for a voltage bidirectional two-quadrant switch?

(a) MOSFET (b) SCR

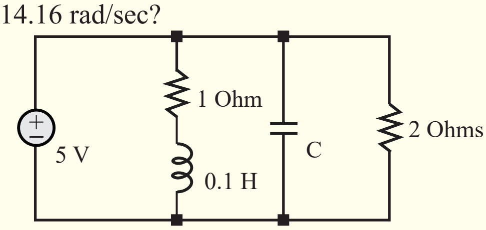
(c) BJT (d) Diode

37. Ans: (b)

Sol: MOSFET is unipolar, unidirectional switch.
Diode is unipolar, unidirectional switch.
SCR is Bipolar, unidirectional switch.
BJT is unipolar, unidirectional switch.
Voltage bidirectional two quadrant switch means bipolar, unidirectional switch. SCR is bipolar unidirectional switch.



38. What should be the value of the capacitance so that the resonance frequency of the circuit below is 314.16 rad/sec?

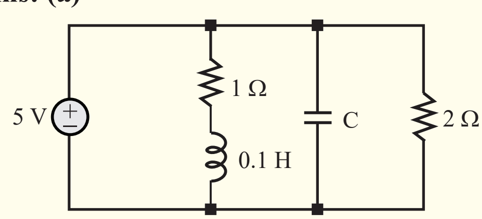


(a) C = 0.1 mF (b) C = 0.01 mF

(c) C = 1 mF (d) C = 10mF

38. Ans: (a)

Sol:



$$Y = Y_1 + Y_2 + Y_3$$

$$= \frac{1}{(R_1 + jX_L)} + \frac{1}{-jX_C} + \frac{1}{R_2}$$

$$= \frac{1}{(1 + jX_L)} + \frac{j}{X_C} + \frac{1}{2}$$

$$= \frac{1-jX_L}{1+X_L^2} + \frac{j}{X_C} + \frac{1}{2}$$

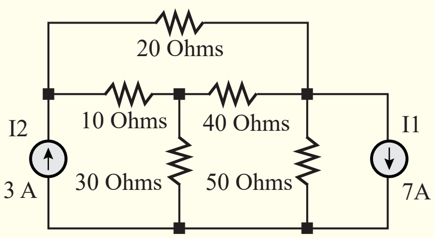
$$= \left(\frac{1}{2} + \frac{1}{1+X_L^2}\right) + j\left(\frac{1}{X_C} - \frac{X_L}{1+X_L^2}\right)$$

For Resonance, imaginary part = 0

$$\frac{1}{X_C} = \frac{X_L}{1+X_L^2} \Rightarrow 1 + X_L^2 = X_C X_L$$

$$1 + (\omega_0 L)^2 = \frac{L}{C} \Rightarrow C = 0.1 \text{ mF}$$

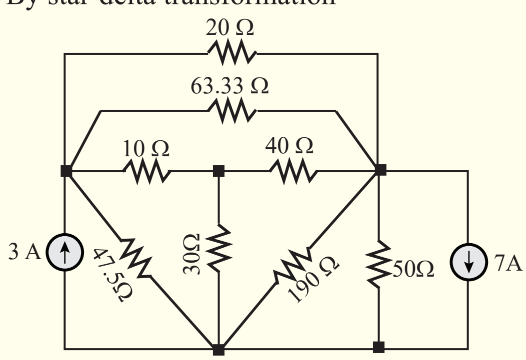
39. Consider a circuit below. The voltage across the 3A current source is

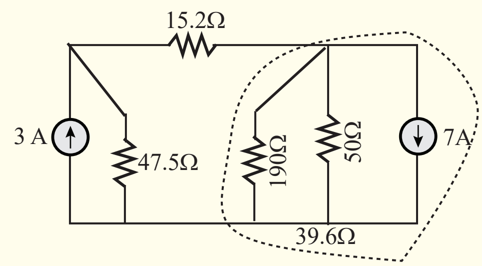


(a) 26.17V (b) 2.617V
(c) 52.35 V (d) 5.235V

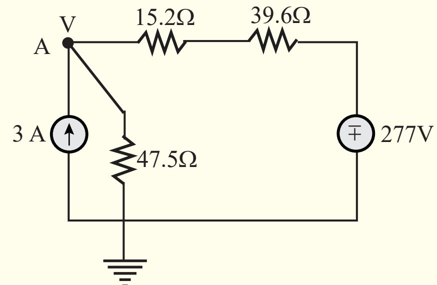
39. Ans: (c)

Sol: By star-delta transformation





By S.T T.



By Nodal analysis at point, A

$$\frac{V-(-277)}{15.2+39.6} + \frac{V}{47.5} = 3$$

$$47.5V + 13157.5 + 54.8\ V = 3 \times 47.5 \times 54.8$$

$$V = \frac{-5348.5}{102.3}$$

$$V = 52.28 \text{ V}$$

40. Laplace transform of f(t) is $\frac{s}{s^2-4}$. Then the f(t) is

(a) f(t) = cos(2t) (b) f(t) = sin(2t)
(c) f(t) = cosh(2t) (d) f(t) = sinh(2t)

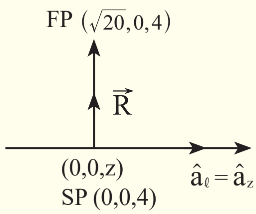
40. Ans: (c)

41. An infinitely long current filament carrying 28.1A of current in the positive z direction. The magnetic field intensity, H, at $(\sqrt{20}, 0, 4)$

(a) 0.1 $\hat{y}$ A/m (b) 10 $\hat{y}$ A/m
(c) 1 $\hat{y}$ A/m (d) 0.5 $\hat{y}$ A/m

41. Ans: (c)

Sol: I = 28.1 Amp



$\hat{a}_\ell = +\hat{a}_z$

$$\hat{a}_\perp = \hat{a}_R = \frac{\vec{R}}{|\vec{R}|}$$

$$\hat{a}_\perp = \frac{\sqrt{20}}{\sqrt{20}}\hat{a}_x$$

$\vec{H}$ due to infinite line is given by

$$\vec{H} = \frac{I}{2\pi R}(\hat{a}_\ell \times \hat{a}_\perp)$$

$$= \frac{28.1}{2\pi \times \sqrt{20}}(\hat{a}_z \times \hat{a}_x)$$

$$\therefore \vec{H} = \hat{a}_y \text{ A/m}$$

42. Consider the following statements about a phase controlled single-phase full-bridge converter using SCRs:

A. The average output voltage at the dc side varies linearly with the firing angle

B. The power factor at the ac input side depends on the converter firing angle

C. The converter cannot be operated with firing angle greater than 90 degrees

Which of the above statements is/are true?

(a) B only (b) A only

(c) A and B only (d) B and C only

42. Ans: (a)

Sol: The average output voltage (V_0) of 1-ϕ full bridge converter is proportional to cosα. So, V_0 is not varies linearly with the firing angle.

$$V_0 = \frac{2V_m}{\pi}\cos\alpha$$

I.p.f = 0.9cosα

The power factor at the ac input side depends on the converter firing angle.

The converter can be operated with firing angle greater than 90° also. The range of firing angle is 0° to 180°.

43. A DC shunt motor with an armature resistance of 0.15Ω is supplied from 230V input supply. If the back emf of the motor is 200V, then the armature current will be equal to

(a) 150A (b) 250A

(c) 100A (d) 200A

43. Ans: (d)

Sol: $$I_a = \frac{V - E_b}{R_a} = \frac{230-200}{0.15}$$

$$= \frac{30}{0.15} = 200 \text{ A}$$

44. Consider the following statements about the operation of a synchronous machine:

A. the armature reaction in the generating modes aids the field flux when supplying a leading current

B. the armature reaction opposes the field flux for a motor that draws a leading power factor current

C. armature reaction in motoring mode always opposes the field excitation irrespective of the power factor.

Which of the above statements is/are true?

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

44. Ans: (b)

45. If the value of complex power flow in a certain transmission line is assumed to be fixed and if V denotes the sending end voltage of the line, then the real power loss in the line would be proportional to

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

45. Ans: (b)

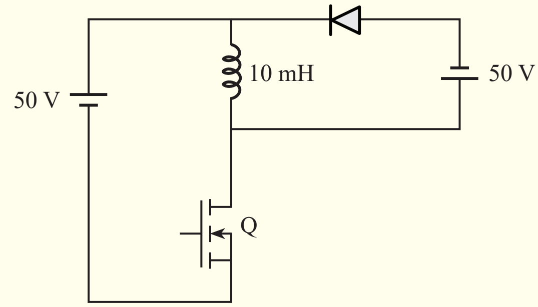
Sol: $P_T = V_s.I_s \cos\phi$

$$I_S = \frac{P_T}{V_s \cos\phi}$$

$$P_T = I_s^2 R = \left(\frac{P_T}{V_S \cos\phi}\right)^2 R$$

$$\therefore P_L \propto \frac{1}{V_s^2}$$

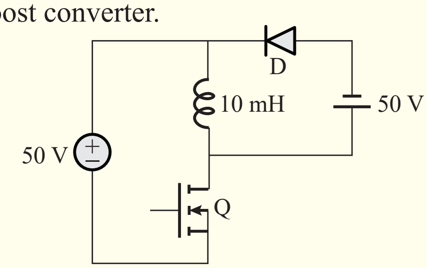
46. The MOSFET in the circuit shown below is operated as a switch at a frequency of 10kHz and duty ratio of 0.6. The initial inductor current is zero. If all the components can be assumed to be ideal, what would be the energy stored in the inductor at the end of 10 switching cycles?



(a) 0.01J (b) 0.008J
(c) 0.005J (d) 0.001J

46. Ans: (c)

Sol: The given DC-DC converter is match with buck boost converter.

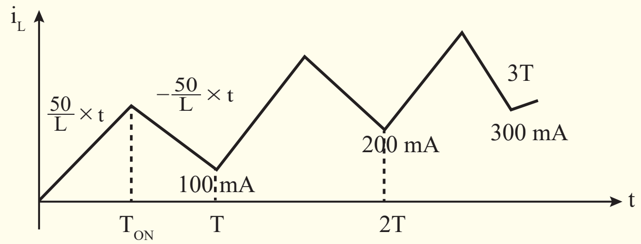


In DC-DC buck boost converter, for continuous conduction.

$$V_0 = \frac{D}{1-D} V_s = \frac{0.6}{1-0.6} \times 50 = 75V$$

But given output voltage is 50V, so it is not continuous conduction mode. At the same time, it is not discontinuous conduction mode. (DCM) because, in D.C.M output voltage will be more than 50V.

So in every cycle inductor getting energy in 0.6 T and delivering energy during 0.4 T duration. The slope of current during ON time (T_{ON}) and OFF time (T_{OFF}) are as follows.



$\frac{V_S}{L} \times t$..........T_{ON}

$\frac{V_0}{L} \times t$ ....T_{OFF}

L = 10 mH

$$T = \frac{1}{10 \times 10^3} = 100\mu s$$

D = 0.6

During 1st cycle, at the end of T_{ON},

$$I_{L1} = \frac{50}{10 \times 10^{-3}} \times 100 \times 10^{-6} \times 0.6 = 300mA$$

at the end of T; $I_{L2} = 300 - \frac{50}{L} \times T_{OFF}$

$$I_{L2} = 300 \times 10^{-3} - \frac{50}{10 \times 10^{-3}} \times 0.4 \times 100 \times 10^{-6}$$

$$= 100 \text{ mA}$$

At the end of 1st cycle it gets a current of 100 mA. It is continuous so at the end of 10^{th} cycle, current through inductor is 1000 mA. i.e., 1A

$\therefore$ Stored energy in inductor = $\frac{1}{2}LI^2$

$$= \frac{1}{2} \times 10 \times 10^{-3} \times (1)^2$$

$$= 5 \text{ mJ}$$

47. In a salient pole synchronous generator with X_d and X_q denoting the reactance in the d and q axes, what is likely to be the relation between X_d and X_q?

(a) $X_d > X_q$ (b) $X_d = -X_q$

(c) $X_d < X_q$ (d) $X_d = X_q$

47. Ans: (a)

Sol: $X_d > X_q$

48. Consider the following statements made about the sequence impedance of power system components.

A. a fully transposed transmision line has equal positive and negative sequence impedances

B. the negative sequence impedance of a synchronous generator is usually smaller than the positive sequence impedance

C. the negative sequence impedance of a transformer is generally much higher than the positive sequence impedance

Which of the above statements is/are true?

(a) A and C only (b) A only

(c) A and B only (d) B and C only

48. Ans: (c)

Sol: For generator

$X_1 \geq X_2 >> X_0$

For Transformer

$X_1 = X_2 = X_0$

For Transmission Line

$X_1 = X_2 << X_0$

49. A dynamometer type wattmeter is used to measure power of a room heater. Which option is correct?

(a) Current in the fixed coil is lower than the current in the moving coil

(b) Cannot comment on the relative currents in the moving and fixed coil

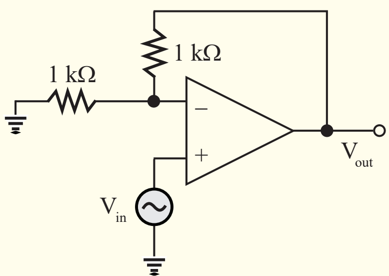
(c) Current in the fixed coil is same as the current in the moving coil

(d) Current in the fixed coil is more than the current in the moving coil

49. Ans: (d)

Sol: In dynamomter type wattmeter, the current in the moving coil is less (PC) and the current in the current coil (CC) is more. CC is in series with load. So, load current is equval to current coil current.

50. Find the type of feedback in the below circuit.



(a) Shunt - series feedback

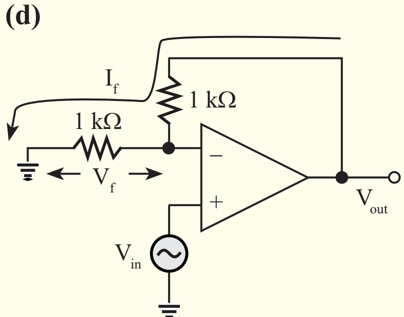
(b) Shunt - shunt feedback

(c) Series - series feedback

(d) Series - shunt feedback

50. Ans: (d)

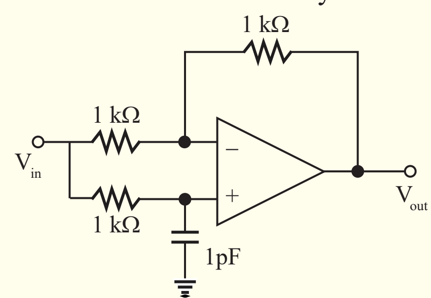
Sol:



1. Since output is voltage, shunt sampling is implemented.
2. Since the feedback signal is voltage, series mixing is implemented.

$\therefore$ The type of feedback is voltage-series (or) series shunt.

51. What kind of filter is realized by the below circuit?

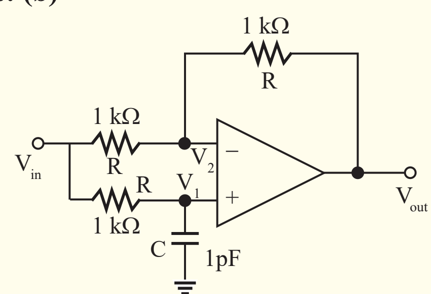


(a) Band-pass filter (b) All-pass filter

(c) Low-pass filter (d) High-pass filter

51. Ans: (b)

Sol:



$$\text{Step (1): } V_1 = \frac{\frac{1}{sC}V_{in}}{R+\frac{1}{sC}} = \frac{V_{in}}{1+sRC} \quad \text{......(1)}$$

$$\Rightarrow V_{01} = \frac{2V_{in}}{1+sRC} \quad \text{.........(2)}$$

$$\text{Step (2): } V_{02} = -V_{in} \quad \text{..........(3)}$$

$$\text{Step (3): } V_0 = V_{01} + V_{02} = \frac{2V_{in}}{1+sRC} - V_{in}$$

$$= V_{in}\left[\frac{2-1-sRC}{1+sRC}\right] = V_{in}\left[\frac{1-sCR}{1+sCR}\right]$$

$$\therefore \left|\frac{V_0}{V_{in}}\right| = \sqrt{\frac{1+s^2C^2R^2}{1+s^2C^2R^2}} = 1 \text{ ....(4)}$$

The given circuit is an **All Pass Filter.**

52. The decimal equivalent of the HEX number EF.A is
(a) 239.625 (b) 239.16
(c) 239.15 (d) 239.6

52. Ans: (a)

Sol: $(EF.A) = 16^1 \times E + 16^0 \times F + 16^{-1} \times A$
$= 224 + 15 + 0.625$
$= (239.625)_{10}$

53. A three-phase full controlled converter (with 6 SCRs only) is feeding the armature of a separately excited DC motor. The motor has to also operate in quadrant-III. Which of the following methods is suitable?
(a) By operating with triggering angle $\alpha > \pi/2$ rad
(b) By connecting a free wheeling diode across the armature in addition to adjusting the triggering angle α
(c) By adjusting the triggering angle α only
(d) By adjusting the triggering angle α followed by armature connection reversal

53. Ans: (d)

Sol: $3-\phi$ full converter fed seperately excited DC motor quadrant-III operation.
$V_a \rightarrow -ve$, $i_a \rightarrow -ve$
So, we have to adjusting the triggering angle (α) followed by armature connection reversal.

54. A lamp takes 10A at 250V and emits 16000 Lumens. Determine its Mean Spherical Candle Power (MSCP).
(a) $4000/\pi$ (b) 8000π
(c) 2000π (d) 4000π

54. Ans: (a)

Sol: Mean spherical candle power (MSCP)

$$= \frac{\text{Total luminous flux}}{4\pi}$$

$$= \frac{16000}{4\pi} = \frac{4000}{\pi}$$

55. What is the effect on co-efficient of adhesion due to following conditions on rails?
(a) it is high when the rails have grease
(b) it is high when the rails are dry
(c) it is high when the rails are oiled
(d) it is high when the rails are wet

55. Ans: (b)

Sol: The coefficient of adhesion is high when the rails are dry.

56. In a slip power recovery scheme of 3-phase induction motor drives, what is the operating speed with respect to the synchronous speed of the motor, if the power is injected into the rotor circuit from an external source?
(a) motor speed is always below the synchronous speed
(b) motor speed reduce to zero
(c) motor speed is above the synchronous speed
(d) motor speed is equal to the synchronous speed

56. Ans: (c)

Sol: In slip-power recover scheme motor speed is always above the synchronous speed $N_r > N_s$.

57. What is the effect of AC side source inductance in SCR based phase-controlled rectifier operating with firing angle less than π/2 radians during R-L type loading condition, compared to that in zero source impedance condition?
   (a) Average output voltage remain unchanged
   (b) Average output voltage may increase or decrease
   (c) Average output voltage increases
   (d) Average output voltage decreases

57. Ans: (d)

Sol: V_0 with L_s (Effect of source inductance)

$$V_0 = \frac{2V_m}{\pi}\cos\alpha - \frac{2\omega L_s}{\pi} I_0$$

V_0 decreases by amount $\frac{2\omega L_s}{\pi} I_0$

58. Choose the correct statement.
   (a) Moore and Mealy machine outputs depend on both the input and the current state
   (b) Moore and Mealy machine outputs does not depend on input
   (c) Moore and Mealy machine outputs depends on input
   (d) Moore and Mealy machine outputs depends on current state

58. Ans: (d)

Sol: In Mealy machine, output depends on present state and input

In Moore machine, output depends on the present state.

59. Find the minimum sum-of-products representation for the Boolean expression.

$$Z = \overline{X}Y + X\overline{Y} + XY$$

   (a) $\overline{X} + \overline{Y}$ (b) $\overline{X}\,\overline{Y}$
   (c) XY (d) X + Y

59. Ans: (d)

Sol: Given $Z = \overline{X}Y + X\overline{Y} + XY$

$= \overline{X}Y + X = X + Y$

60. The octal representation of 111100010001 is
   (a) 6512 (b) 6541
   (c) 7421 (d) 7241

60. Ans: (c)

Sol: $(\underline{1\,1\,1}\ \underline{1\,0\,0}\ \underline{0\,1\,0}\ \underline{0\,0\,1})_2 = (7421)_8$

61. Which of the following can be the result of introducing an integral action in the forward path of a unity feedback system?
   (a) faster system response
   (b) reduced noise immunity
   (c) elimination of steady state error
   (d) increased stability margins

61. Ans: (c)

Sol: Integral control Reduces steady state error

62. Which of these is responsible for developing the pressure in the working fluid cycle in a thermal power plant?
   (a) feed water pump (b) superheater
   (c) steam turbine (d) condenser

62. Ans: (a)

Sol: The feed water pump is responsible for developing the pressure in the working fluid cycle in a thermal power plant.

63. If u(t) denotes the unit step function, which of the following is an example of a bounded signal?
(a) $e^t \sin(t)u(t)$ (b) $tu(t)$
(c) $e^{2t}u(t)$ (d) $e^{-2t}u(t)$

63. Ans: (d)

Sol: If the signal amplitude is bounded throughout the time interval $-\infty$ to ∞, then the signal is called bounded signal.
So, options (a), (b) and (c) are unbounded signals, option (d) is example of a bounded signal.

64. Consider the following lists regarding speed control methods for dc motors:
A. Armature voltage
B. Field current control
C. Use of diverter resistor
D. Rheostatic voltage

1. Poor efficiency
2. Speed below based speed
3. Speed above base speed
4. DC series motor control

Choose the option in which all the items are correctly matched
(a) A–4, B–2, C–1, D–3
(b) A–2, B–1, C–3, D–4
(c) A–2, B–3, C–4, D–1
(d) A–2, B–3, C–1, D–4

64. Ans: (c)

65. Reducing the speed in a three-phase induction motor by using stator voltage control while supplying a constant torque load would result in
(a) higher airgap flux within the machine
(b) reduced efficiency
(c) reduction in rotor slip
(d) increased peak torque capability

65. Ans: (b)

Sol: $T_{em} = \dfrac{KSV^2}{R_2}$

$SV^2 = \text{constant}$

$S\uparrow \propto \dfrac{1}{V^2\downarrow}$

and $S\uparrow \Rightarrow N_r\downarrow$

$\phi_e \propto \dfrac{V\downarrow}{f}$

$I_2 \propto S\uparrow$

$I_2^2R\ \uparrow$

$\eta\downarrow$

66. In a transformer, the load current is kept constant, while the power factor is varied. Under this situation, zero voltage regulation will be observed
(a) at power factor equal to unity
(b) independent of load power factor
(c) load power factor is leading
(d) load power factor is lagging

66. Ans: (c)

Sol: Zero regulation always possible at leading power-factor loads.

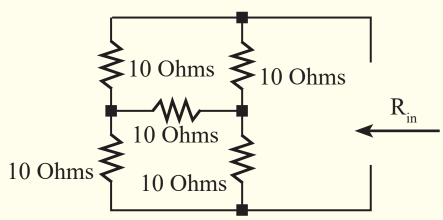
67. The minimum value of anode current in an SCR that is required to sustain conduction in a thyristor with zero gate current is called
(a) Base current
(b) Fundamental current
(c) Latching current

(d) Holding current

67. Ans: (c)

Sol: Latching current (I_L) can be defined as the minimum value of anode current (I_a) required to maintain the conduction even when gate current is removed. In order to turn ON SCR, $I_a > I_L$.

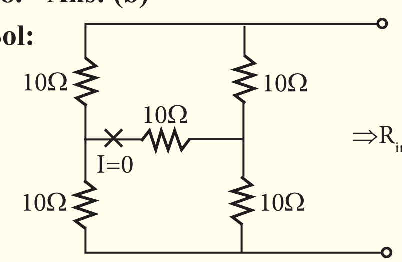
68. What is Thevenin equivalent resistance of the network shown below?



(a) R_{in} = 20 Ohms (b) R_{in} = 10 Ohms
(c) R_{in} = 40 Ohms (d) R_{in} = 30 Ohms

68. Ans: (b)

Sol:



$\Rightarrow R_{in} = (10+10)||(10+10)$
$= 10\Omega$

Bridge is balanced

$10 \times 10 = 10 \times 10$

69. Consider three infinite uniform charge sheets located in a free space as follows: 1) 3nC/m² at z = –2m, 2) 6nC/m² at z = 0.5m, 3) –8nC/m² at z = 4m. The electric field at (2, 5, –5) is

(a) $-5.65\ \hat{z}$ V/m (b) $+5.65\ \hat{z}$ V/m
(c) $-56.5\ \hat{z}$ V/m (d) $+56.5\ \hat{z}$ V/m

69. Ans: (c)

Sol: Given $\rho_{s1} = 3\text{nC/m}^2$ at $z = -2\text{m}$

$\rho_{s2} = 6\text{nC/m}^2$ at $z = 0.5\text{m}$

$\rho_{s3} = -8\text{nC/m}^2$ at $z = 4\text{m}$

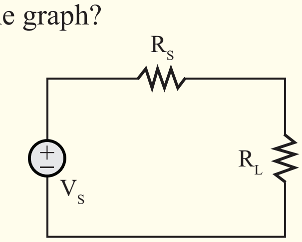
Electric field intensity at FP (2, 5, –5)m is

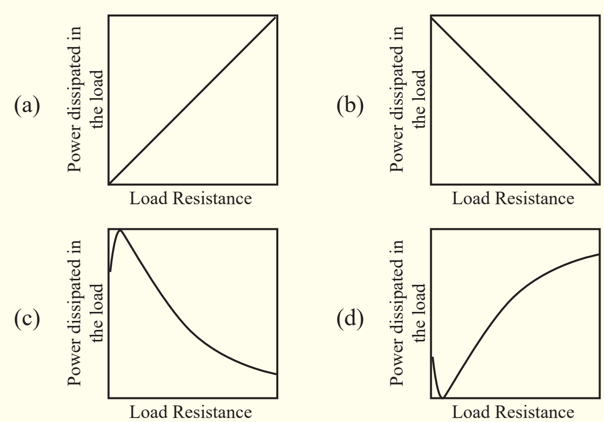
$$\vec{E} = \frac{10^{-9}}{2\varepsilon_0}[3(-\hat{a}_z) + 6(-\hat{a}_z) - 8(-\hat{a}_z)]$$

$$= \frac{10^{-9}}{2 \times \frac{10^{-9}}{36\pi}}[-1.\hat{a}_z]$$

$$\therefore \vec{E} = -56.5\ \hat{z}\ \text{V/m}$$

70. In the circuit below, the power dissipated in the R_L as a function of R_L is schematically represented by which of the graph?





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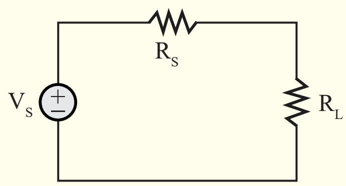
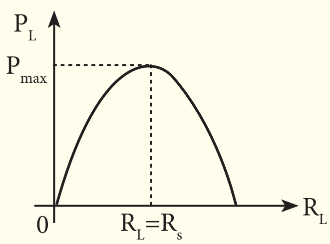
70. Ans: (c)

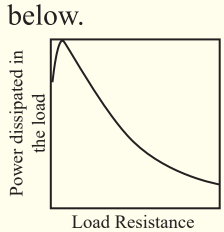
Sol:



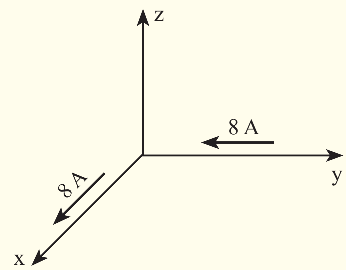
Power across the load vs load resistance



After maximum power dissipation, if load resistance is still increased, the power dissipated to the load will be decreased and the corresponding graph is shown below.



71. Calculate the magnetic field intensity, H, at (0.4, 0.3, 0) due to the 8A filamentary current directed from outward from origin to the infinity along the positive x axis and inward from the infinity to origin along the positive y axis as shown below.

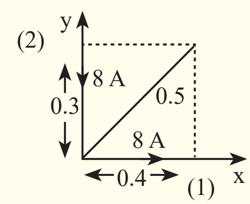


(a) $63.7\,\hat{z}$ A/m (b) $-63.7\,\hat{z}$ A/m

(c) $6.37\,\hat{z}$ A/m (d) $-6.37\,\hat{z}$ A/m

71. Ans: (c)

Sol:



$$H_1 = \frac{8}{4\pi(0.4)}\left[1+\frac{3}{5}\right]\hat{z}$$

$$H_2 = \frac{8}{4\pi(0.3)}\left[1+\frac{4}{5}\right]\hat{z}$$

$$\vec{H}_T = \vec{H}_1 + \vec{H}_2$$

$$\overline{H}_T = \frac{8}{4\pi}\left[\frac{1}{0.4}\left[1+\frac{3}{5}\right]+\frac{1}{0.3}\left[1+\frac{4}{5}\right]\right]\hat{z}$$

$$= 6.37\,\hat{z}\text{ A/m}$$

72. Consider the following statements about a triac:

A. A triac has bidirectional current carrying capability as well as bidirectional voltage blocking capability

B. A triac is functionally equivalent to two antiparallel connected thyristors

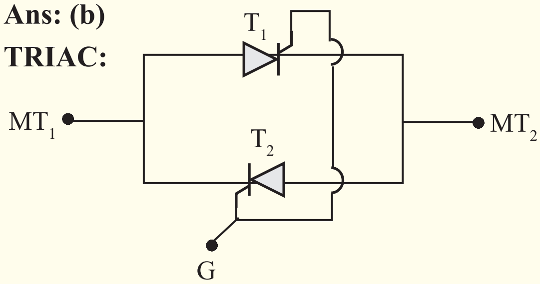
C The triac can be turned on with both positive and negative gate currents

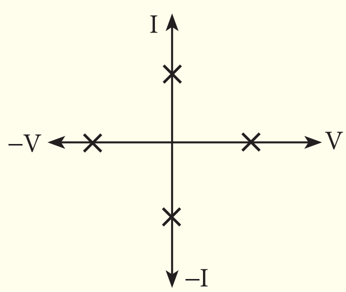
Which of the above statements is/are true?

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

72. Ans: (b)

Sol: TRIAC:





TRIAC is bipolar and bidirectional switch.
TRIAC is functionally equivallent to two antiparallel connected thyristors. It can be turned on with both positive and negative gate currents.

73. The stator of a three-phase, 4-pole squirrel cage induction motor rated for 1450 rpm at 50 Hz, is rewounded to have six poles without any change made on the rotor. This motor would then

(a) operate with speed slightly above 1800 rpm at 50 Hz
(b) run at the same speed with higher torque rating
(c) operate with speed slightly below 1000 rpm at 50Hz
(d) fail to develop any torque

73. Ans: (c)

Sol: P = 6

Now $N_s = \frac{120f}{P} = \frac{120 \times 50}{6} = 1000$ rpm

Therefore induction motor always runs at a speed less than synchronous speed N_s.

74. Consider the following statements about a dc series motor:

A. the developed torque in the machine is directly proportional to the current in the machine
B the motor is suitable only for loads having a small starting torque
C. the machine can run even when a single phase ac supply is applied across its terminals

Which of the above statements is/are true?

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

74. Ans: (b)

75. Which of the following represents the transfer function of a zero-order hold with sample period T?

(a) $s(1 - e^{-sT})$ (b) $s(1 + e^{-sT})$
(c) $\frac{1-e^{-sT}}{s}$ (d) $\frac{1+e^{-sT}}{s}$

75. Ans: (c)

Sol: The Impulse response of a zero-order hold with sample period T is

h(t) = u(t) –u(t–T)

$$H(s) = \frac{1}{s} - \frac{e^{-sT}}{s}$$
$$= \frac{1-e^{-sT}}{s}$$

76. For the open loop transfer function of a system is given as $G(s)H(s) = \frac{\pi e^{-0.25s}}{s}$, the gain crossover

frequency in rad/sec is

(a) $\pi/4$ (b) 2π

(c) π (b) $\pi/2$

76. Ans: (c)

Sol: Magnitude $\big|_{\omega=\omega_{gc}} = 1$

$$\left|\frac{\pi e^{-0.25\omega}}{\omega}\right|_{\omega=\omega_{gc}} = 1$$

$$\frac{\pi}{\omega_{gc}} = 1 \qquad \Rightarrow \omega_{gc} = \pi \text{ rad/ sec}$$

77. Gauss-Siedel technique is commonly used in power systems for which of the following?

(a) Unit Commitment

(b) Stability Analysis

(c) Load flow Analysis

(b) Fault Analysis

77. Ans: (c)

Sol: Gauss-siedel technique is one of the load flow method

78. A balanced three-phase supply feeds power to a balanced three-phase R-L load. Under this condition, the total instantaneous power supplied to the load would be

(a) Pulsating with non-zero average

(b) Zero

(c) Constant

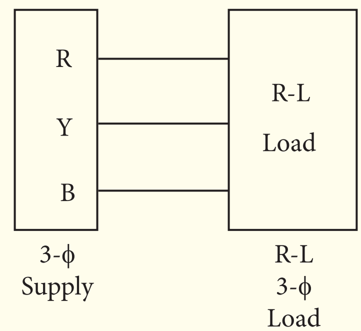
(b) Pulsating with zero average

78. Ans: (c)

Sol: $V_R = V_m \sin\omega t$

$V_Y = V_m \sin(\omega t - 120°)$

$V_B = V_m \sin(\omega t + 120°)$



For R-L load, $Z = |Z|\angle\phi$

$$I_R = \frac{V_R}{Z} = \frac{V_m \sin\omega t}{Z\angle\phi} = I_m \sin(\omega t - \phi) A$$

$I_Y = I_m \sin(\omega t - 120° - \phi)$ A

$I_B = I_m \sin(\omega t + 120° - \phi)$ A

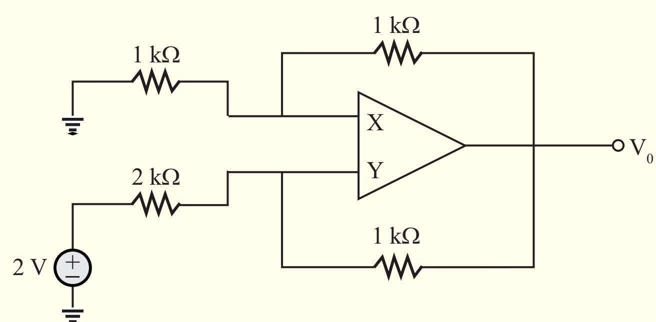
Total instantaneous power

$P = P_R + P_Y + P_B$

$P = V_m I_m \sin\omega t \sin(\omega t - \phi) + V_m I_m \sin(\omega t - 120°) \sin(\omega t - 120° - \phi) + V_m I_m \sin(\omega t + 120°) \sin(\omega t + 120° - \phi)$

$= 3V_m I_m \cos\phi \rightarrow$ constant

79. In the circuit below, find the terminals of X and Y, for the circuit to be in negative feedback.



(a) Any of the terminals can be negative or positive

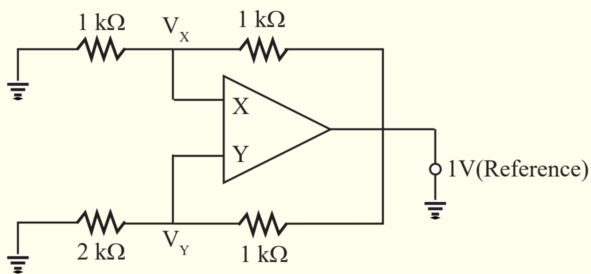
(b) Circuit will never be in negative feedback

(c) X negative and Y positive

(d) X positive and Y negative

79. Ans: (d)

Sol: We can test the feedback by connecting some reference voltage at the output "V_0" and the i/p excitation should be neutralize.



from the circuit

$V_x = 1/2, \quad V_y = \frac{2}{3}$

$V_x = 0.5\text{ V}, \ V_y = 0.67\text{ V}$

$V_y > V_x$

as per the requirement of –ve feedback the output feedback quantity which is fed back to –ve terminal should be more than that of +ve terminal so X should be +ve & Y should be –ve.

80. What is the hexadecimal conversion of this binary number 1111?

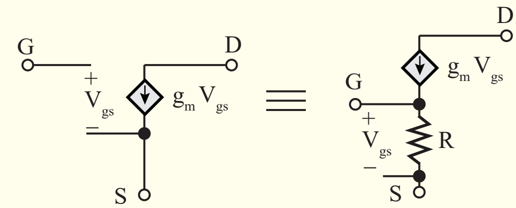
(a) A (b) F

(c) 4 (d) 8

80. Ans: (b)

Sol: $(1111)_2 = (F)_{16}$

81. For the two circuits to be equivalent, R should be equal to

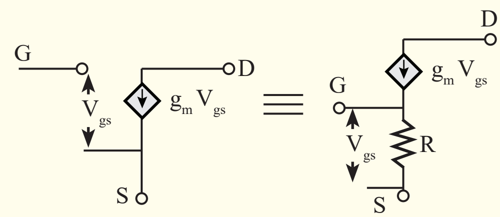


(a) $\frac{1}{g_m}$ (b) $\frac{1}{(2g_m)}$

(c) 0 (b) infinity

81. Ans: (a)

Sol:



from circuit V_{gs} = Voltage across R

$= g_m V_{gs} \times R$

$g_m R = 1 \Rightarrow R = 1/g_m$

82. Which of the following load offers characteristic close to a constant load torque?

(a) Fan type of load

(b) Water pumping load

(c) Traction load

(d) Low speed hoist

82. Ans: (d)

Sol: The constant load torque applications are

- working motor have each mechanical nature of work like cutting, grinding (or) sharing
- Similarly cranes during the hoisting.

83. Which of the following is used in overhead power supply for AC electric locomotive in India?
(a) 415V, Three phase
(b) 25kV, Single phase
(c) 110kV, Single phase
(d) 330 kV, Single phase

83. Ans: (b)

Sol: The system of traction employing 25 kV, 50 Hz 1-ϕ, AC supply has adopted by Indian Railways.

84. Which of the following statements are entirely true regarding Eddy current?
(a) Eddy current loss can be minimized by thin laminate core and Eddy current is proportional to the flux frequency
(b) Eddy current loss can be minimized by using material which have low hysteresis coefficient and Eddy current is proportional to the square of the flux frequency
(c) Direction of Eddy current can be found by Lenz's law and Eddy current is proportional to the square of the flux frequency
(d) Eddy current loss can be minimized by using material which have low hysteresis coefficient and Eddy current is proportional to the flux frequency

84. Ans: (a)

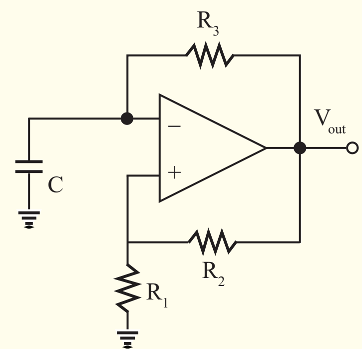
Sol: It doesn't depends hysteresis coefficient

85. Which of the following statements is true in the case of dynamic braking of separately excited DC motor?
(a) The voltage supply/source is removed and the armature terminals are connected to a resistance
(b) The voltage supply/source is reversed keeping armature terminal fixed
(c) The armature terminals are reversed and the voltage supply/source is present
(d) The voltage supply/source is removed and the armature terminals are shorted

85. Ans: (a)

Sol: During dynamic braking, the armature is removed from source and connected to a resistance.

86. What is the time period of oscillation of V_{out}?



(a) $2\frac{R_1}{R_2}R_3C\ln\left(1+\frac{2R_1}{R_2}\right)$

(b) $2\frac{R_2}{R_1}R_3C\ln\left(1+\frac{2R_2}{R_1}\right)$

(c) $2R_3C\ln\left(1+\frac{2R_1}{R_2}\right)$

(d) $2\frac{R_2}{R_1}R_3C\ln\left(1+\frac{2R_1}{R_2}\right)$

86. Ans: (c)

Sol: The given circuit is an Astable Multivibrator.

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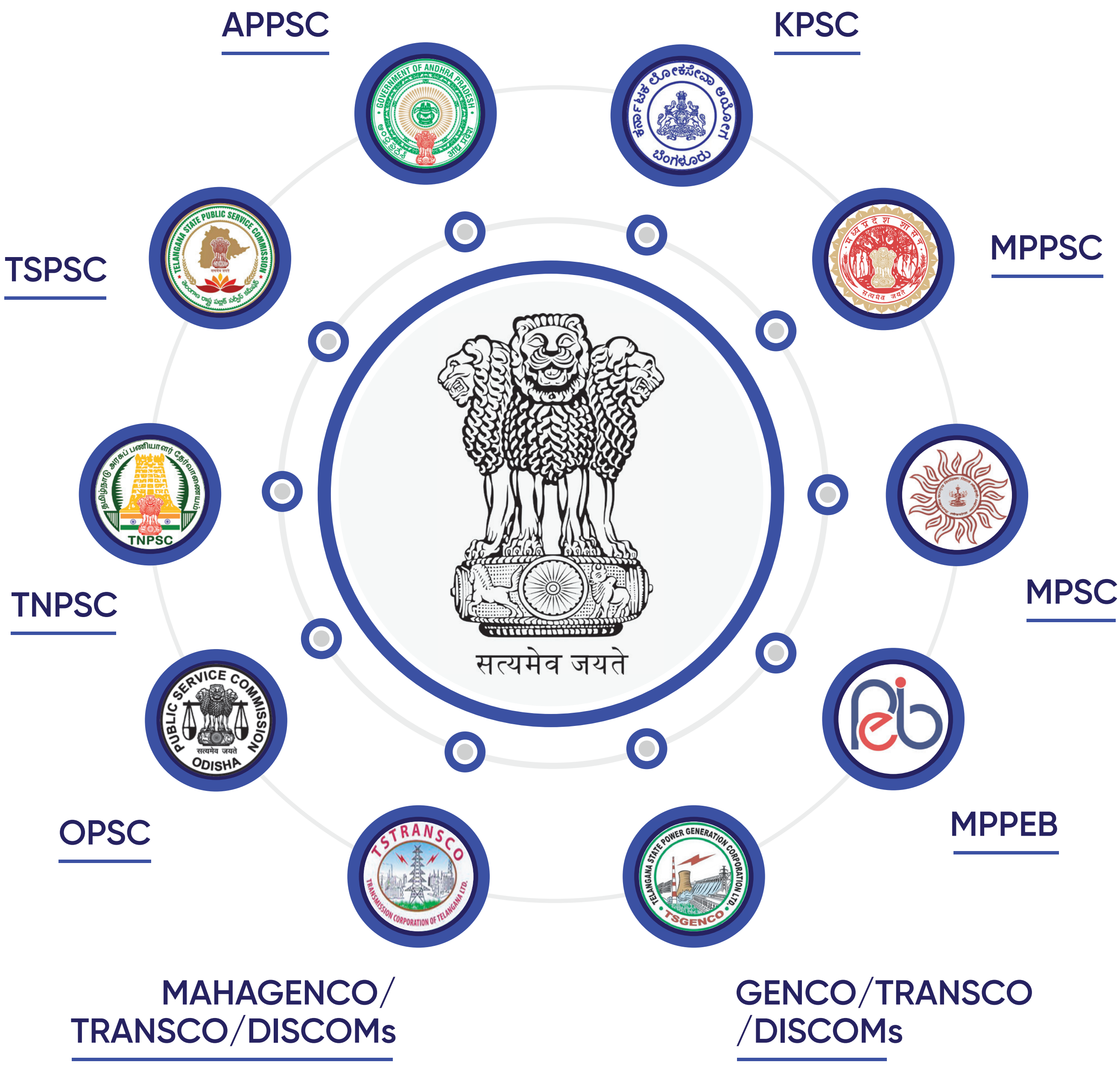
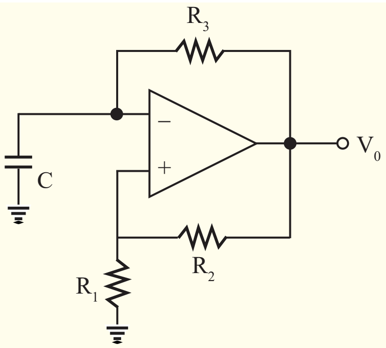




Case I: The duration of positive half cycle, T_1 is given by

$$T_1 = R_3C.\ln\left(\frac{1+\beta}{1-\beta}\right), \text{ where } \beta = \frac{R_1}{R_1+R_2}$$

Case II: The duration of negative half cycle, T_2 is given by

$$T_2 = R_3C.\ln\left(\frac{1+\beta}{1-\beta}\right)$$

Case III: Total period of output

$$T = T_1 + T_2 = 2R_3C\ln\left(\frac{1+\beta}{1-\beta}\right)$$

$$= 2R_3C\ln\left(\frac{1+\frac{R_1}{R_1+R_2}}{1-\frac{R_1}{R_1+R_2}}\right)$$

$$T = 2R_3C\ln\left(1+\frac{2R_1}{R_2}\right)$$

87 Which bridge can be used for measuring relative permeability?

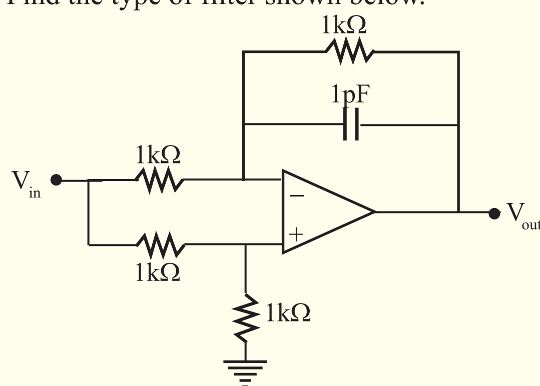
(a) Schering (b) Anderson

(c) Wheatstone (d) Kelvin

87. Ans: (b)

Sol: The relative pemeability is measured by Anderson's bridge. Schering bridge is measured capacitance and relative permittivity. Wheatstone bridge is measured medium resistance. Kelvin bridge is measured low resistance.

88. Find the type of filter shown below.

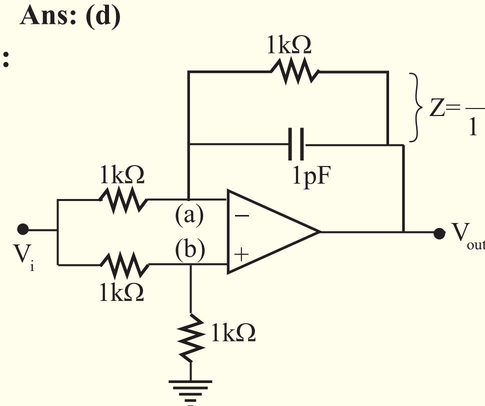


(a) Band-pass filter (b) Band-stop filter

(c) Low-pass filter (d) High-pass filter

88. Ans: (d)

Sol:



$$Z = \frac{R}{1+SCR}$$

Let R = 1K, C = 1 pF

Since $V_d = 0$, $V_a(s) = V_b(s)$

$$V_b(s) = \frac{V_i(s)}{2}$$

KCL at (a) $\frac{V_i - V_a}{R} = \frac{V_a - V_0}{z}$

$$\frac{V_i(s)-V_a(s)}{R}=\frac{V_a(s)-V_0(s)}{\frac{R}{1+SCR}}$$

$$V_i(s)-V_a(s)=(1+SCR)\,V_a(s)-V_0(s).\,(1+SCR)$$

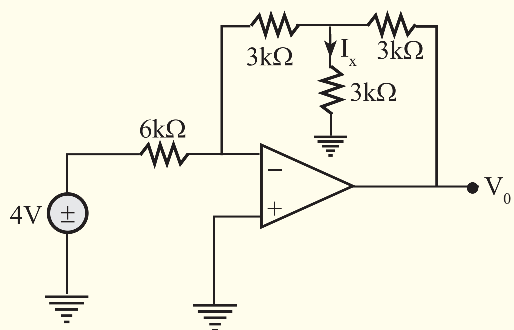
$$V_0(s)\,(1+SCR)=(2+SCR)\,V_a(s)-V_i(s)$$

$$=2V_a(s)+SCR\,V_a(s)-V_i(s)$$

$$=\frac{SCR}{2}\;V_i(s)$$

$$\frac{V_0(s)}{V_i(s)}=\frac{1}{2}\left(\frac{SCR}{1+SCR}\right)\leftarrow \text{HPF}$$

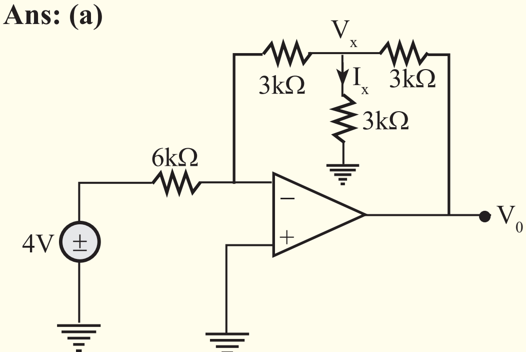
89. For the circuit below, find the value of current I_x.



(a) –0.67 mA (b) –0.33mA
(c) 0.33mA (d) 0.67mA

89. Ans: (a)

Sol:



$$\frac{0-4}{6k}+\frac{0-V_x}{3k}=0$$

$$\frac{V_x}{3k}=\frac{-4}{6k}$$

$$V_x=\frac{-12}{6}\Rightarrow V_x=-2V$$

$$I_x=-\,2V/3k$$

$$I_x=-\,0.67\text{ mA}$$

90. Which of the following could be the effect of using high-speed circuit breakers in a power system?

(a) Increased short circuit current
(b) Reduced system reliability
(c) Improved system stability
(d) Reduced short circuit current

90. Ans: (c)

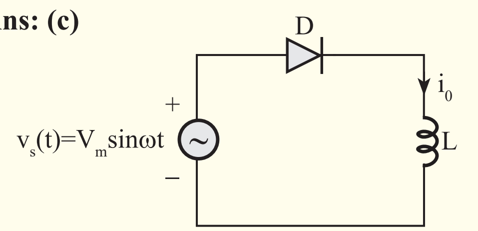
Sol: To improve the stability of the system high speed and auto reclosing circuit breakers are used.

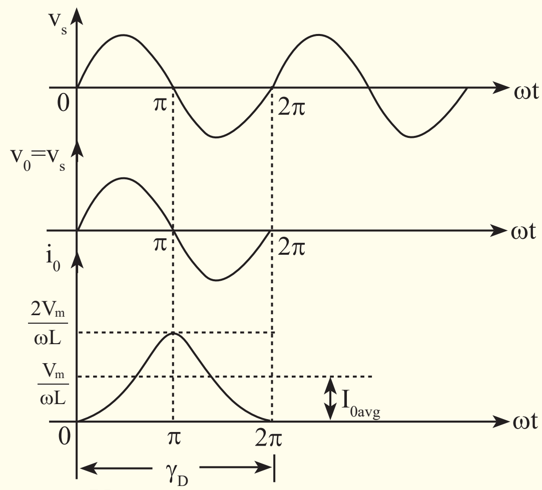
91. An ideal diode connected in series with a pure inductance is supplied from an ideal AC voltage source. Then for what duration in radians will the diode conduct, with respect to the AC voltage waveform?

(a) $\pi/2$ (b) $\pi/4$
(c) 2π (d) π

91. Ans: (c)

Sol:





$i_0(t) = \frac{V_m}{\omega_L}[1-\cos\omega t]$

Conduction angle of diode (D) = $\gamma_D = 2\pi - 0 = 2\pi$

92. The impedance of a three phase transmission line in ohms is given as $Z_{line} = 5 + j10$. If the line delivers 100 MVA of power at 400 kV, what would be the transmission power loss in the line?

(a) 356 kW (b) 104 kW
(c) 621 kW (d) 210 kW

92. Ans: (b)

Sol: $S = \sqrt{3}\ V_L \cdot I_L$

$$I_L = \frac{100\times10^6}{\sqrt{3}\times400\times10^3}$$

$$P_{Loss} = I_L^2 \cdot R$$

$$= \left(\frac{100\times10^6}{\sqrt{3}\times400\times10^3}\right)^2 \times 5$$

$P_{Loss/ph} = 104.17$ kW/ph

$P_{Loss(T)} = 312.51$ kW

93. The characteristic polynomial of a linear system is given as $s^4 + 3s^3 + 5s^2 + 6s + K + 10 = 0$. What should be the condition on K so that the system is stable?

(a) $K > -10$ (b) $-10 < K < -4$
(c) $K > 10$ (d) $K > -4$

93. Ans: (b)

Sol: Given C.E. = ⇒ $s^4+3s^3+5s^2+6s+(k+10) = 0$

s^4	1	5	$k+10$
s^3	3	6	0
s^2	3	$k+10$	
s^1	$-(k+4)$	0	
s^0	$k+10$		

For stability $k + 10 > 0$ and $(k + 4) < 0$

$k > -10$ and $k < -4$

Condition for stability

$-10 < K < -4$

94. Consider the following statements about the armature mmf wave in a dc machine

A. The mmf waveform has a sinusoidal shape.
B. The mmf waveform has a triangular shape.
C. The mmf waveform rotates with respect to the armature
D. The armature waveform rotates wtih respect to the stator.

Which of the above statements is/are true?

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

94. Ans: (a)

Sol: The armature mmf is triangular and rotates w.r.t armature.

95. In a grid-connected synchronous generator working at unity power factor, increasing the field excitation has the effect of

(a) Increasing both active power and reactive power supplied to the grid

(b) Increasing the operating frequency of the grid.

(c) Increasing only the active power supplied to the grid

(d) Increasing only the reactive power supplied to the grid

95. Ans: (d)

Sol: A synchronous generator connected to the grid by changing excitation with constant primemover input results only change in its reactive power, but no change in its frequency and active power.

96. A voltage source inverter is most suitable in applications where

(a) Both source and load have large inductances

(b) Both source and load have small inductances

(c) Source has a large inductance and the load has a small inductance

(d) Source has a small inductance and load inductance is large

96. Ans: (d)

Sol: Voltage source inverters (VSI) are suitable for inductive loads.

In VSI circuit, source has a small inductance and load has large inductance.

97. Which of the following is the function of an R-C snubber circuit connected in parallel to an SCR?

(a) Forced commutation of the SCR

(b) Limiting the di/dt through the SCR

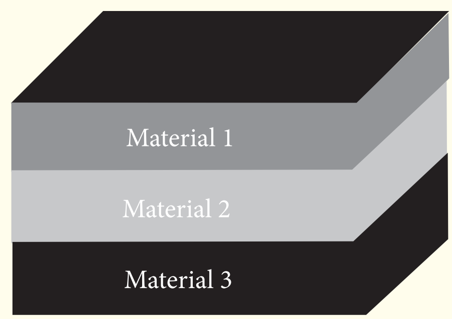
(c) Triggering the SCR

(d) Preventing over voltages across the SCR

97. Ans: (d)

Sol: R-C snubber circuit connected in parallel to an SCR to protect the SCR against high $\frac{dv}{dt}$ protection and avoiding the false triggering.

98. A parallel plate capacitor is made with three dielectrics placed between two metal electrodes.



The thickness of Material 1, Material 2 and Material 3 is d_1, d_2, d_3 respectively. The dielectric constant for Material 1, Material 2 and Material 3 is ε_1, ε_2, ε_3 respectively. The capacitance per unit area of this system is given by

(a) $C = \left[\frac{d_1}{\varepsilon_1} + \frac{d_3}{\varepsilon_3}\right]^{-1}$

(b) $C = \frac{d_1}{\varepsilon_1} + \frac{d_3}{\varepsilon_3}$

(c) $C = \left[\frac{d_1}{\varepsilon_1} + \frac{d_2}{\varepsilon_2} + \frac{d_3}{\varepsilon_3}\right]^{-1}$

(d) $C = \frac{d_1}{\varepsilon_1} + \frac{d_2}{\varepsilon_2} + \frac{d_3}{\varepsilon_3}$

98. Ans: (c)

Sol: As dielectric interface is parallel to metal plates, this configuration is series combination of 3 capacitors.

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

$$\frac{1}{C_{eq}} = \frac{1}{\left(\frac{\varepsilon_1 A}{d_1}\right)} + \frac{1}{\left(\frac{\varepsilon_2 A}{d_2}\right)} + \frac{1}{\left(\frac{\varepsilon_3 A}{d_3}\right)}$$

$$\frac{1}{C_{eq}} = \left(\frac{d_1}{\varepsilon_1} + \frac{d_2}{\varepsilon_2} + \frac{d_3}{\varepsilon_3}\right)\frac{1}{A}$$

$$C_{eq} = A\left[\frac{d_1}{\varepsilon_1} + \frac{d_2}{\varepsilon_2} + \frac{d_3}{\varepsilon_3}\right]^{-1}$$

Capacitance per unit area is

$$C'_{eq} = \frac{C_{eq}}{A} = \left[\frac{d_1}{\varepsilon_1} + \frac{d_2}{\varepsilon_2} + \frac{d_3}{\varepsilon_3}\right]^{-1}$$

99. A two port network has the following impedance parameters (all in Ω) $z = \begin{bmatrix} 10^2 & 1 \\ -10^5 & 10^3 \end{bmatrix}$

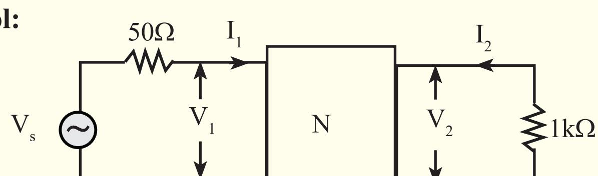
The input is connected to a sinusoidal voltage source V_s, having 50Ω of series resistance. A 1k Ω load resistance is connected. Calculate the voltage gain of the network

(a) $G_v = 10^5$ (b) $G_v = -10^5$

(c) $G_v = -\frac{1000}{3}$ (d) $G_v = \frac{1000}{3}$

99. Ans: (c)

Sol:



$$V_2 = -I_2(1k)$$

$$Z = \begin{bmatrix} 10^2 & 1 \\ -10^5 & 10^3 \end{bmatrix}$$

$$V_1 = 10^2 I_1 + (1)I_2$$

$$V_2 = -10^5 I_1 + 10^3 I_2$$

$$-I_2 \times 1k = -10^5 I_1 + 10^3 I_2$$

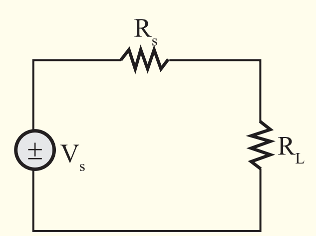
$$10^5 I_1 = 2 \times 10^3 I_2 \Rightarrow I_2 = 50 I_1$$

$$V_1 = 100 I_1 + I_2 = \frac{100 I_2}{50} + I_2 = 3I_2$$

$$V_1 = 3\left(\frac{-V_2}{1000}\right)$$

$$\text{Voltage gain } (G_V) = \frac{V_2}{V_1} = \frac{-1000}{3}$$

100. Consider a circuit shown below with DC supply (V_S = 5V). The series resistance (R_S) of 5Ω is connected as shown. Maximum power dissipated in the R_L is

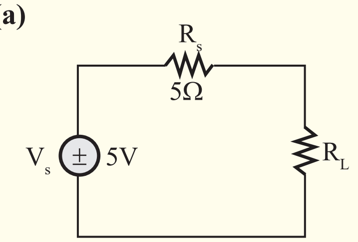


(a) 1.25 W (b) 0.00125 W

(c) 0.0125 W (d) 0.125 W

100. Ans: (a)

Sol:



For maximum power transfer, $R_L = R_S$

$$P_{max} = \frac{V_s^2}{4R_s} = \frac{(5)^2}{4\times 5} = 1.25 \text{ Watts}$$

101. The Laplace transform of the differential equation $y'' + ay' + by = f(t)$. Assume that $y(0) = 5$, $y'(0) = 10$, $Y(s)$ and $F(s)$ are the Laplace transforms of $y(t)$ and $f(t)$ respectively

(a) $s^2Y + 5s + 10 + a(sY + 5) + bY = R(s)$
(b) $s^2Y + 10s + 5 + a(sY + 10) + bY = R(s)$
(c) $s^2Y - 5s - 10 + a(sY - 5) + bY = R(s)$
(d) $s^2Y - 10s - 5 + a(sY - 10) + bY = R(s)$

101. Ans: (c)

Sol: $y''+ay'+by = f(t)$

apply Laplace transforms on both sides

$s^2 Y(s) - sy(0) - y'(0) + a(sY(s)-y(0)) + bY(s) = F(s)$

$s^2 Y(s) - 5s - 10 + a(sY(s)-5) + bY(s) = F(s)$.

102. Consider the following devices and their characteristics

A. Schottky Diode
B. Silicon Controlled Rectifier
C. IGBT
D. BJT

1. Current controlled turn-on and turn-off
2. Majority carrier device
3. Voltage controlled turn-on and turn-off
4. Four layer device structure

Choose the option in which all the items are correctly matched.

(a) A-4, B-2, C-1, D-3
(b) A-2, B-1, C-3, D-4
(c) A-1, B-2, C-3, D-4
(d) A-2, B-4, C-3, D-1

102. Ans: (d)

103. The maximum efficiency of a single phase transformer operating at unity power factor is found to be 90% under full load conditions. The efficiency at half load at the same power factor would be

(a) 88.3% (b) 90%
(c) 84.5% (d) 87.8%

103. Ans: (d)

Sol: Assume transformer rating = 1 kVA

$$0.9 = \frac{1\times1\times1}{1\times1\times1+2W_i} \Rightarrow 2W_i = 0.11$$

$W_{cu} = W_i = 0.055$ pu.

$$\eta_{1/2full} = \frac{\frac{1}{2}\times1\times1}{\frac{1}{2}\times1\times1+0.055+\frac{1}{4}\times0.055}\times100$$

$= 87.8\%$

104. In a single-phase SCR based full-converter with continuous conduction operating with firing angle α, what is the angle duration of conduction for each pair of SCRs in radians ?

(a) π (b) α
(c) $\pi - \alpha$ (d) $\pi + \alpha$

104. Ans: (a)

Sol: 1-ϕ full converter

Highly inductive load

T_1, T_2 conducts for α to $\pi+\alpha$ and T_3, T_4 conducts for $\pi+\alpha$ to $2\pi+\alpha$.

$$\gamma_{(T_1/T_2)} = (\pi+\alpha)-\alpha = \pi$$

$$\gamma_{(T_3/T_4)} = (2\pi+\alpha)-(\pi+\alpha) = \pi$$

Each pair of SCR conduct for π rad

105. Consider a linear system represented in state space form as shown below:

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -3 & -6 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$$

$y = [1 \;\; 0]\, x$

Which of the following is true for this system?

(a) The system is stable, controllable and observable
(b) The system is stable and observable, but not controllable
(c) The system is stable and controllable but not observable
(d) The system is controllable and observable, but unstable

105. Ans: (a)

Sol: Given $A = \begin{bmatrix} 0 & 1 \\ -3 & -6 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 0 \end{bmatrix}, C = [1 \; 0]$

C.E. $\Rightarrow |SI - A| = 0$

$$[SI - A] = S\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} - A$$

$$[SI - A] = \begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} - \begin{bmatrix} 0 & 1 \\ -3 & -6 \end{bmatrix} = \begin{bmatrix} s & -1 \\ 3 & s+6 \end{bmatrix}$$

$$\text{C.E.} \Rightarrow \begin{vmatrix} s & -1 \\ 3 & s+6 \end{vmatrix} = 0$$

C.E. $\Rightarrow s(s + 6) + 3 = 0$

C.E. $\Rightarrow s^2 + 6s + 3 = 0$

Roots are Negative, lies in the Left half of s-plane hence given system is stable.

Controllability: $\Rightarrow M_c = [B \;\; AB]$

$$\text{Now A.B.} = \begin{bmatrix} 0 & 1 \\ -3 & -6 \end{bmatrix}\begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ -3 \end{bmatrix}$$

$$M_c = \begin{bmatrix} 1 & 0 \\ 0 & -3 \end{bmatrix}$$

$|M_c| = \phi \times (-3) - 0 \neq 0 \Rightarrow$ Controllable

Observability:- $M_o = [C^T \; A^T \, C^T]$

$$\text{Now } A^T.\, C^T = \begin{bmatrix} 0 & -3 \\ 1 & -6 \end{bmatrix}\begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

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

$|M_o| = 1 \times 1 - 0 = 1 \neq 0 \Rightarrow$ Observable

106. A three-phase induction motor rated at 15hp, 440V has an efficiency of 85% and operates at a power factor of 0.9 (lag), while delivering rated output power. What would be the reactive power drawn by the motor under this condition ?

(a) 8.21kVAr (b) 5.11kVAr
(c) 7.42kVAr (d) 6.38kVAr

106. Ans: (d)

Sol: $\eta = \dfrac{\text{output}}{\text{input}} = \dfrac{15 \times 746}{0.85}$

$\Rightarrow \sqrt{3} \times 440 \times I_2 \times 0.9 = 13164.7$

$I_2 = 19.19$ A

$\therefore Q = \sqrt{3}\, VI \sin\phi$

$= \sqrt{3} \times 440 \times 19.19 \times 0.436 = 6376.4$ VAR

107. A dc shunt motor supplied from a 220 V DC input supply runs at 1200 rpm. Neglecting all losses and saturation, what would be the speed when the same motor is supplied from a 175 V DC input?

(a) 1200 rpm (b) 1100rpm
(c) 750 rpm (d) 950 rpm

107. Ans: (a)

Sol: The speed of shunt motor is almost same with change in voltage.

108. 4 μA current flows through a conductor for 4s. Find the number of electrons passed through the conductor.
   (a) $1e^{14}$ (b) $16e^{14}$
   (c) $16e^{-6}$ (d) 16

108. Ans: (a)

Sol:
$$I = \frac{Q}{t}$$
$$I = \frac{ne}{t}$$
$$n = \frac{I \times t}{e}$$
$$= \frac{4 \times 10^{-6} \times 4}{1.6 \times 10^{-19}}$$
$$\therefore n = 1 \times 10^{14}$$

109. Two 10-bit ADCs, one of successive approximation type and other of single slope integrating type, take Ta and Tb time respectively to convert 3V analog input signal to digital output. If the input analog signal is increased to 6V, the approximate time taken by the two ADCs will respectively be
   (a) 2Ta, Tb (b) 2Ta, 2Tb
   (c) Ta, Tb (d) Ta, 2Tb

109. Ans: (d)

Sol: In successive approx-type ADC, $T_{conv} = n.T_C$ to the conversion time is independent on input voltage.
- In a single slope ADC, the conversion time is proportional to input analog sample magnitude and it is having linear relationship hence when V_a is changing from 3 V to 6 V
  T_a becomes T_a (in successive ADC)
  T_b becomes $2T_b$ (in single slope ADC)

110. A bipolar junction transistor is
   (a) a charge-controlled device
   (b) a field-controlled device
   (c) a voltage-controlled device
   (d) a current-controlled device

110. Ans: (d)

Sol: In a BJT, input current controls the output current, hence it is considered as a current - controlled device.

111. What is the way of imparting braking action of three phase induction motor in plugging scheme?
   (a) By reversal of the phase sequence of the stator
   (b) By increasing the stator voltage magnitude
   (c) By decreasing the stator voltage magnitude
   (d) By decreasing synchronous speed

111. Ans: (a)

Sol: Plugging is possible by reversal of phase sequence of stator supply

112. Which of the following statements is correct in the case of multi-loop based close-loop control of DC and AC drives having speed and current feedbacks?
   (a) Current control loop is faster than the speed control loop
   (b) Output of current control provides the reference speed
   (c) Speed control loop is faster than the current control loop
   (d) Speed control and current control loops have equal bandwidth.

Staff Selection Commission JE

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- Border Roads Organisation

CUT-OFF MARKS

CE - PAPER-1

Category	2020	2019	2018	2017	2016
UR	120.02	123.52	127.4	136.25	100
OBC	114.21	115.93	122.91	133.25	92.5
EWS	108.14	112.28	118.99	–	–
SC	99.15	101.70	107.61	120	84.5
ST	99.15	102.61	107.01	114.5	85.5
OH	79.83	92.24	–	113	72.5
HH	48.86	55.73	–	83.5	40

ME | EE - PAPER 1

Category	2020	2019	2018	2017	2016
UR	141.59	157.47	152.16	117c	115
OBC	137.46	153.26	149.3	110.75	109.5
EWS	131.23	151.04	147.47	–	–
SC	123.23	140.59	133.39	101.75	99
ST	115.34	135.88	125.49	105	94.5
OH	99.43	127.29	–	91.5	87
HH	63.07	92.49	–	61.75	54

112. Ans: (a)

Sol: This is the multi loop system where in this speed control have two loops one is the outer loop that is the speed control loop second one is inner loop that is the current control loop. And on the output of current control loop our speed control loop output depends then current control loop is faster than the speed control loop.

113. What happens in coasting mode of an electric traction?

(a) Regenerative braking is provided to recover the energy from locomotive
(b) Continuous power is provided by the electric drive to maintain the locomotive speed
(c) The power supply is cut off and the train is allowed to run with its own inertia
(d) Electric drive accelerates the motor from standstill condition to the rated speed

113. Ans: (c)

Sol: During coasting period the power supply to the motor will be cut off and the train runs due to the momentum attained at that particular instant.

114. What is the status of machine flux, for the range of frequency above the rated (base) frequency, in the case of a speed regulated V/f controlled induction motor drive?

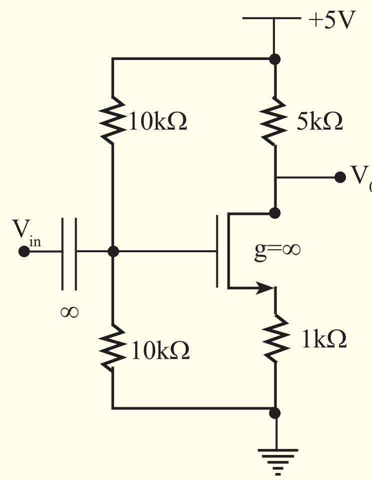
(a) Machine flux unchanged
(b) Machine flux may increase or decrease based on load
(c) Machine flux increases from the rated flux
(d) Machine flux decreases from the rated flux

114. Ans: (d)

Sol: $\downarrow B_{max} \propto \dfrac{V}{f\uparrow}$

As frequency increases, flux also decreases.

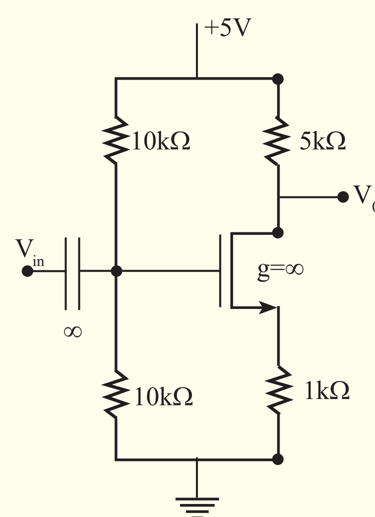
115. What is the small-signal gain of below circuit?



(a) –4 (b) –5
(c) 4 (d) 5

115. Ans: (b)

Sol:



The given circuit is common-source (CS) amplifier with unbypassed R_s.

The formula for small - signal gain in such circuit is, $A_V = -\frac{g_m R_D}{1+g_m R_S}$ .... (1)

$$A_V = -\frac{g_m R_D}{g_m R_S} \quad .... \quad (2)$$

$[\because g_m = \infty \Rightarrow g_m R_S >> 1]$

$$A_V = -\frac{R_D}{R_S}$$

$$A_V = -\frac{5k}{1k} = -5 \quad .... \quad (3)$$

116. The following gates are designated as Universal Gates

(a) NOR and NAND

(b) NOT, OR and AND

(c) XOR, OR and AND

(d) XNOR, NOR and NAND

116. Ans: (a)

Sol: NAND & NOR gates are universal gates.

117. In a three-phase bridge inverter operating in the square wave mode, the output voltage waveform contains

(a) Only even order harmonics

(b) Both even and odd order harmonics, but no triplen harmonics

(c) Only triplen order harmonics

(d) Only odd order harmonics

117. Ans: (d)

Sol: In 180° square waveform is symmetric then all even harmonics are absent. Only odd order harmonics are present.

118. An electric machine wherein the self-inductances of both stator and rotor windings are independent of the rotor position will NOT develop any

(a) Hysteresis torque

(b) Synchronizing torque

(c) Starting torque

(d) Reluctance torque

118. Ans: (d)

119. If the Nyquist plot of the open loop transfer function G(s)H(s) of a system passes through the −1 + j0 point, then the phase margin of this system is likely to be

(a) 90 degrees (b) 45 degrees

(c) 180 degrees (d) 0 degree

119. Ans: (d)

Sol: If system passes through (−1 + j0) then system is marginal stable [M.S.]

For M.S. ⇒ G.M. = 0 dB and P.M.= 0^o

120. At low values of operating slip, the torque developed in a three-phase induction motor is

(a) inversely proportional to slip

(b) proportional to the square of slip

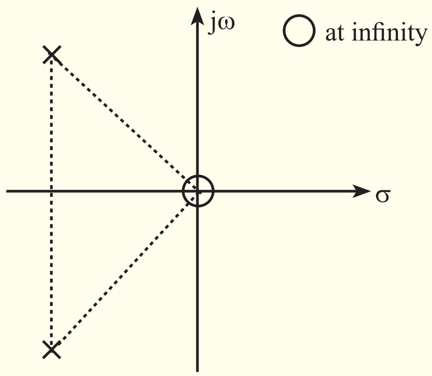
(c) linearly proportional to slip

(d) independent of slip

120. Ans: (c)

Sol: For low value of slip region, $T_{em} \propto S$.

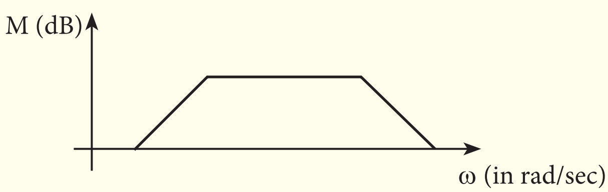
121. The pole zero plot shown below represents a system whose frequency response is approximately that of a



(a) Notch filter (b) Bandpass filter
(c) Low pass filter (d) High pass filter

121. Ans: (c)

Sol: The Bode magnitude plot for given pole-zero plot is shown below.



So, it is Band-pass filter

122. If P_e and P_h denote the eddy current loss and hysteresis loss in a magnetic core operating with an alternating flux density waveform of frequency f, then

(a) P_e and P_h are both proportional to f^2
(b) The total loss $(P_e + P_h)$ is proportional to f
(c) P_e is proportional to f and P_h is proportional to f^2
(d) P_e is proportional to f^2 and P_h is proportional to f

122. Ans: (d)

Sol: $P_h \propto f$

$P_e \propto f^2$ (at constant B_{max})

123. Consider a coaxial cable having inner radius of 0.8mm and outer radius of 4 mm and filled with a material having a relative permeability of 50. The self-inductance will be

(a) 32.2μH/m (b) 32.2μH
(c) 16.1μH/m (d) 16.1μH

123. Ans: (c)

Sol: Inductance per unit length, of coaxial cable is given by

$$L' = \frac{\mu_0\mu_r}{2\pi}\ln\left(\frac{b}{a}\right)$$

$$= \frac{4\pi\times10^{-7}\times50}{2\pi}\ln\left(\frac{4}{0.8}\right)$$

$$= 100\times10^{-7}\times\ln(5)$$

$$= (10^{-6})\times10\times1.61$$

$$\therefore L' = 16.1\mu H/m$$

124. A set of 4-point charges of 3μC are placed at (1, 1, 0), (–1, 1, 0), (–1, –1, 0) and (1, –1, 0) in a space with relative permittivity of 2. Calculate the resultant electric field at the (1, 1, 1).

(a) $\vec{E} = 16.4\,\hat{x} + 16.4\,\hat{y} + 3.41\,\hat{z}$ kV/m
(b) $\vec{E} = -16.4\,\hat{x} - 16.4\,\hat{y} + 3.41\,\hat{z}$ kV/m
(c) $\vec{E} = -3.41\,\hat{x} - 3.41\,\hat{y} + 16.4\,\hat{z}$ kV/m
(d) $\vec{E} = 3.41\,\hat{x} + 3.41\,\hat{y} + 16.4\,\hat{z}$ kV/m

124. Ans: (d)

Sol: $\vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \vec{E}_4$

$$\vec{E} = \frac{9\times10^9\times3\times10^{-6}}{2}\left[\frac{1}{(1)^2}\left(\frac{\hat{a}_z}{(1)}\right) + \frac{1}{(\sqrt{5})^2}\frac{(2\hat{a}_x+\hat{a}_z)}{(\sqrt{5})} + \frac{1}{(3)^2}\left(\frac{2\hat{a}_x+2\hat{a}_y+\hat{a}_z}{(3)}\right) + \frac{1}{(\sqrt{5})^2}\frac{(2\hat{a}_y+\hat{a}_z)}{(\sqrt{5})}\right]$$

$$= \frac{27\times10^3}{2}\left[\hat{a}_z + \frac{2\hat{a}_x}{5\sqrt{5}} + \frac{\hat{a}_z}{5\sqrt{5}} + \frac{2\hat{a}_x}{27} + \frac{2\hat{a}_y}{27} + \frac{\hat{a}_z}{27} + \frac{2}{5\sqrt{5}}\hat{a}_y + \frac{1}{5\sqrt{5}}\hat{a}_z\right]$$

$$= \frac{27\times10^3}{2}\left[\left(\frac{2}{5\sqrt{5}}+\frac{2}{27}\right)\hat{a}_x + \left(\frac{2}{27}+\frac{2}{5\sqrt{5}}\right)\hat{a}_y + \left(1+\frac{1}{5\sqrt{5}}+\frac{1}{27}+\frac{1}{5\sqrt{5}}\right)\hat{a}_z\right] \text{V/m.}$$

$$\therefore \overline{E} = 3.41\hat{x} + 3.41\hat{y} + 16.4\hat{z}\,\text{kV/m.}$$

125. Any periodic function f(x) with a period of 2L can be written as

$$f(x) = k + \sum_{i=1}^{\infty}\left(a_i\cos\left(\frac{i\pi}{L}x\right) + b_i\sin\left(\frac{i\pi}{L}x\right)\right)$$

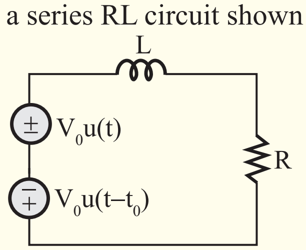
Given that f(x) is an even function. Which of the following option is correct ?

(a) $b_i = 0$ (b) $k \neq 0, a_i \neq 0, b_i \neq 0$
(c) $k = 0$ (d) $a_i = 0$

125. Ans: (a)

Sol: For an even periodic signal $b_i = 0\ \forall\ i$.

126. Consider a series RL circuit shown below



u(t) and $u(t - t_0)$ are unit step functions. The current flowing through the resistance R at time t > 0 is given by

(a) $i(t) = \frac{V}{R}e^{\frac{Rt_0}{L}}\left(e^{\frac{-Rt}{L}} - 1\right)$

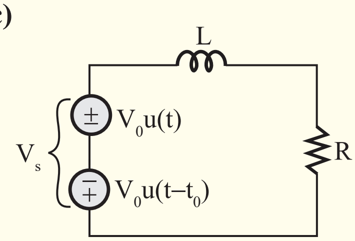
(b) $i(t) = \frac{V}{R}e^{\frac{-Rt_0}{L}}\left(e^{\frac{-Rt}{L}} - 1\right)$

(c) $i(t) = \frac{V}{R}e^{\frac{-Rt}{L}}\left(e^{\frac{Rt_0}{L}} - 1\right)$

(d) $i(t) = \frac{V}{R}e^{\frac{-Rt}{L}}\left(e^{\frac{-Rt_0}{L}} - 1\right)$

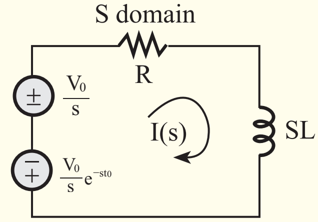
126. Ans: (c)

Sol:



$$V_s = V_0u(t) - V_0u(t - t_0)$$

S domain



$$\frac{V_0}{s} - \frac{V_0}{s}e^{-st_0} = I(s)(R + SL)$$

$$I(s) = \frac{V_0}{s}\frac{(1-e^{-st_0})}{(R+sL)} = \frac{V_0}{L}\left[\frac{1}{s\left(s+\frac{R}{L}\right)}\right](1-e^{-st_0})$$

$$I(s) = \frac{V_0}{R}\left[\frac{1}{s} - \frac{1}{s+\frac{R}{L}}\right](1-e^{-st_0})$$

$$I(s) = \frac{V_0}{R}\left[\frac{1}{s} - \frac{1}{s}e^{-st_0} - \frac{1}{\left(s+\frac{R}{L}\right)} + \frac{1}{\left(s+\frac{R}{L}\right)}e^{-st_0}\right]$$

By I.LT, $i(t) = \frac{V_0}{R}\left(-e^{\frac{-R}{L}t} + e^{\frac{-R}{L}(t-t_0)}\right)$

$$i(t) = \frac{V_0}{R}e^{\frac{-R}{L}t}\left(e^{\frac{R}{L}t_0} - 1\right)$$

127. Calculate the amount of the point charge at the origin given that the potential at (–2, 3, 1) is 36 V and reference is taken to be at infinity.
(a) Q = 7.5 nC (b) Q =1.5 nC
(c) Q =15 nC (d) Q = 30 nC

127. Ans: (c)

Sol: $V = \dfrac{Q}{4\pi\varepsilon R}$

$R = \sqrt{(-2)^2 + (3)^2 + 1^2} = \sqrt{14}$

Given V = 36Volt

$36 = \dfrac{9\times10^9 Q}{\sqrt{14}}$

$Q = \dfrac{36\times\sqrt{14}}{9\times10^9}$

$\therefore Q \simeq 15nC$

128. A step up chopper delivers an average output voltage of 100 V from an input supply of 60 V when operating with a continuous source current. What is the operating duty ratio for the switch ?
(a) 2/3 (b) 1/3
(c) 0.6 (d) 0.4

128. Ans: (d)

Sol: Step up chopper

$V_0 = 100$ V, $V_s = 60$ V

D = ?

$V_0 = \dfrac{V_s}{(1-D)}$

$100 = \dfrac{60}{(1-D)}$

D = 0.4

129. For the parallel operation of 2 single-phase transformers with same voltage ratio and different kVA ratings, the load is shared by these transformers in proportion to their kVA ratings when the transformers have
(a) leakage reactance in ohms inversely proportional to their ratings.
(b) equal per unit impedances on their respective ratings.
(c) the same leakage reactance in ohms.
(d) the same magnetising reactance in ohms.

129. Ans: (b)

Sol: The two transformer's should have equal pu impedance based on their respective kVA ratings.

130. A three phase induction motor with a 6-pole winding is rotating at 1200 rpm. The speed of rotation in electrical and mechanical radians per second are respectively
(a) 40π, 40π/3 (b) 40π/3, 40π
(c) 120π, 40π (d) 40π, 120π

130. Ans: (c)

Sol: $\omega_m = \dfrac{2\pi N}{60}$ (mech)

$= \dfrac{2\pi\times1200}{60} = 40\pi$

$\omega_e = \dfrac{P}{2}\omega_m$

$= \dfrac{6}{2}\times40\pi$

$= 120\pi$

131. What is the SNR of an ideal 10 bit ADC ?
(a) 71.96 dB (b) 81.96 dB
(c) 51.96 dB (d) 61.96 dB

Railway Recruitment Board JE

About

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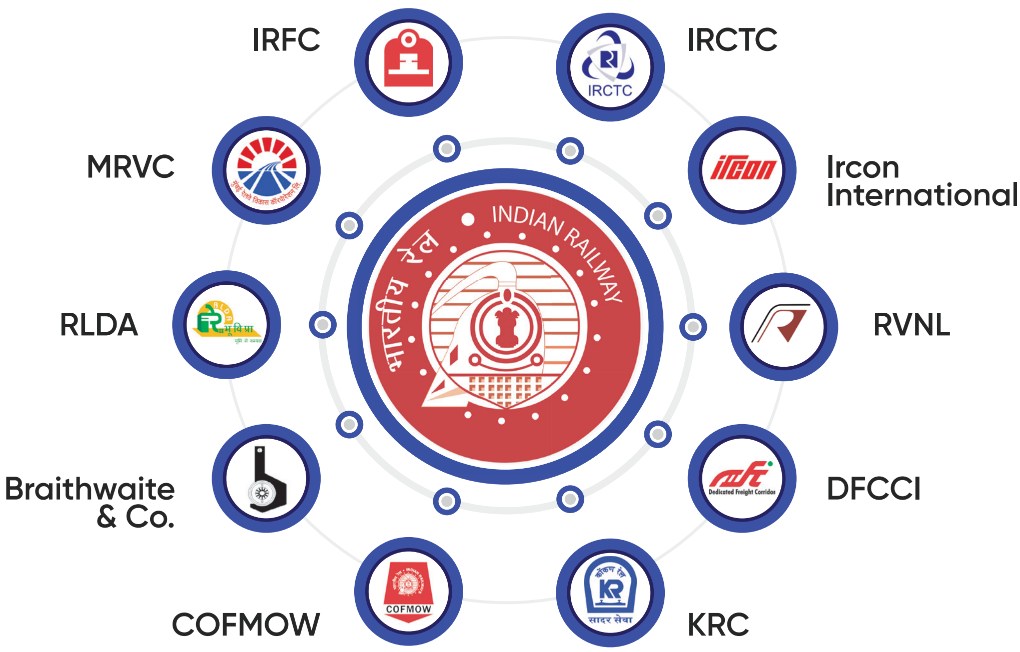


CUT-OFF MARKS

RRB JE CBT - 1

Category	Ahmedabad	Allahbad	Mumbai
Gen	53.25	74.67	65.4
SC	35.06	59.89	52.55
ST	41.59	51.48	44.025
OBC	39.86	62.61	54.01
-	-	-	-

RRB JE CBT - 2

Category	Min. Qualifying Perc	Min. Qualifying Marks (Out of 150)
Gen	40%	60
EWS	40%	60
SC	30%	45
ST	25%	37.5
OBC	30%	45

131. Ans: (d)

Sol: For an ideal n - bit ADC SNR is $6.02 \times n + 1.76$ dB.
For n = 10, SNR = 61.96 dB.

132. A motor-load combination operating in motoring mode (quadrant-1) has the following speed torque characteristics :
T(motor) = 0.1 N - 10 (N-m)
T(load) = 0.25 N - 75 (N-m)
where T(motor) is a motor torque in N-m,
T(load) is a load torque in N-m and N is a speed of the motor-load combination in RPM. What is the steady state speed of the system after exciting it ?
(a) 700 RPM (b) 666.3 RPM
(c) 433.3 RPM (d) 0 RPM

132. Ans: (c)

Sol: $T_M = 0.1\ N - 10$
$T_L = 0.25N - 75$
N = ?
At steady state
$T_M = T_L$
$0.1N - 10 = 0.25N - 75$
$\therefore\ 65 = 0.15\ N$
$$\therefore\ N = \frac{65}{0.15} = 433.33 \text{ rpm}$$

133. Which type of transformers is used in AC welding ?
(a) Step down type (b) Equal turns ratio type
(c) Ferrite core type (d) Step up type

133. Ans: (a)

Sol: The type of transformer used in the AC welding set is step down transformer. It will give low voltage and high current on secondary.

134. A 200 Volt, 1200 RPM, 100 Amp DC separately excited motor has an armature resistance of 0.1Ω. It is braked by plugging from initial speed of 1200 RPM. What is the external resistance to be placed in series with the armature circuit to limit the braking current to twice the full load value ?
(a) 10.2 Ω (b) 7.33 Ω
(c) 1.5 Ω (d) 3.8 Ω

134. Ans: (*)

Sol: $E_b = V - I_aR_a = 200 - 100 \times 0.1 = 190$ V
$$2I_a = \frac{V + E_b}{R_a + R_B} = \frac{200 + 190}{0.1 + R_B}$$
$\Rightarrow (200)\ (0.1 + R_B) = 390$
$\Rightarrow 20 + 200\ R_B = 390$
$R_B = 1.85\Omega$

135. A 200 Volt, 1000 RPM, 100 Amp separately excited dc motor has an armature resistance of 0.1 Ω. The motor is fed from a DC-DC step down chopper. The input dc source has a voltage of 300 Volt to this chopper. What is the duty cycle of the chopper for motoring operation at rated torque and speed of 500 RPM assuming operation with continuous conduction and field flux remains unchanged ?
(a) 0.50 (b) 0.35
(c) 0.25 (d) 0.84

135. Ans: (b)

Sol: Seperately excited dc motor,
$V_{a\ rated} = 200$ V, $N_{rated} = 1000$ rpm
$i_{a\ rated} = 100$ A, $R_a = 0.1\ \Omega$
Step down chopper
$V_s = 300$ V, D = ?
$T_2 = T_{rated}$, $N_2 = 500$ rpm

$\phi_2 = \phi_{rated}$

$E_{b\,rated} = V_{a\,rated} - i_{a\,rated}R_a$

$= 200 - 100 \times 0.1$

$E_{b\,rated} = 190$ V

$E_b \propto \phi N$

$E_b \propto N$

$\therefore \dfrac{N_2}{N_{rated}} = \dfrac{E_{b2}}{E_{b\,rated}}$

$\dfrac{500}{1000} = \dfrac{E_{b2}}{190}$

$\therefore \quad E_{b2} = 95$ V

$T \propto \phi i_a$ (Flux ϕ = constant)

$T \propto i_a$

$\dfrac{T_2}{T_{rated}} = \dfrac{i_{a2}}{i_{a\,rated}}$

$i_{a2} = i_{a\,rated} = 100$ A

$V_{a2} = E_{b2} + i_{a2}.R_a$

$= 95 + 100 \times 0.1$

$\therefore \; V_{a2} = 105$ V

Output of chopper $V_0 = V_{a2} = 105$ V

$V_0 = D.V_s$

$105 = D \times 300$

$\therefore D = 0.35$

136. In a long transmission line operating under lightly loaded conditions, the receiving end voltage is found to be higher than the sending end voltage. Which effect accounts for this phenomenon ?

(a) Proximity effect
(b) Skin effect
(c) Corona effect
(d) Ferranti effect

136. Ans: (d)

Sol: When a transmission line is operating under no-load or lightly loaded condition some times the receiving end voltage may be more than sending end voltage, this phenomenon is called as Ferranti effect.

137. Which of the following represents an expression for the damping factor in a series R-L-C circuit?

(a) $\dfrac{RC}{2L}$
(b) $R\sqrt{LC}$
(c) $\dfrac{R\sqrt{C}}{2\sqrt{L}}$
(d) $\dfrac{R\sqrt{C}}{2L}$

137. Ans: (c)

Sol: For RLC series circuit

Damping factor $\zeta = \dfrac{1}{2Q}$

$Q = \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$

$\zeta = \dfrac{R}{2}\sqrt{\dfrac{C}{L}}$

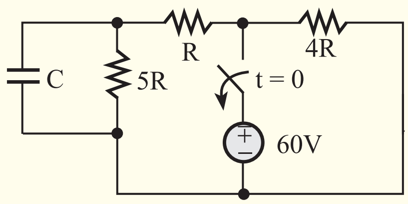
138. If the magnetic circuit in a dc machine is operating under saturated conditions, then the armature reaction in the machine results in

(a) decrease in the value of flux per pole
(b) increase or decrease depending on motoring or generating mode of operation
(c) increase in the value of flux per pole
(d) no change in the value of flux per pole

138. Ans: (a)

Sol: Due to armature reaction, the flux per pole reduces in both generator and motor.

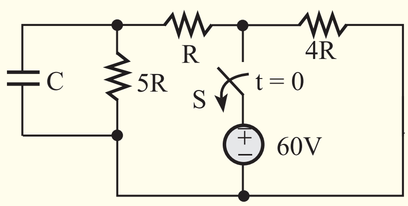
139. Initially the switch is closed, and steady state has been reached. At t = 0 the switch is opened. What is the voltage across the capacitor at $t = 0^+$?



(a) 0 V (b) 60 V
(c) 10 V (d) 50 V

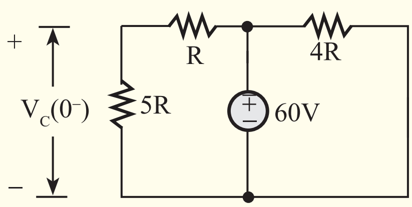
139. Ans: (d)

Sol:



For t < 0, 'S' is closed

At $t = 0^-$ [s-s] C → open circuit



By VDR, $V_C(0^-) = \dfrac{60 \times 5R}{5R + R} = 50$ Volts

$V_C(0^+) = V_C(0^-) = 50$ Volts

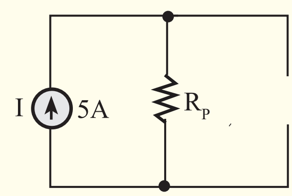
140. Which of the following is a characteristic of an ideal transformer ?

(a) Infinite core reluctance
(b) Zero stored magnetic energy
(c) Large magnetising current
(d) Zero core flux

140. Ans: (b)

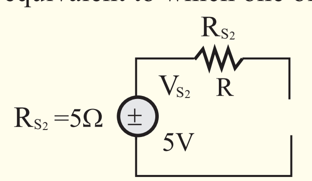
Sol: No energy will be stored (or) loss in magnetic material.

141. Consider a circuit below with $R_p = 5\Omega$.

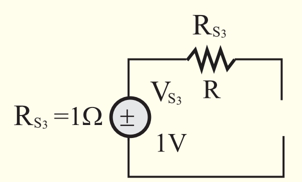


It is equivalent to which one of the following?

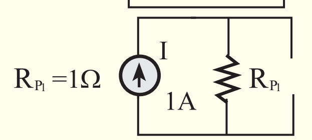
(a)



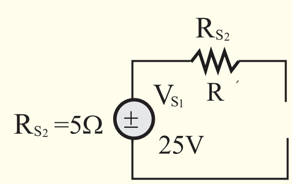
(b)



(c)

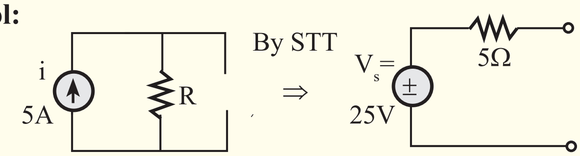


(d)



141. Ans: (d)

Sol:



142. Which of the following transformation between the z (impedance) and h (hybrid) parameters is correct?

(a) $z = \begin{bmatrix} \frac{h_{11}h_{22}-h_{12}h_{21}}{h_{22}} & \frac{-h_{12}}{h_{22}} \\ \frac{-h_{21}}{h_{22}} & \frac{1}{h_{22}} \end{bmatrix}$

(b) $z = \begin{bmatrix} \frac{h_{11}h_{22}-h_{12}h_{21}}{h_{22}} & \frac{h_{12}}{h_{22}} \\ \frac{h_{21}}{h_{22}} & \frac{1}{h_{22}} \end{bmatrix}$

(c) $z = \begin{bmatrix} \frac{h_{11}h_{22}-h_{12}h_{21}}{h_{22}} & \frac{h_{12}}{h_{22}} \\ \frac{-h_{21}}{h_{22}} & \frac{1}{h_{22}} \end{bmatrix}$

(d) $z = \begin{bmatrix} \frac{h_{11}h_{22}-h_{12}h_{21}}{h_{22}} & \frac{h_{12}}{h_{22}} \\ \frac{-h_{21}}{h_{22}} & \frac{-1}{h_{22}} \end{bmatrix}$

142. Ans: (c)

Sol: Z-parameter

$V_1 = Z_{11}I_1 + Z_{12}I_2$

$V_2 = Z_{21}I_1 + Z_{22}I_2$

h-parameter

$V_1 = h_{11}I_1 + h_{12}V_2$

$I_2 = h_{21}I_1 + h_{22}V_2$

For z-parameter

When $I_2 = 0$

$Z_{11} = \frac{V_1}{I_1}$

From h-parameter

$V_2 = \frac{-h_{21}}{h_{22}}I_1$

$V_1 = h_{11}I_1 - \frac{h_{12}h_{21}}{h_{22}}I_1$

$= I_1\left(\frac{h_{11}h_{22}-h_{12}h_{21}}{h_{22}}\right)$

$Z_{11} = \frac{V_1}{I_1} = \left(\frac{h_{11}h_{22}-h_{12}h_{21}}{h_{22}}\right)$

$Z_{21} = \frac{V_2}{I_1} = \frac{-h_{21}}{h_{22}}$

When $I_1=0 \Rightarrow Z_{12} = \frac{V_1}{I_2} = \frac{h_{12}V_2}{h_{22}V_2}$ (From h-parameter)

$Z_{22} = \frac{V_2}{I_2} = \frac{1}{h_{22}}\mho$

Z-parameter

$$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} \frac{h_{11}h_{22}-h_{12}h_{21}}{h_{22}} & \frac{h_{12}}{h_{22}} \\ \frac{-h_{21}}{h_{22}} & \frac{1}{h_{22}} \end{bmatrix}$$

143. Which of the following is correct regarding Eddy currents in the coil ?

(a) By making use of a laminated core, Eddy currents are increased

(b) Eddy currents converts useful energy into heat and waste it

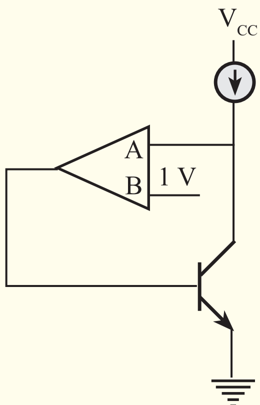
(c) Eddy currents flow in straight lines, like a wire and complete circuit path without power loss

(d) Eddy current helps in generating electrical energy

143. Ans: (b)

Sol: They will generate in the core and produces heat and wasted.

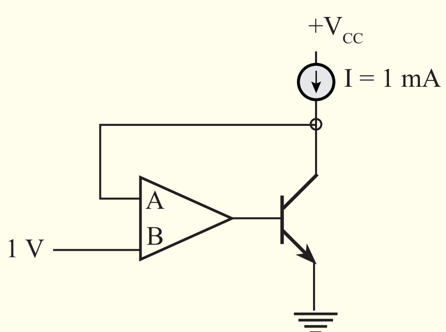
144. Find the polarity of op-amp input for negative feedback operation.



(a) The circuit will never operate in negative feedback
(b) The circuit will always operate in negative feedback irrespective of the op-amp input polarity
(c) A is positive and B is negative
(d) A is negative and B is positive

144. Ans: (c)

Sol:



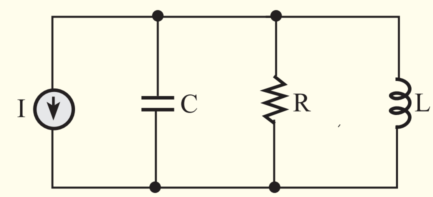
⇒ Inorder to turn ON the BJT, V_{BE} should be positive (or) V_{op} should be positive

⇒ If A is positive the loop gain can satisfy this condition

⇒ If A is positive then only the loop gain can be negative

'A' should be positive, 'B' should be negative

145. The resonance frequency, ω_0, for the circuit shown below is



(a) $\omega_0 = \dfrac{1}{\sqrt{LC}}$ Hz

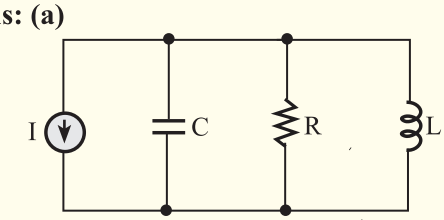
(b) $\omega_0 = \dfrac{1}{RC} + \dfrac{R}{L} + \dfrac{1}{\sqrt{LC}}$ Hz

(c) $\omega_0 = \dfrac{1}{RC}$ Hz

(d) $\omega_0 = \dfrac{R}{L}$ Hz

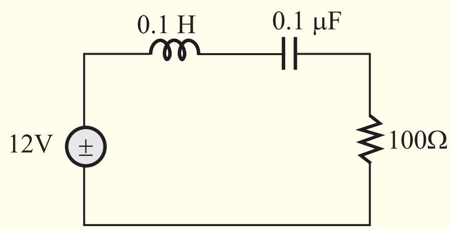
145. Ans: (a)

Sol:



Resonance frequency, $\omega_0 = \dfrac{1}{\sqrt{LC}}$ Hz

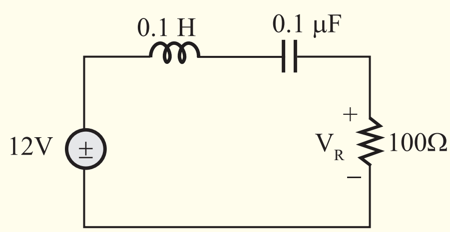
146. The output of the circuit is taken across the resistance. The bandwidth of the circuit shown is



(a) 1M rads (b) 10M rads
(c) 1k rads (d) 100k rads

146. Ans: (c)

Sol:



Bandwidth, $BW = \dfrac{\omega_0}{Q}$

$$= \frac{\omega_0}{\frac{\omega_0 L}{R}} = \frac{R}{L} = \frac{100}{0.1} = 1000 \text{ rad}$$

BW = 1 krad

147. The Fourier series of a function described below

$f(x) = x + \pi;\ -\pi < x < \pi$

$f(x + 2\pi) = f(x)$

is given by which of the following options ?

(a) $\pi + \sum_{n=1}^{\infty}\left(-\frac{2}{n}\sin(n\pi)\right)\cos(nx)$

(b) $\frac{\pi}{2} + \sum_{n=1}^{\infty}\left(-\frac{2}{n}\sin(n\pi)\right)\cos(nx)$

(c) $\pi + \sum_{n=1}^{\infty}\left(-\frac{2}{n}\cos(n\pi)\right)\sin(nx)$

(d) $\frac{\pi}{2} + \sum_{n=1}^{\infty}\left(-\frac{2}{n}\cos(n\pi)\right)\sin(nx)$

147. Ans: (c)

Sol: Time period T = 2π seconds

$$\text{DC value} = \frac{1}{2\pi}\int_{-\pi}^{\pi}(x+\pi)\,dx$$

$$= \frac{1}{2\pi}\left(\frac{x^2}{2} + \pi x\right)_{-\pi}^{\pi}$$

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

$$= \pi$$

options (b) and (d) are eliminated

f(x) has hidden odd symmetry therefore in Fourier series representations of f(x) sin(nx) terms are present. Option (a) is eliminated.

Hence option (c) is correct.

148. Consider a coaxial capacitor having inner radius of 0. 1045 m and outer radius of 0.68 m and having a length of 0.3048 m. Assume the dielectric to be air. The capacitance is

(a) 9.05 nF (b) 90.5 nF
(c) 9.05 pF (d) 90.5 pF

148. Ans: (c)

Sol: Capacitance of coaxial cable is given by

$$C = \frac{2\pi\varepsilon_o \ell}{\ln\left(\frac{b}{a}\right)} = \frac{2\pi \times \frac{10^{-9}}{36\pi} \times 0.3048}{\ln\left(\frac{0.68}{0.1045}\right)}$$

$$= \frac{0.0169 \times 10^{-9}}{1.87}$$

$C \simeq 9.05 \times 10^{-12}$ (or) 9.05pF

149. In rotor resistance control of an induction motor, which one of the following is true with increase in rotor resistance ?

(a) Maximum torque increases, starting torque increases and the slip at which maximum torque occurs increases

(b) Maximum torque remains unchanged, starting torque increases and the slip at which maximum torque occurs increases

(c) Maximum torque increases, starting torque increases and the slip at which maximum torque occurs decreases

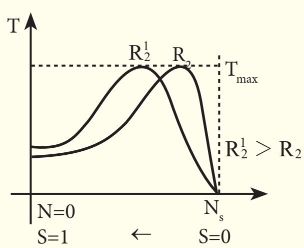
(d) Maximum torque remains unchanged, starting torque decreases and the slip at which maximum torque occurs increases

149. Ans: (b)

Sol: $T_{st} \propto R_2$

$$s_m = \frac{R_2}{X_2}$$

T_{max} = constant



150. Which type of material is used for filament illumination in the incandescent lamp?

(a) Silicon (b) Tungsten

(c) Copper (d) Aluminum

150. Ans: (b)

Sol: Tungsten is used for the filament illumination in the incandescent lamp.