GATE EE 2011

Q. No. 1 – 25 Carry One Mark Each

MCQ 1.1 Roots of the algebraic equation $x^3 + x^2 + x + 1 = 0$ are

(A) $(+1, +j, -j)$

(B) $(+1, -1, +1)$

(C) $(0,0,0)$

(D) $(-1, +j, -j)$

MCQ 1.2 With K as a constant, the possible solution for the first order differential equation $\frac{dy}{dx} = e^{-3x}$ is

(A) $-\frac{1}{3}e^{-3x} + K$

(B) $-\frac{1}{3}e^{3x} + K$

(C) $-\frac{1}{3}e^{-3x} + K$

(D) $-3e^{-x} + K$

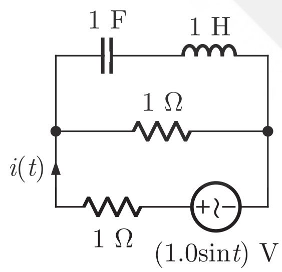
MCQ 1.3 The r.m.s value of the current $i(t)$ in the circuit shown below is

(A) $\frac{1}{2}$ A

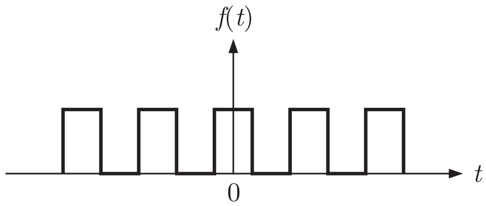
(B) $\frac{1}{\sqrt{2}}$ A

(C) 1 A

(D) $\sqrt{2}$ A



MCQ 1.4 The fourier series expansion $f(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos n\omega t + b_n \sin n\omega t$ of the periodic signal shown below will contain the following nonzero terms



(A) a_0 and $b_n, n = 1,3,5,...\infty$
(B) a_0 and $a_n, n = 1,2,3,...\infty$
(C) $a_0\ a_n$ and $b_n, n = 1,2,3,...\infty$
(D) a_0 and $a_n\ n = 1,3,5,...\infty$

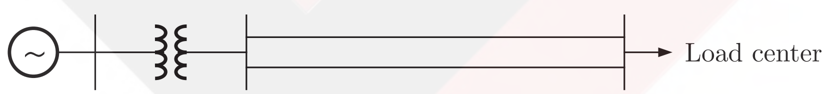
MCQ 1.5 A 4 point starter is used to start and control the speed of a

(A) dc shunt motor with armature resistance control
(B) dc shunt motor with field weakening control
(C) dc series motor
(D) dc compound motor

MCQ 1.6 A three phase, salient pole synchronous motor is connected to an infinite bus. It is operated at no load a normal excitation. The field excitation of the motor is first reduced to zero and then increased in reverse direction gradually. Then the armature current.

(A) Increases continuously
(B) First increases and then decreases steeply
(C) First decreases and then increases steeply
(D) Remains constant

MCQ 1.7 A nuclear power station of 500 MW capacity is located at 300 km away from a load center. Select the most suitable power evacuation transmission configuration among the following options

(A)


132 kV, 300 km double circuit

(B)


132 kV, 300 km single circuit with 40% series capacitor compensation

(C)


400 kV, 300 km single circuit

(D) 

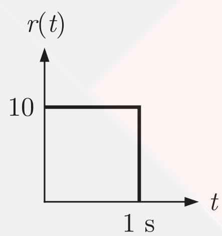
MCQ 1.8 The frequency response of a linear system $G(j\omega)$ is provided in the tubular form below

$\lvert G(j\omega)\rvert$	1.3	1.2	1.0	0.8	0.5	0.3
$\angle G(j\omega)$	-130°	-140°	-150°	-160°	-180°	-200°

Gain Margin and phase margin are

(A) 6 dB and 30°
(B) 6 dB and -30°
(C) -6 dB and 30°
(D) -6 dB and -30°

MCQ 1.9 The steady state error of a unity feedback linear system for a unit step input is 0.1. The steady state error of the same system, for a pulse input $r(t)$ having a magnitude of 10 and a duration of one second, as shown in the figure is



(A) 0
(B) 0.1
(C) 1
(D) 10

MCQ 1.10 Consider the following statement

(1) The compensating coil of a low power factor wattmeter compensates the effect of the impedance of the current coil.

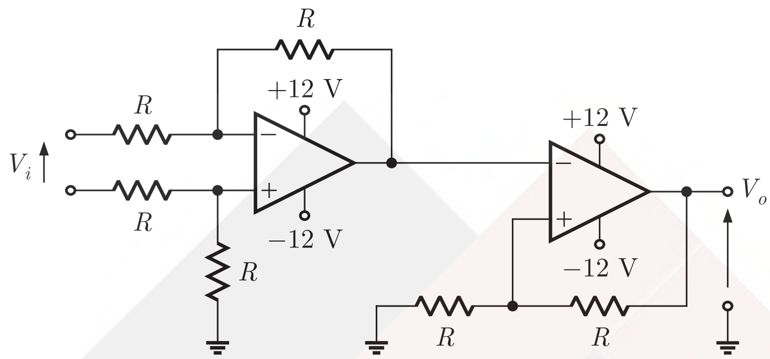
(2) The compensating coil of a low power factor wattmeter compensates the effect of the impedance of the voltage coil circuit.

(A) (1) is true but (2) is false
(B) (1) is false but (2) is true
(C) both (1) and (2) are true
(D) both (1) and (2) are false

MCQ 1.11 A low-pass filter with a cut-off frequency of 30 Hz is cascaded with a high pass filter with a cut-off frequency of 20 Hz. The resultant system of filters will function as

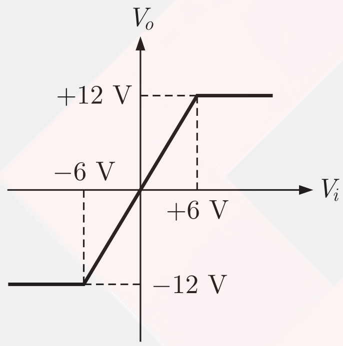
(A) an all – pass filter
(B) an all – stop filter
(C) an band stop (band-reject) filter
(D) a band – pass filter

MCQ 1.12

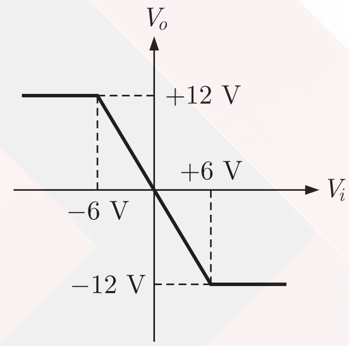


The CORRECT transfer characteristic is

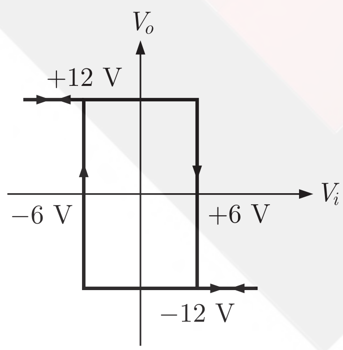
(A)



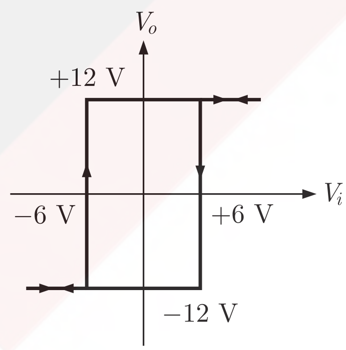
(B)



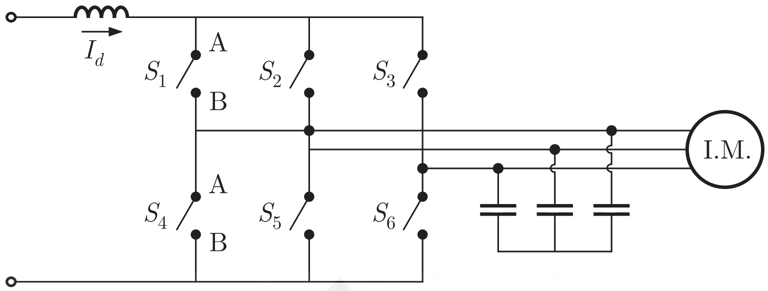
(C)



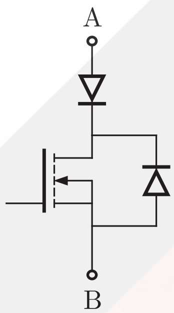
(D)

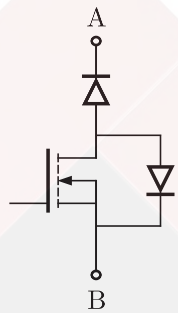


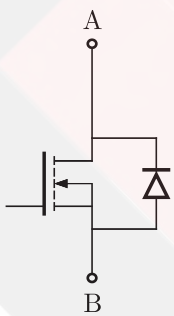
MCQ 1.13 A three phase current source inverter used for the speed control of an induction motor is to be realized using MOSFET switches as shown below. Switches S_1 to S_6 are identical switches.

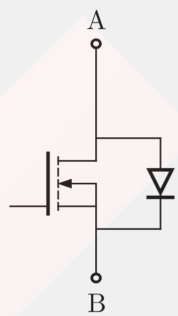


The proper configuration for realizing switches S_1 to S_6 is

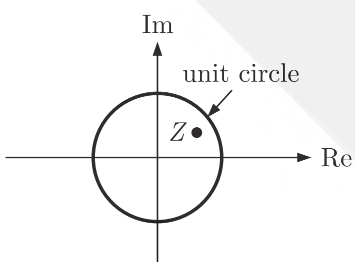
(A)


(B)


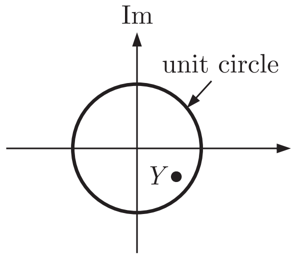
(C)


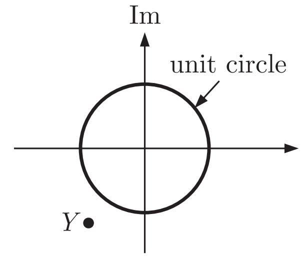
(D)


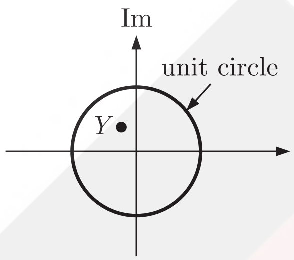
MCQ 1.14 A point Z has been plotted in the complex plane, as shown in figure below.

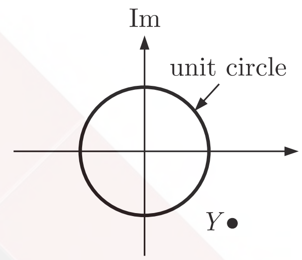


The plot of the complex number $Y = \frac{1}{Z}$ is

(A) 

(B) 

(C) 

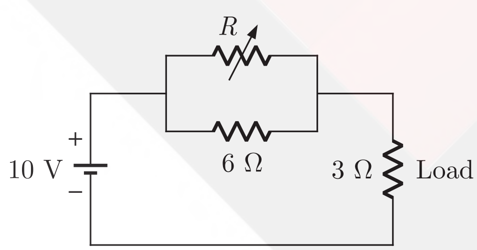
(D) 

MCQ 1.15 The voltage applied to a circuit is $100\sqrt{2}\cos(100\pi t)$ volts and the circuit draws a current of $10\sqrt{2}\sin(100\pi t + \pi/4)$ amperes. Taking the voltage as the reference phasor, the phasor representation of the current in amperes is

(A) $10\sqrt{2}\angle -\pi/4$ (B) $10\angle -\pi/4$

(C) $10\angle +\pi/4$ (D) $10\sqrt{2}\angle +\pi/4$

MCQ 1.16 In the circuit given below, the value of R required for the transfer of maximum power to the load having a resistance of $3\,\Omega$ is



(A) zero

(B) $3\,\Omega$

(C) $6\,\Omega$

(D) infinity

MCQ 1.17 Given two continuous time signals $x(t) = e^{-t}$ and $y(t) = e^{-2t}$ which exist for $t > 0$, the convolution $z(t) = x(t)^{*} y(t)$ is

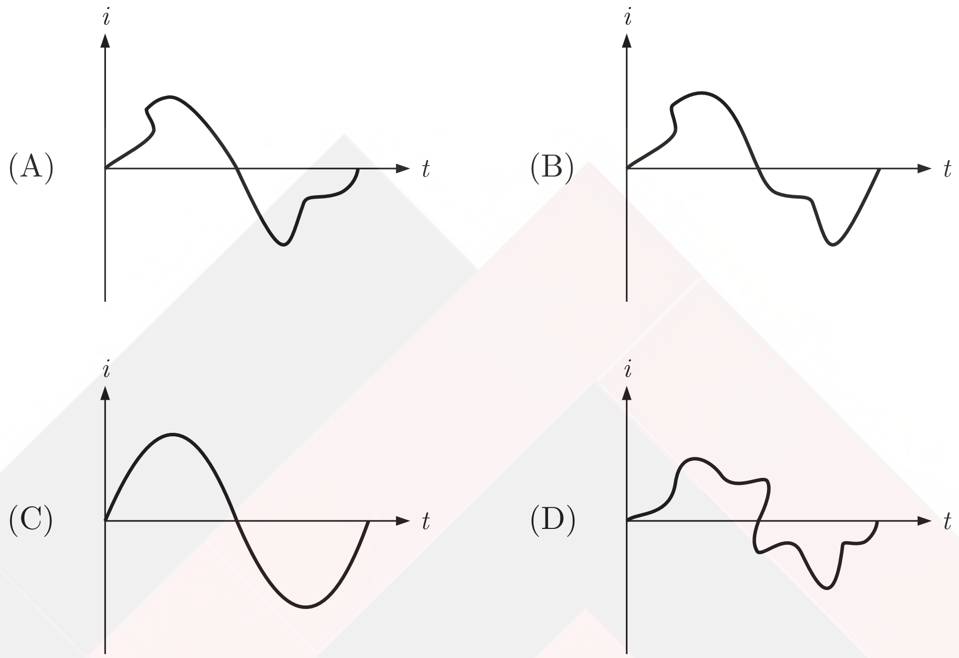
(A) $e^{-t} - e^{-2t}$

(B) e^{-3t}

(C) e^{+t}

(D) $e^{-t} + e^{-2t}$

MCQ 1.18 A single phase air core transformer, fed from a rated sinusoidal supply, is operating at no load. The steady state magnetizing current drawn by the transformer from the supply will have the waveform



MCQ 1.19 A negative sequence relay is commonly used to protect

(A) an alternator | (B) an transformer

(C) a transmission line | (D) a bus bar

MCQ 1.20 For enhancing the power transmission in along EHV transmission line, the most preferred method is to connect a

(A) Series inductive compensator in the line

(B) Shunt inductive compensator at the receiving end

(C) Series capacitive compensator in the line

(D) Shunt capacitive compensator at the sending end

MCQ 1.21 An open loop system represented by the transfer function

$$G(s) = \frac{(s-1)}{(s+2)(s+3)} \text{ is}$$

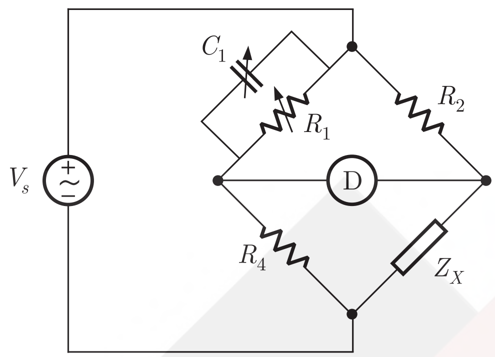
(A) Stable and of the minimum phase type

(B) Stable and of the non–minimum phase type

(C) Unstable and of the minimum phase type

(D) Unstable and of non–minimum phase type

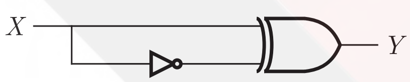
MCQ 1.22 The bridge circuit shown in the figure below is used for the measurement of an unknown element Z_X. The bridge circuit is best suited when Z_X is a



(A) low resistance (B) high resistance
(C) low Q inductor (D) lossy capacitor

MCQ 1.23 A dual trace oscilloscope is set to operate in the ALTernate mode. The control input of the multiplexer used in the y-circuit is fed with a signal having a frequency equal to
(A) the highest frequency that the multiplexer can operate properly
(B) twice the frequency of the time base (sweep) oscillator
(C) the frequency of the time base (sweep) oscillator
(D) haif the frequency of the time base (sweep) oscillator

MCQ 1.24 The output Y of the logic circuit given below is



(A) 1 (B) 0
(C) X (D) $\overline{X}$

Q. No. 26 – 51 Carry Two Mark Each

MCQ 1.25 Circuit turn-off time of an SCR is defined as the time
(A) taken by the SCR turn to be off
(B) required for the SCR current to become zero
(C) for which the SCR is reverse biased by the commutation circuit
(D) for which the SCR is reverse biased to reduce its current below the holding current

MCQ 1.26 Solution of the variables x_1 and x_2 for the following equations is to be obtained by employing the Newton-Raphson iterative method.

equation (1) $10x_2 \sin x_1 - 0.8 = 0$

equation (2) $10x_2^2 - 10x_2 \cos x_1 - 0.6 = 0$

Assuming the initial values are $x_1 = 0.0$ and $x_2 = 1.0$, the jacobian matrix is

(A) $\begin{bmatrix} 10 & -0.8 \\ 0 & -0.6 \end{bmatrix}$ (B) $\begin{bmatrix} 10 & 0 \\ 0 & 10 \end{bmatrix}$

(C) $\begin{bmatrix} 0 & -0.8 \\ 10 & -0.6 \end{bmatrix}$ (D) $\begin{bmatrix} 10 & 0 \\ 10 & -10 \end{bmatrix}$

MCQ 1.27 The function $f(x) = 2x - x^2 - x^3 + 3$ has

(A) a maxima at $x = 1$ and minimum at $x = 5$

(B) a maxima at $x = 1$ and minimum at $x = -5$

(C) only maxima at $x = 1$ and

(D) only a minimum at $x = 5$

MCQ 1.28 A lossy capacitor C_x, rated for operation at 5 kV, 50 Hz is represented by an equivalent circuit with an ideal capacitor C_p in parallel with a resistor R_p. The value C_p is found to be 0.102 μF and value of $R_p = 1.25\,\mathrm{M}\Omega$. Then the power loss and $\tan\delta$ of the lossy capacitor operating at the rated voltage, respectively, are

(A) 10 W and 0.0002 (B) 10 W and 0.0025

(C) 20 W and 0.025 (D) 20 W and 0.04

MCQ 1.29 Let the Laplace transform of a function $f(t)$ which exists for $t > 0$ be $F_1(s)$ and the Laplace transform of its delayed version $f(t-\tau)$ be $F_2(s)$. Let $F_1{}^*(s)$ be the complex conjugate of $F_1(s)$ with the Laplace variable set $s = \sigma + j\omega$. If $G(s) = \dfrac{F_2(s)\,F_1{}^*(s)}{|F_1(s)|^2}$, then the inverse Laplace transform of $G(s)$ is

(A) An ideal impulse $\delta(t)$

(B) An ideal delayed impulse $\delta(t-\tau)$

(C) An ideal step function $u(t)$

(D) An ideal delayed step function $u(t-\tau)$

MCQ 1.30 A zero mean random signal is uniformly distributed between limits $-a$ and $+a$ and its mean square value is equal to its variance. Then the r.m.s value of the signal is

(A) $\dfrac{a}{\sqrt{3}}$ (B) $\dfrac{a}{\sqrt{2}}$

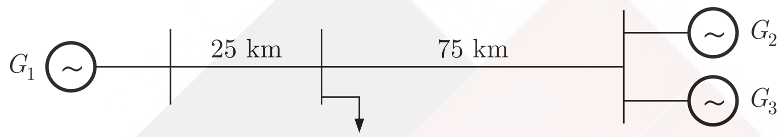
(C) $a\sqrt{2}$ (D) $a\sqrt{3}$

MCQ 1.31 A 220 V, DC shunt motor is operating at a speed of 1440 rpm. The armature resistance is $1.0\,\Omega$ and armature current is 10 A. of the excitation of the machine is reduced by 10%, the extra resistance to be put in the armature circuit to maintain the same speed and torque will be

(A) $1.79\,\Omega$ (B) $2.1\,\Omega$

(C) $18.9\,\Omega$ (D) $3.1\,\Omega$

MCQ 1.32 A load center of 120 MW derives power from two power stations connected by 220 kV transmission lines of 25 km and 75 km as shown in the figure below. The three generators G_1, G_2 and G_3 are of 100 MW capacity each and have identical fuel cost characteristics. The minimum loss generation schedule for supplying the 120 MW load is



(A) $P_1 = 80\text{ MW} + \text{losses}$, $P_2 = 20\text{ MW}$, $P_3 = 20\text{ MW}$

(B) $P_1 = 60\text{ MW}$, $P_2 = 30\text{ MW} + \text{losses}$, $P_3 = 30\text{ MW}$

(C) $P_1 = 40\text{ MW}$, $P_2 = 40\text{ MW}$, $P_3 = 40\text{ MW} + \text{losses}$

(D) $P_1 = 30\text{ MW} + \text{losses}$, $P_2 = 45\text{ MW}$, $P_3 = 45\text{ MW}$

MCQ 1.33 The open loop transfer function $G(s)$ of a unity feedback control system is given as

$$G(s) = \frac{K\left(s + \frac{2}{3}\right)}{s^2(s+2)}$$

From the root locus, at can be inferred that when K tends to positive infinity,

(A) Three roots with nearly equal real parts exist on the left half of the s-plane

(B) One real root is found on the right half of the s-plane

(C) The root loci cross the $j\omega$ axis for a finite value of $K; K \neq 0$

(D) Three real roots are found on the right half of the s-plane

MCQ 1.34 A portion of the main program to call a subroutine SUB in an 8085 environment is given below.

```
  ⋮
LXI D, DISP
LP :   CALL SUB
LP+3
  ⋮
```

It is desired that control be returned to LP+DISP+3 when the RET instruction is executed in the subroutine. The set of instructions that precede the RET instruction in the subroutine are

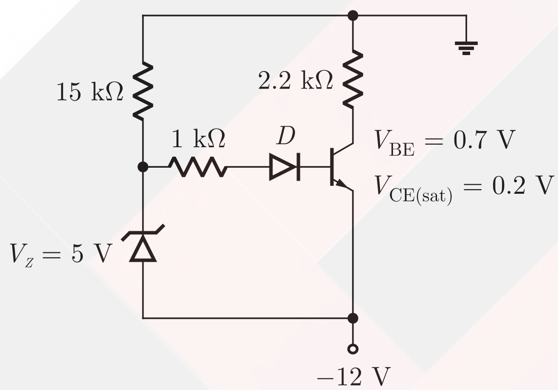
(A)
POP D
DAD H
PUSH D

(B)
POP H
DAD D
INX H
INX H
INX H
PUSH H

(C)
POP H
DAD D
PUSH H

(D)
XTHL
INX D
INX D
INX D
XTHL

MCQ 1.35 The transistor used in the circuit shown below has a β of 30 and I_{CBO} is negligible

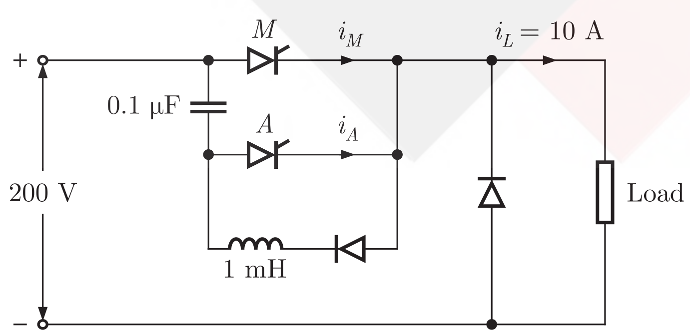


If the forward voltage drop of diode is 0.7 V, then the current through collector will be

(A) 168 mA (B) 108 mA

(C) 20.54 mA (D) 5.36 mA

MCQ 1.36 A voltage commutated chopper circuit, operated at 500 Hz, is shown below.



If the maximum value of load current is 10 A, then the maximum current through the main (M) and auxiliary (A) thyristors will be

(A) $i_{M\max} = 12$ A and $i_{A\max} = 10$ A

(B) $i_{M\max} = 12$ A and $i_{A\max} = 2$ A

(C) $i_{M\max} = 10$ A and $i_{A\max} = 12$ A

(D) $i_{M\max} = 10$ A and $i_{A\max} = 8$ A

MCQ 1.37 The matrix $[A] = \begin{bmatrix} 2 & 1 \\ 4 & -1 \end{bmatrix}$ is decomposed into a product of a lower triangular matrix $[L]$ and an upper triangular matrix $[U]$. The properly decomposed $[L]$ and $[U]$ matrices respectively are

(A) $\begin{bmatrix} 1 & 0 \\ 4 & -1 \end{bmatrix}$ and $\begin{bmatrix} 1 & 1 \\ 0 & -2 \end{bmatrix}$

(B) $\begin{bmatrix} 2 & 0 \\ 4 & -1 \end{bmatrix}$ and $\begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$

(C) $\begin{bmatrix} 1 & 0 \\ 4 & 1 \end{bmatrix}$ and $\begin{bmatrix} 2 & 1 \\ 0 & -1 \end{bmatrix}$

(D) $\begin{bmatrix} 2 & 0 \\ 4 & -3 \end{bmatrix}$ and $\begin{bmatrix} 1 & 1.5 \\ 0 & 1 \end{bmatrix}$

MCQ 1.38 The two vectors [1,1,1] and $[1, a, a^2]$ where $a = \left(-\frac{1}{2} + j\frac{\sqrt{3}}{2}\right)$, are

(A) Orthonormal

(B) Orthogonal

(C) Parallel

(D) Collinear

MCQ 1.39 A three-phase 440 V, 6 pole, 50 Hz, squirrel cage induction motor is running at a slip of 5%. The speed of stator magnetic field to rotor magnetic field and speed of rotor with respect of stator magnetic field are

(A) zero, -5 rpm

(B) zero, 955 rpm

(C) 1000 rpm, -5 rpm

(D) 1000 rpm, 955 rpm

MCQ 1.40 A capacitor is made with a polymeric dielectric having an ε_r of 2.26 and a dielectric breakdown strength of 50 kV/cm. The permittivity of free space is 8.85 pF/m. If the rectangular plates of the capacitor have a width of 20 cm and a length of 40 cm, then the maximum electric charge in the capacitor is

(A) 2 μC

(B) 4 μC

(C) 8 μC

(D) 10 μC

MCQ 1.41 The response $h(t)$ of a linear time invariant system to an impulse $\delta(t)$, under initially relaxed condition is $h(t) = e^{-t} + e^{-2t}$. The response of this system for a unit step input $u(t)$ is

(A) $u(t) + e^{-t} + e^{-2t}$

(B) $(e^{-t} + e^{-2t})\,u(t)$

(C) $(1.5 - e^{-t} - 0.5e^{-2t})\,u(t)$

(D) $e^{-t}\delta(t) + e^{-2t}u(t)$

MCQ 1.42 The direct axis and quadrature axis reactances of a salient pole alternator are 1.2 p.u and 1.0 p.u respectively. The armature resistance is negligible. If this alternator is delivering rated kVA at upf and at rated voltage then its power angle is

(A) 30°

(B) 45°

(C) 60°

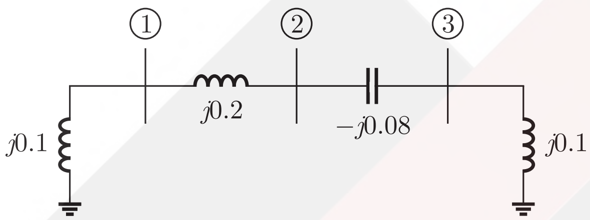
(D) 90°

MCQ 1.43 A $4\frac{1}{2}$ digit DMM has the error specification as: 0.2% of reading + 10 counts. If a dc voltage of 100 V is read on its 200 V full scale, the maximum error that can be expected in the reading is

(A) $\pm 0.1\%$ (B) $\pm 0.2\%$

(C) $\pm 0.3\%$ (D) $\pm 0.4\%$

MCQ 1.44 A three – bus network is shown in the figure below indicating the p.u. impedance of each element.

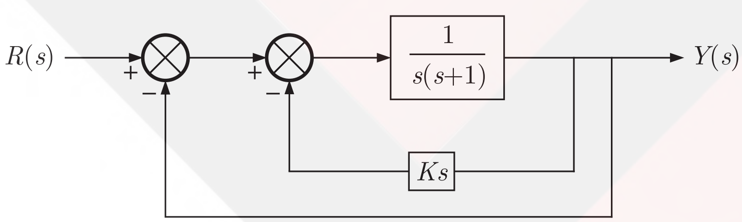


The bus admittance matrix, Y-bus, of the network is

(A) $j\begin{bmatrix} 0.3 & -0.2 & 0 \\ -0.2 & 0.12 & 0.08 \\ 0 & 0.08 & 0.02 \end{bmatrix}$ (B) $j\begin{bmatrix} -15 & 5 & 0 \\ 5 & 7.5 & -12.5 \\ 0 & -12.5 & 2.5 \end{bmatrix}$

(C) $j\begin{bmatrix} 0.1 & 0.2 & 0 \\ 0.2 & 0.12 & -0.08 \\ 0 & -0.08 & 0.10 \end{bmatrix}$ (D) $j\begin{bmatrix} -10 & 5 & 0 \\ 5 & 7.5 & 12.5 \\ 0 & 12.5 & -10 \end{bmatrix}$

MCQ 1.45 A two loop position control system is shown below



The gain K of the Tacho-generator influences mainly the

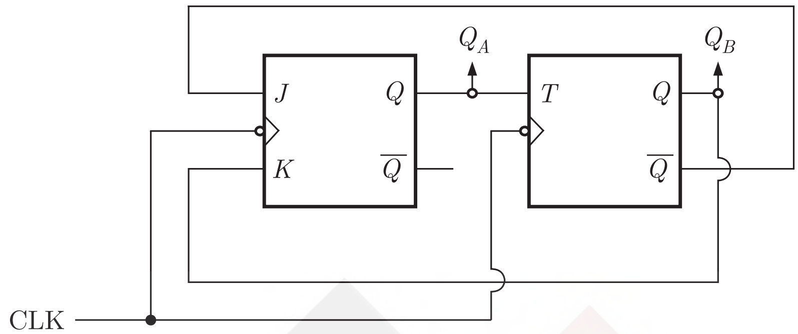
(A) Peak overshoot

(B) Natural frequency of oscillation

(C) Phase shift of the closed loop transfer function at very low frequencies ($\omega \to 0$)

(D) Phase shift of the closed loop transfer function at very high frequencies ($\omega \to \infty$)

MCQ 1.46 A two bit counter circuit is shown below

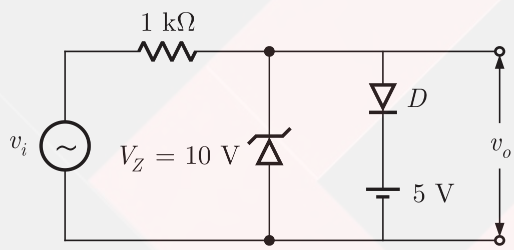


It the state $Q_A Q_B$ of the counter at the clock time t_n is '10' then the state $Q_A Q_B$ of the counter at $t_n + 3$ (after three clock cycles) will be

(A) 00 (B) 01

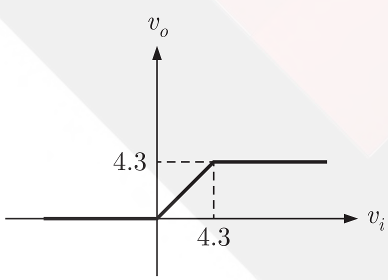
(C) 10 (D) 11

MCQ 1.47 A clipper circuit is shown below.

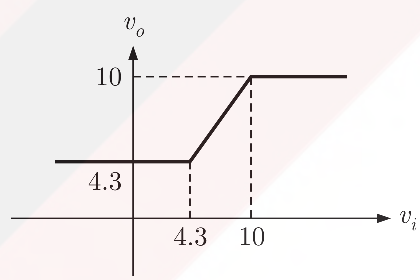


Assuming forward voltage drops of the diodes to be 0.7 V, the input-output transfer characteristics of the circuit is

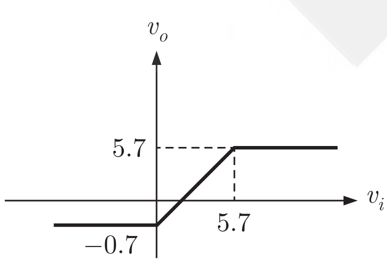
(A)



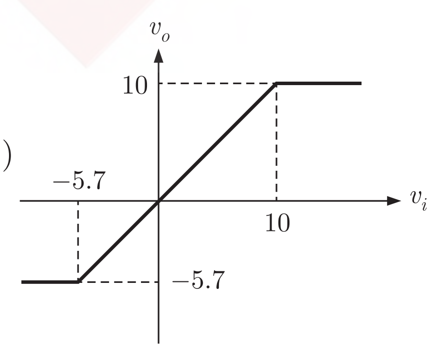
(B)



(C)



(D)



Common Data questions: 48 & 49

The input voltage given to a converter is

$$v_i = 100\sqrt{2}\sin(100\pi t)\text{ V}$$

The current drawn by the converter is

$$i_i = 10\sqrt{2}\sin(100\pi t - \pi/3) + 5\sqrt{2}\sin(300\pi t + \pi/4) + 2\sqrt{2}\sin(500\pi t - \pi/6)\text{ A}$$

MCQ 1.48 The input power factor of the converter is

(A) 0.31 (B) 0.44

(C) 0.5 (D) 0.71

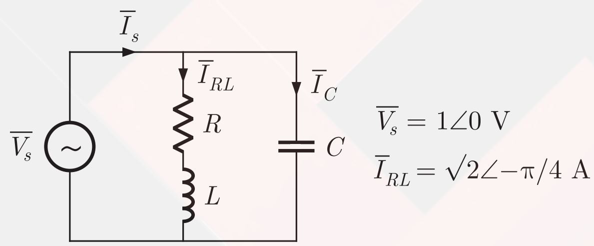
MCQ 1.49 The active power drawn by the converter is

(A) 181 W (B) 500 W

(C) 707 W (D) 887 W

Common Data questions: 50 & 51

An RLC circuit with relevant data is given below.



MCQ 1.50 The power dissipated in the resistor R is

(A) 0.5 W (B) 1 W

(C) $\sqrt{2}$ W (D) 2 W

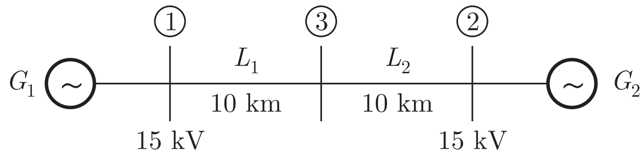
MCQ 1.51 The current $\overline{I_C}$ in the figure above is

(A) $-j2$ A (B) $-j\frac{1}{\sqrt{2}}$ A

(C) $+j\frac{1}{\sqrt{2}}$ A (D) $+j2$A

Linked Answer questions: Q.52 to Q.55 Carry Two Marks Each Statement for Linked Answer Questions: 52 & 53

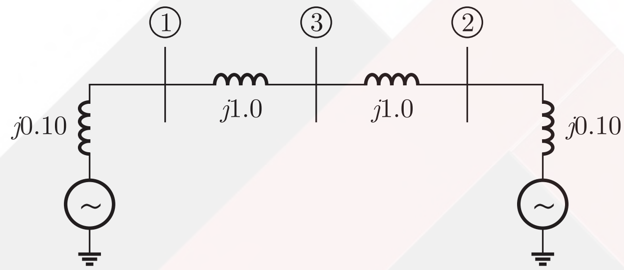
MCQ 1.52 Two generator units G_1 and G_2 are connected by 15 kV line with a bus at the mid-point as shown below



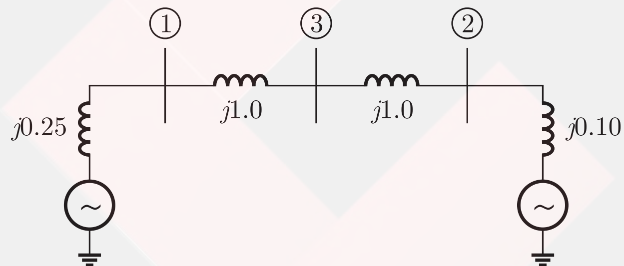
$G_1 = 250\,\text{MVA}$, 15 kV, positive sequence reactance $X_{G_1} = 25\%$ on its own base

$G_2 = 100\,\text{MVA}$, 15 kV, positive sequence reactance $X_{G_2} = 10\%$ on its own base L_1 and $L_2 = 10\,\text{km}$, positive sequence reactance $X_L = 0.225\,\Omega/\text{km}$

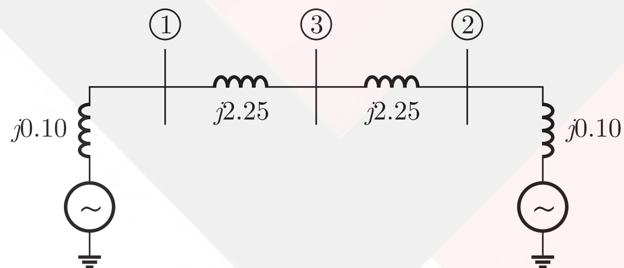
(A)



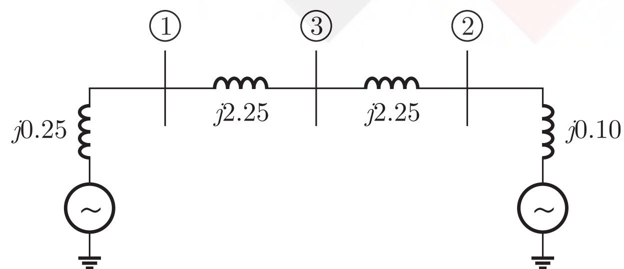
(B)



(C)



(D)



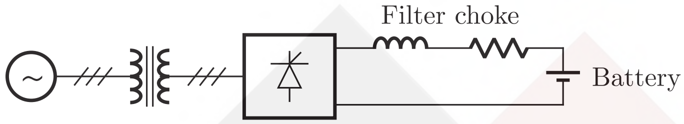
MCQ 1.53 In the above system, the three-phase fault MVA at the bus 3 is

(A) 82.55 MVA (B) 85.11 MVA

(C) 170.91 MVA (D) 181.82 MVA

Statement for Linked Answer Questions: 54 & 55

A solar energy installation utilize a three – phase bridge converter to feed energy into power system through a transformer of 400 V/400 V, as shown below.



The energy is collected in a bank of 400 V battery and is connected to converter through a large filter choke of resistance $10\,\Omega$.

MCQ 1.54 The maximum current through the battery will be

(A) 14 A (B) 40 A

(C) 80 A (D) 94 A

MCQ 1.55 The kVA rating of the input transformer is

(A) 53.2 kVA (B) 46.0 kVA

(C) 22.6 kVA (D) 7.5 kVA

Q. No. 56 – 60 Carry One Mark Each

MCQ 1.56 There are two candidates P and Q in an election. During the campaign, 40% of the voters promised to vote for P, and rest for Q. However, on the day of election 15% of the voters went back on their promise to vote for P and instead voted for Q.25% of the voters went back on their promise to vote for Q and instead voted for P. Suppose, P lost by 2 votes, then what was the total number of voters?

(A) 100 (B) 110

(C) 90 (D) 95

MCQ 1.57 Choose the most appropriate word from the options given below to complete the following sentence:

It was her view that the country's problems had been____by foreign technocrats, so that to invite them to come back would be counter-productive.

(A) Identified (B) ascertained

(C) Texacerbated (D) Analysed

MCQ 1.58 Choose the work from the options given below that is most nearly opposite in meaning to the given word:

Frequency

(A) periodicity (B) rarity

(C) gradualness (D) persistency

MCQ 1.59 Choose the most appropriate word from the options given below to complete the following sentence: Under ethical guidelines recently adopted by the Indian Medical Association, human genes are to be manipulated only to correct diseases for which_____treatments are unsatisfactory.

(A) Similar (B) Most

(C) Uncommon (D) Available

MCQ 1.60 The question below consists of a pair of related words followed by four paris of words. Select the pair that best expresses the relation in the original pair:

Gladiator : Arena

(A) dancer : state

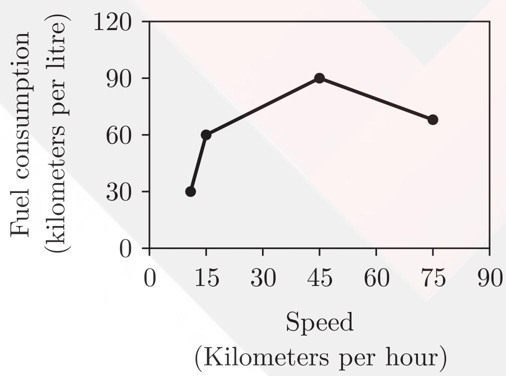
(B) commuter : train

(C) teacher : classroom

(D) lawyer : courtroom

Q. No. 61 – 65 Carry Two Mark Each

MCQ 1.61 The fuel consumed by a motorcycle during a journey while traveling at various speeds is indicated in the graph below.



The distances covered during four laps of the journey are listed in the table below

Lap	Distance (kilometers)	Average speed (kilometers per hour)
P	15	15
Q	75	45
R	40	75
S	10	10

From the given data, we can conclude that the fuel consumed per kilometer was least during the lap

(A) P (B) Q

(C) R (D) S

MCQ 1.62 Three friends, R, S and T shared toffee from a bowl. R took $1/3^{rd}$ of the toffees, but returned four to the bowl. S took $1/4^{th}$ of what was left but returned three toffees to the bowl. T took half of the remainder but returned two back into the bowl. If the bowl had 17 toffees left, how many toffees were originally there in the bowl?

(A) 38 (B) 31

(C) 48 (D) 41

MCQ 1.63 Given that $f(y) = [y]/y$ and q is any non-zero real number, the value of $|f(q) - f(-q)|$ is

(A) 0 (B) -1

(C) 1 (D) 2

MCQ 1.64

The sum of n terms of the series 4+44+444+... is

(A) $(4/81)\ [10^{n+1} - 9n - 1]$ (B) $(4/81)\ [10^{n-1} - 9n - 1]$

(C) $(4/81)\ [10^{n+1} - 9n - 10]$ (D) $(4/81)\ [10^{n} - 9n - 10]$

MCQ 1.65 The horse has played a little known but very important role in the filed of medicine. Horses were injected with toxins of diseases until their blood build up immunities. Then a serum was made from their blood. Serums to flight with diphtheria and tetanus were developed this way.

It can be inferred from the passage that horses were

(A) given immunity to diseases

(B) generally quite immune to diseases

(C) given medicines to flight

(D) given diphtheria and tetanus serums

SOLUTION

SOL 1.1

$$x^3+x^2+x+1 = 0$$

$$x^2(x+1)+(x-1) = 0$$

$$(x+1)(x^2+1) = 0$$

or $\quad x+1=0 \Rightarrow x=-1$

and $\quad x^2+1=0 \Rightarrow x=-j,j$

$$x=-1,-j,j$$

Hence (D) is correct option.

SOL 1.2

$$\frac{dy}{dx} = e^{-3x}$$

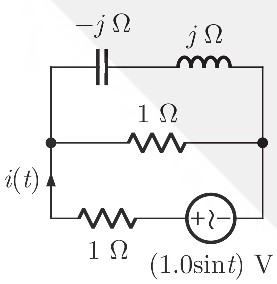
$$dy = e^{-3x}dx$$

by integrating, we get

$$y = -\frac{1}{3}e^{-3x}+K, \text{ where } K \text{ is constant.}$$

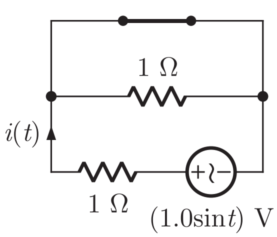
Hence (A) is correct option.

SOL 1.3 The frequency domains equivalent circuit at $\omega = 1\,\text{rad/sec}$.



Since the capacitor and inductive reactances are equal in magnitude, the net impedance of that branch will become zero.

Equivalent circuit



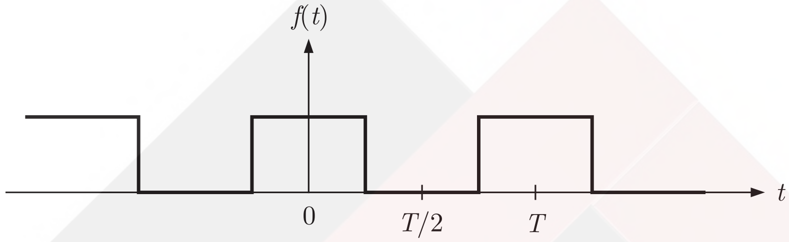
Current $i(t) = \frac{\sin t}{1\,\Omega} = (1\sin t)\,\mathrm{A}$

rms value of current

$$i_{\text{rms}} = \frac{1}{\sqrt{2}}\,\mathrm{A}$$

Hence (B) is correct option.

SOL 1.4



$$f(t) = a_0 + \sum_{n=1}^{\infty}(a_n\cos\omega t + b_n\sin n\omega t)$$

- The given function $f(t)$ is an even function, therefore $b_n = 0$
- $f(t)$ is a non zero average value function, so it will have a non-zero value of a_0

$$a_0 = \frac{1}{(T/2)}\int_0^{T/2} f(t)\,dt \text{ (average value of } f(t))$$

- a_n is zero for all even values of n and non zero for odd n

$$a_n = \frac{2}{T}\int_0^{T} f(t)\cos(n\omega t)\,d(\omega t)$$

So, fourier expansion of $f(t)$ will have a_0 and a_n, $n = 1,3,5...\infty$

Hence (D) is correct option.

SOL 1.5 The armature current of DC shunt motor

$$I_a = \frac{V - E_b}{R_a}$$

at the time of starting, $E_b = 0$. If the full supply voltage is applied to the motor, it will draw a large current due to low armature resistance.

A variable resistance should be connected in series with the armature resistance to limit the starting current.

A 4-point starter is used to start and control speed of a dc shut motor.

Hence (A) is correct option

SOL 1.6 The Back emf will go to zero when field is reduced, so Current input will be increased. But when Field increases (though in reverse direction) the back emf will cause the current to reduce.

Hence (B) is correct option.

SOL 1.7

SOL 1.8 Gain margin is simply equal to the gain at phase cross over frequency (ω_p). Phase cross over frequency is the frequency at which phase angle is equal to -180°.

From the table we can see that $\angle G(j\omega_p) = -180^\circ$, at which gain is 0.5.

$$GM = 20\log_{10}\left(\frac{1}{|G(j\omega_p)|}\right)$$

$$= 20\log\left(\frac{1}{0.5}\right) = 6\text{ dB}$$

Phase Margin is equal to 180° plus the phase angle ϕ_g at the gain cross over frequency (ω_g). Gain cross over frequency is the frequency at which gain is unity.

From the table it is clear that $|G(j\omega_g)| = 1$, at which phase angle is -150°

$$\phi_{PM} = 180^\circ + \angle G(j\omega_g)$$

$$= 180 - 150 = 30^\circ$$

Hence (A) is correct option.

SOL 1.9 We know that steady state error is given by

$$e_{ss} = \lim_{s\to 0}\frac{sR(s)}{1+G(s)}$$

where $R(s) \to$ input

$G(s) \to$ open loop transfer function

For unit step input

$$R(s) = \frac{1}{s}$$

So $$e_{ss} = \lim_{s\to 0}\frac{s\left(\frac{1}{s}\right)}{1+G(s)} = 0.1$$

$$1 + G(0) = 10$$

$$G(0) = 9$$

Given input $r(t) = 10[\mu(t) - \mu(t-1)]$

or $$R(s) = 10\left[\frac{1}{s} - \frac{1}{s}e^{-s}\right]$$

$$= 10\left[\frac{1-e^{-s}}{s}\right]$$

So steady state error

$$e'_{ss} = \lim_{s\to 0}\frac{s\times 10\frac{(1-e^{-s})}{s}}{1+G(s)}$$

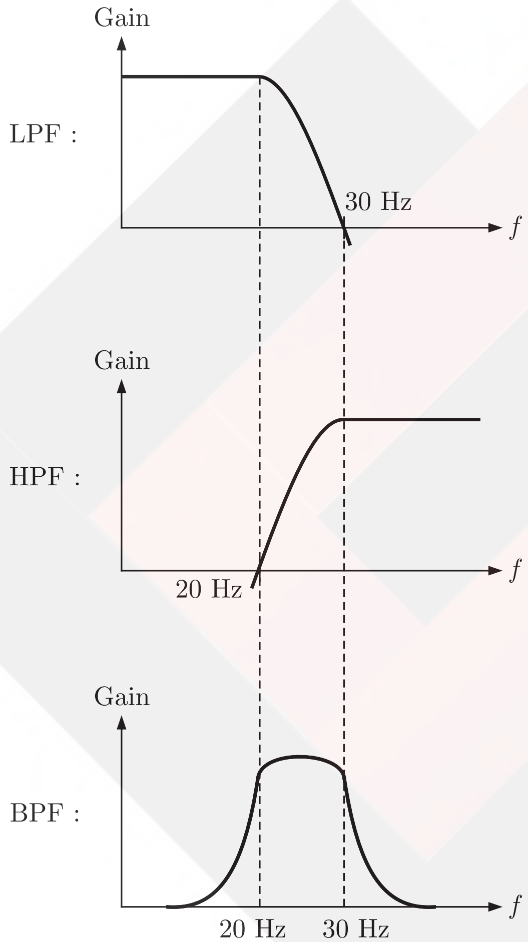
$$= \frac{10(1-e^{0})}{1+9}$$

$= 0$

Hence (A) is correct option.

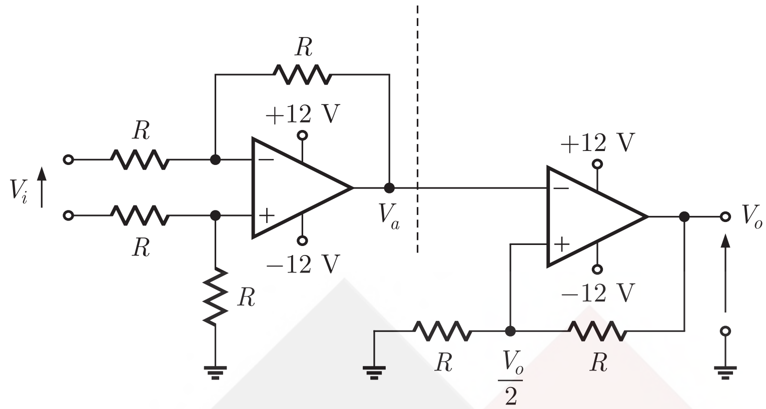
SOL 1.10 The compensating coil compensation the effect of impedance of current coil.
Hence (A) is correct option.

SOL 1.11



So, it will act as a Band pass filter.
Hence (D) is correct option.

SOL 1.12



The first half of the circuit is a differential amplifier (negative feedback)

$$V_a = -(V_i)$$

Second op-amp has a positive feedback, so it acts as an schmitt trigger. Since

$V_a = -V_i$ this is a non-inverting schmitt trigger.

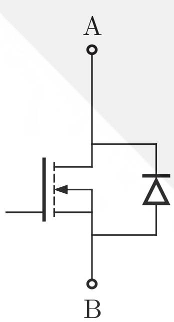
Threshold value

$$V_{TH} = \frac{12}{2} = 6 \text{ V}$$

$$V_{TL} = -6 \text{ V}$$

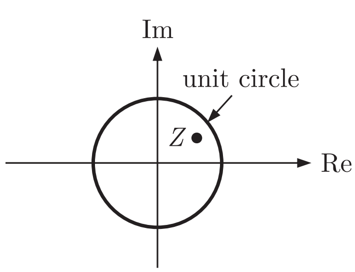
Hence (D) is correct option.

SOL 1.13 Only option C allow bi direction power flow from source to the drive



Hence (C) is correct option.

SOL 1.14

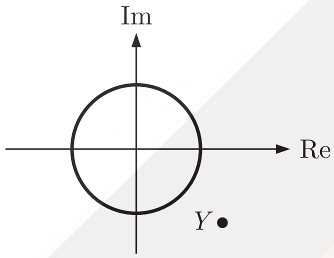


$\overline{Z}$ is $|Z| = 0$ where θ is around 45° or so.

$$\therefore \quad \overline{Z} = |Z|\angle 45^\circ \text{ where } |Z| < 1$$

$$\overline{Y} = \frac{1}{Z} = \frac{1}{|Z|\angle 45^\circ} = \frac{1}{|Z|}\angle -45^\circ$$

$$|\overline{Y}| > 1 [\because |Z| < 1]$$



So Y will be out of unity circle.
Hence D is correct option.

SOL 1.15 Voltage in time domain

$$v(t) = 100\sqrt{2}\cos(100\pi t)$$

Current in time domain

$$i(t) = 10\sqrt{2}\sin(100\pi t + \pi/4)$$

by applying the following trigonometric identity

$$\sin(\phi) = \cos(\phi - 90^\circ)$$

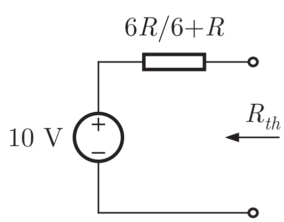
$$\text{So, } i(t) = 10\sqrt{2}\cos(100\pi t + \pi/4 - \pi/2)$$
$$= 10\sqrt{2}\cos(100\pi t - \pi/4)$$

In phasor form

$$\therefore \quad \boldsymbol{I} = \frac{10\sqrt{2}}{\sqrt{2}}\angle -\pi/4$$

Hence (D) is correct option.

SOL 1.16



Power transferred to the load

$$P = I^2 R_L$$

$$= \left(\frac{10}{R_{th} + R_L}\right)^2 R_L$$

For maximum power transfer R_{th}, should be minimum.

$$R_{th} = \frac{6R}{6+R} = 0$$

$$R = 0$$

Note: Since load resistance is constant so we choose a minimum value of R_{th}

Hence (A) is correct option.

SOL 1.17

$$x(t) = e^{-t}$$

Laplace transformation

$$X(s) = \frac{1}{s+1}$$

$$y(t) = e^{-2t}$$

$$Y(s) = \frac{1}{s+2}$$

Convolution in time domain is equivalent to multiplication in frequency domain.

$$z(t) = x(t) * y(t)$$

$$Z(s) = X(s)\, Y(s) = \left(\frac{1}{s+1}\right)\left(\frac{1}{s+2}\right)$$

by partial fraction and taking inverse laplace transformation, we get

$$Z(s) = \frac{1}{s+1} - \frac{1}{s+2}$$

$$\therefore \; z(t) = e^{-t} - e^{-2t}$$

Hence (A) is correct option.

SOL 1.18 An air-core transformer has linear B-H characteristics, which implies that magnetizing current characteristic will be perfectly sinusoidal.

Hence (C) is correct option.

SOL 1.19 Negative phase sequence relay is used for the protection of alternators against unbalanced loading that may arise due to phase-to-phase faults.

Hence (A) is correct option.

SOL 1.20 Steady state stability or power transfer capability

$$P_{\max} = \frac{|E||V|}{X}$$

To improve steady state limit, reactance X should be reduced. The stability may be increased by using two parallel lines. Series capacitor can also be used to get a

better regulation and to increase the stability limit by decreasing reactance.
Hence (C) is correct option.

SOL 1.21 Transfer function having at least one zero or pole in RHS of s-plane is called non-minimum phase transfer function.

$$G(s) = \frac{s-1}{(s+2)(s+3)}$$

- In the given transfer function one zero is located at $s = 1$ (RHS), so this is a non-minimum phase system.
- Poles $-2, -3$, are in left side of the complex plane, So the system is stable

Hence (B) is correct option.

SOL 1.22 Let $Z_1 = R_1 || j\omega C_1$

so admittance $Y_1 = \frac{1}{Z_1} = \frac{1}{R_1} + j\omega C_1$

$$Z_2 = R_2$$
$$Z_4 = R_4$$

Let $Z_X = R_X + j\omega L_X$ (Unknown impedance)

For current balance condition of the Bridge

$$Z_2 Z_4 = Z_X Z_1 = \frac{Z_X}{Y_1}$$

Let $Z_X = Z_2 Z_4 Y_1$

$$R_X + j\omega L_X = R_2 R_4 \left(\frac{1}{R_1} + j\omega C_1\right)$$

by equating imaginary and real parts

$$R_X = \frac{R_2 R_4}{R_1}$$

and $L_X = R_2 R_4 C_1$

Quality factor of inductance which is being measured

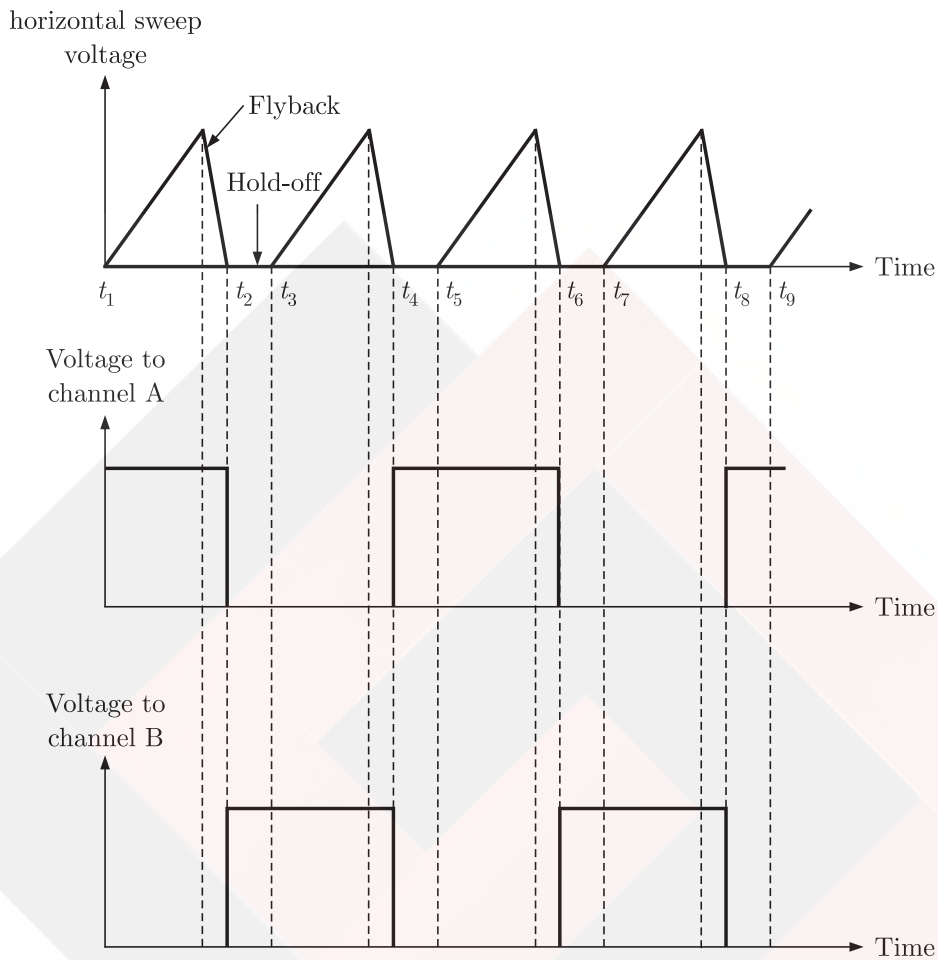
$$Q = \frac{\omega L_X}{R_X} = \omega R_1 C_1$$

From above equation we can see that for measuring high values of Q we need a large value of resistance R_4 which is not suitable. This bridge is used for measuring low Q coils.r

Note: We can observe directly that this is a maxwell's bridge which is suitable for low values of Q(i.e. $Q < 10$)

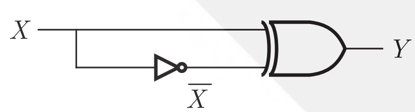
Hence (C) is correct option.

SOL 1.23 In the alternate mode it switches between channel A and channel B, letting each through for one cycle of horizontal sweep as shown in the figure.



Hence (C) is correct option.

SOL 1.24



$$\begin{aligned} Y &= X \oplus \overline{X} \\ &= X\,\overline{\overline{X}} + \overline{X}X \\ &= XX + \overline{X}\,\overline{X} \\ &= X + \overline{X} = 1 \end{aligned}$$

Hence (A) is correct option.

SOL 1.25 Once the SCR start conducting by an forward current, the gate has no control on it and the device can be brought back to the blocking state only by reducing the forward current to a level below that of holding current. This process of turn-off is called commutation. This time is known as the circuit turn-off time of an SCR. Hence (C) is correct option.

SOL 1.26

$$f_1 = 10x_2 \sin x_1 - 0.8$$

$$f_2 = 10x_2^2 - 10x_2 \cos x_1 - 0.6$$

Jacobian matrix is given by

$$J = \begin{bmatrix} \frac{\partial f_1}{\partial x_1} & \frac{\partial f_1}{\partial x_2} \\ \frac{\partial f_2}{\partial x_1} & \frac{\partial f_2}{\partial x_2} \end{bmatrix} = \begin{bmatrix} 10x_2 \cos x_1 & 10 \sin x_1 \\ 10x_2 \sin x_1 & 20x_2 - 10\cos x_1 \end{bmatrix}$$

for $x_1 = 0, x_2 = 1$

$$J = \begin{bmatrix} 10 & 0 \\ 0 & 10 \end{bmatrix}$$

Hence (B) is correct option.

SOL 1.27

$$f(x) = 2x - x^2 + 3$$

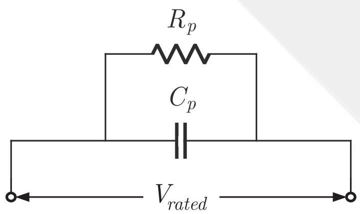
$$f'(x) = 2 - 2x = 0$$

$$x = 1$$

$$f''(x) = -2$$

$f''(x)$ is negative for $x = 1$, so the function has a maxima at $x = 1$.
Hence (C) is correct option.

SOL 1.28



Power loss $= \frac{V_{rated}^2}{R_p} = \frac{(5 \times 10^3)^2}{1.25 \times 10^6} = 20$ W

For an parallel combination of resistance and capacitor

$$\tan \delta = \frac{1}{\omega C_p R_p} = \frac{1}{2\pi \times 50 \times 1.25 \times 0.102}$$

$$= \frac{1}{40} = 0.025$$

Hence (C) is correct option.

SOL 1.29

$$f(t) \xleftrightarrow{\mathcal{L}} F_1(s)$$

$$f(t-\tau) \xleftrightarrow{\mathcal{L}} e^{-s\tau}F_1(s) = F_2(s)$$

$$G(s) = \frac{F_2(s)\,F_1^*(s)}{|F_1(s)|^2}$$

$$= \frac{e^{-s\tau}F_1(s)\,F_1^*(s)}{|F_1(s)|^2}$$

$$= \frac{e^{-sE}|F_1(s)|^2}{|F_1(s)|^2} \qquad \{\because F_1(s)\,F_1^*(s) = |F_1(s)|^2$$

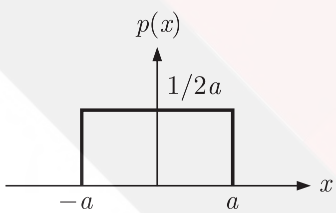
$$= e^{-s\tau}$$

Taking inverse laplace transform

$$g(t) = \mathcal{L}^{-1}[e^{-s\tau}] = \delta(t-\tau)$$

Hence (D) is correct option.

SOL 1.30 Let a signal $p(x)$ is uniformly distributed between limits $-a$ to $+a$.



Variance

$$\sigma_p = \int_{-a}^{a} x^2 p(x)\,dx$$

$$= \int_{-a}^{a} x^2 \cdot \frac{1}{2a}\,dx$$

$$= \frac{1}{2a}\left[\frac{x^3}{3}\right]_{-a}^{a}$$

$$= \frac{2a^3}{6} = \frac{a^2}{3}$$

It means square value is equal to its variance

$$p_{\text{rms}}^2 = \sigma_p = \frac{a^2}{3}$$

$$p_{\text{rms}} = \frac{a}{\sqrt{3}}$$

Hence (A) is correct option.

SOL 1.31 Initially

$$E_{b_1} = V - I_a R_a$$
$$= 220 - 1 \times 10 = 210 \text{ V}$$

Now the flux is reduced by 10% keeping the torque to be constant, so the current will be

$$I_{a_1}\phi_1 = I_{a_2}\phi_2$$

$$I_{a_2} = I_{a_1}\frac{\phi_1}{\phi_2} \qquad \therefore \phi_2 = 0.9\phi_1$$

$$= 10 \times \frac{1}{0.9} = 11.11 \text{ A}$$

$$E_b \propto N\phi$$

$$\Rightarrow \quad \frac{E_{b_2}}{E_{b_1}} = \frac{N_2\phi_2}{N_1\phi_1} = 0.9 \qquad N_1 = N_2$$

$$E_{b_2} = 0.9E_{b_1} = 0.9 \times 210$$
$$= 189 \text{ V}$$

Now adding a series resistor R in the armature resistor, we have

$$E_{b_2} = V - I_{a_2}(R_a + R)$$
$$189 = 220 - 11.11(1 + R)$$
$$R = 1.79\,\Omega$$

Hence (A) is correct option.

SOL 1.32 We know that

$$loss \propto P_G^2$$
$$loss \propto \text{length}$$

Distance of load from G_1 is 25 km Distance of load from G_2 & G_3 is 75 km generally we supply load from nearest generator. So maximum of load should be supplied from G_1. But G_2 & G_3 should be operated at same minimum generation.
Hence (A) is correct option.

SOL 1.33

$$G(s) = \frac{K\left(s + \frac{2}{3}\right)}{s^2(s + 2)}$$

Steps for plotting the root-locus
(1) Root loci starts at $s = 0, s = 0$ and $s = -2$
(2) $n > m$, therefore, number of branches of root locus $b = 3$
(3) Angle of asymptotes is given by

$$\frac{(2q + 1)180^\circ}{n - m}, \; q = 0, 1$$

(I) $\dfrac{(2\times 0+1)180^\circ}{(3-1)} = 90^\circ$

(II) $\dfrac{(2\times 1+1)180^\circ}{(3-1)} = 270^\circ$

(4) The two asymptotes intersect on real axis at centroid

$$x = \frac{\sum \text{Poles} - \sum \text{Zeroes}}{n-m}$$

$$= \frac{-2-\left(-\frac{2}{3}\right)}{3-1} = -\frac{2}{3}$$

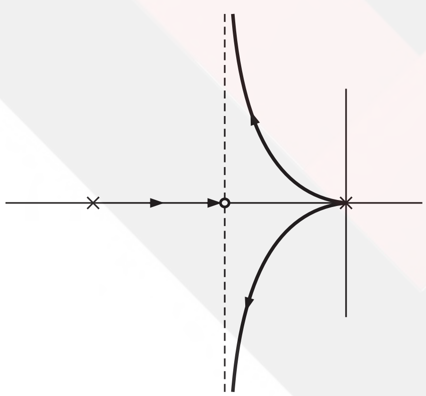
(5) Between two open-loop poles $s=0$ and $s=-2$ there exist a break away point.

$$K = -\frac{s^2(s+2)}{\left(s+\frac{2}{3}\right)}$$

$$\frac{dK}{ds} = 0$$

$$s = 0$$

Root locus is shown in the figure



Three roots with nearly equal parts exist on the left half of s-plane.
Hence (A) is correct option.

SOL 1.34

LXI D, DISP
LP : CALL SUB
LP + 3
When CALL SUB is executed LP+3 value is pushed(inserted) in the stack.

POP H $\Rightarrow HL = LP+3$

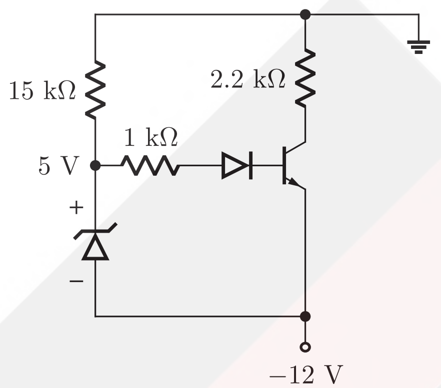
DAD D $\Rightarrow HL = HL + DE$

$= LP + 3 + DE$

PUSH H $\Rightarrow$ The last two value of the stack will be HL value i.e, $LP + DISP + 3$

Hence (C) is correct option.

SOL 1.35 Zener Diode is used as stabilizer.
The circuit is assumed to be as



We can see that both BE and BC Junction are forwarded biased. So the BJT is operating in saturation.
Collector current I_C

$$= \frac{12 - 0.2}{2.2k} = 5.36\,\text{mA}$$

Note:- In saturation mode $I_C \neq \beta I_B$
Hence (D) is correct option.

SOL 1.36 Maximum current through main thyristor

$$I_M(\max) = I_0 + V_s\sqrt{\frac{C}{L}}$$

$$= 10 + 200\sqrt{\frac{0.1 \times 10^{-6}}{1 \times 10^{3}}}$$

$$= 12\text{ A}$$

Maximum current through auxiliary thyristor

$$I_A(\max) = I_0 = 10\text{ A}$$

Hence (A) is correct option.

SOL 1.37 We know that matrix A is equal to product of lower triangular matrix L and upper triangular matrix U.

$$A = [L][U]$$

only option (D) satisfies the above relation.
Hence (D) is correct option.

SOL 1.38 Let the given two vectors are

$$\boldsymbol{X}_1 = [1, 1, 1]$$

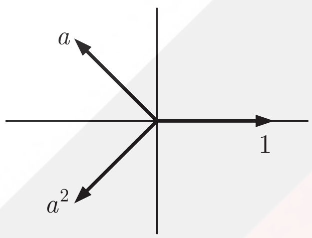
$$X_2 = [1, a, a^2]$$

Dot product of the vectors

$$\mathbf{X}_1 \cdot \mathbf{X}_2 = X_1 X_2^T = [1\ 1\ 1]\begin{bmatrix} 1 \\ a \\ a^2 \end{bmatrix} = 1 + a + a^2$$

Where

$$a = -\frac{1}{2} + j\frac{\sqrt{3}}{2} = 1\underline{/-2\pi/3}$$



so,

$$1 + a + a^2 = 0 \qquad X_1, X_2 \text{ are orthogonal}$$

Note: We can see that X_1, X_2 are not orthonormal as their magnitude is $\neq 1$

Hence (B) is correct option.

SOL 1.39 The steady state speed of magnetic field

$$n_s = \frac{120 \times 50}{6} = 1000\,\text{rpm}$$

Speed of rotor

$$n_r = (1 - S)\,n_s \qquad S = 0.05$$

$$n_r = 0.95 \times 1000 = 950\,\text{rpm}$$

In the steady state both the rotor and stator magnetic fields rotate in synchronism , so the speed of rotor field with respect to stator field would be zero.

Speed of rotor which respect to stator field

$$= n_r - n_s$$

$$= 950 - 1000 = -50\,\text{rpm}$$

None of the option matches the correct answer.

SOL 1.40 Charge

$$Q = CV \qquad \therefore\ C = \frac{\varepsilon_0 \varepsilon_r A}{d}$$

$$= \frac{\varepsilon_0 \varepsilon_r A}{d} V$$

$$= (\varepsilon_0 \varepsilon_r A)\frac{V}{d}$$

$$Q = Q_{\max}$$

Maximum electrical charge on the capacitor when

$$\frac{V}{d} = \left(\frac{V}{d}\right)_{\max} = 50\,\text{kV/cm}$$

Thus,

$$Q = 8.85 \times 10^{-14} \times 2.26 \times 20 \times 40 \times 50 \times 10^{3}$$

$$= 8\,\mu\text{C}$$

Hence (C) is correct option.

$$\varepsilon_0 = 8.85 \times 10^{-14}\,\text{F/}$$

$$\varepsilon_r = 2.26$$

$$A = 20 \times 40\,\text{cm}^2$$

$$\frac{V}{d} = 50 \times 10^{3}\,\text{kV/c}$$

SOL 1.41

$$h(t) = e^{-t} + e^{-2t}$$

Laplace transform of $h(t)$ i.e. the transfer function

$$H(s) = \frac{1}{s+1} + \frac{1}{s+2}$$

For unit step inputinput

$$r(t) = \mu(t)$$

or $R(s) = \frac{1}{s}$

Output

$$Y(s) = R(s)\,H(s) = \frac{1}{s}\left[\frac{1}{s+1} + \frac{1}{s+2}\right]$$

By partial fraction

$$Y(s) = \frac{3}{2s} - \frac{1}{s+1} - \left(\frac{1}{s+2}\right)\frac{1}{2}$$

Taking inverse laplace

$$y(t) = \frac{3}{2}u(t) - e^{-t}u(t) - \frac{e^{-2t}u(t)}{2}$$

$$= u(t)[1.5 - e^{-t} - 0.5e^{-2t}]$$

Hence (C) is correct option.

SOL 1.42 Power angle for salient pole alternator is given by

$$\tan\delta = \frac{V_t \sin\phi + I_a X_q}{V_t \cos\phi + I_a R_a}$$

Since the alternator is delivering at rated kVA rated voltage

$$I_a = 1\,\text{pu}$$

$$V_t = 1\,\text{pu}$$

$$\phi = 0^\circ$$

$$\sin\phi = 0, \quad \cos\phi = 1$$

$$X_q = 1\,\text{pu}, \quad X_d = 1.2\,\text{pu}$$

$$\tan\delta = \frac{1 \times 0 + 1(1)}{1 + 0}$$

$$= 1$$

$$\delta = 45^\circ$$

Hence B is correct option.

SOL 1.43 $4\frac{1}{2}$ digit display will read from 000.00 to 199.99 So error of 10 counts is equal to $= \pm\,0.10\,\text{V}$

For 100 V, the maximum error is

$$e = \pm\,(100 \times 0.002 + 0.1)$$

$$= \pm\,0.3\,\text{V}$$

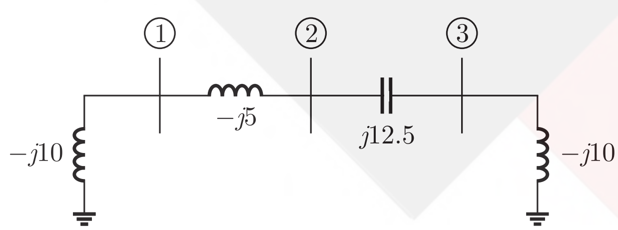
Percentage error

$$= \pm\frac{0.3 \times 100}{100}\%$$

$$= \pm\,0.3\,\%\ \text{of reading}$$

Hence (C) is correct option.

SOL 1.44 The admittance diagram is shown below



here

$$y_{10} = -\,10j, \quad y_{12} = -\,5j, \quad y_{23} = 12.5j, \quad y_{30} = -\,10j$$

Note: y_{23} is taken positive because it is capacitive.

$$Y_{11} = y_{10} + y_{12}$$

$$= -\,10j - 5j$$

$$= -\,15j$$

$$Y_{12} = Y_{21} = -y_{21} = 5j$$
$$Y_{13} = Y_{31} = -y_{13} = 0$$

$$\begin{aligned} Y_{22} &= y_{20} + y_{21} + y_{23} \\ &= 0 + (-5j) + (12.5j) \\ &= 7.5j \end{aligned}$$
$$Y_{23} = Y_{32} = -y_{23} = -12.5j$$
$$\begin{aligned} Y_{33} &= y_{30} + y_{13} + y_{23} \\ &= -10j + 0 + 12.5j \\ &= 2.5j \end{aligned}$$

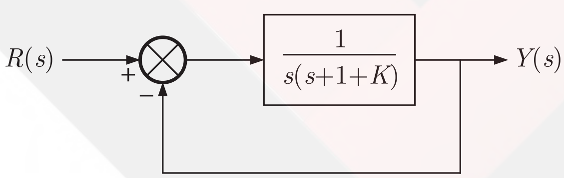
So the admittance matrix is

$$Y = \begin{bmatrix} Y_{11} & Y_{12} & Y_{13} \\ Y_{21} & Y_{22} & Y_{33} \\ Y_{31} & Y_{32} & Y_{33} \end{bmatrix}$$

$$= \begin{bmatrix} -15j & 5j & 0 \\ 5j & 7.5j & -12.5j \\ 0 & -12.5j & 2.5j \end{bmatrix}$$

Hence (B) is correct option.

SOL 1.45 The system may be reduced as shown below



$$\frac{Y(s)}{R(s)} = \frac{\frac{1}{s(s+1+K)}}{1 + \frac{1}{s(s+1+K)}} = \frac{1}{s^2 + s(1+K) + 1}$$

This is a second order system transfer function, characteristic equation is

$$s^2 + s(1+K) + 1 = 0$$

Comparing with standard form

$$s^2 + 2\xi\omega_n s + \omega_n^2 = 0$$

We get

$$\xi = \frac{1+K}{2}$$

Peak overshoot

$$M_p = e^{-\pi\xi/\sqrt{1-\xi^2}}$$

So the Peak overshoot is effected by K.
Hence (A) is correct option.

SOL 1.46 The characteristics equation of the JK flip-flop is

$$Q_{n+1} = J\overline{Q}_n + \overline{K}Q_n \qquad Q_{n+1} \text{ is the next state}$$

From figure it is clear that

$$J = \overline{Q_B}; K = Q_B$$

The output of JK flip flop

$$Q_{A(n+1)} = \overline{Q_B}\,\overline{Q_A} + \overline{Q_B}\,Q_A$$
$$= \overline{Q_B}(\overline{Q_A} + Q_A)$$
$$= \overline{Q_B}$$

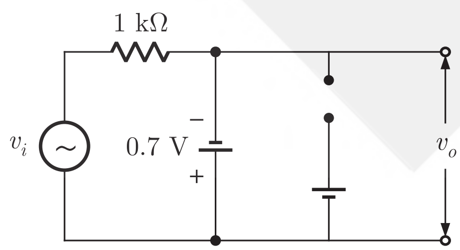
Output of T flip-flop

$$Q_{B(n+1)} = \overline{Q}_A$$

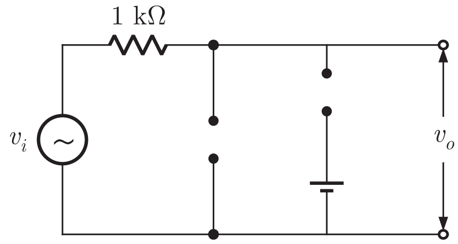
Clock pulse	Q_A	Q_B	$Q_{A(n+1)}$	$Q_{B(n+1)}$
Initially(t_n)	1	0	1	0
$t_n + 1$	1	0	1	0
$t_n + 2$	1	0	1	0
$t_n + 3$	1	0	1	0

Hence (C) is correct option.

SOL 1.47 We can obtain three operating regions depending on whether the Zener and PN diodes are forward biased or reversed biased.
1. $v_i \leq -0.7$ V, zener diode becomes forward biased and diode D will be off so the equivalent circuit looks like



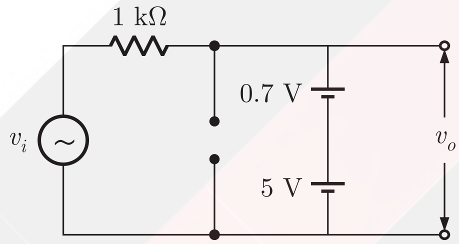
The output $v_o = -0.7$ V
2. When $-0.7 < v_i \leq 5.7$, both zener and diode D will be off. The circuit is



Output follows input i.e $v_o = v_i$

Note that zener goes in reverse breakdown(i.e acts as a constant battery) only when difference between its p-n junction voltages exceeds 10 V.

3. When $v_i > 5.7$ V, the diode D will be forward biased and zener remains off, the equivalent circuit is



$$v_o = 5 + 0.7 = 5.7 \text{ V}$$

Hence (C) is correct option.

SOL 1.48

$$v_i = 100\sqrt{2}\sin(100\pi t) \text{ V}$$

Fundamental component of current

$$i_{i_1} = 10\sqrt{2}\sin(100\pi t - \pi/3) \text{ A}$$

Input power factor

$$pf = \frac{I_{1(rms)}}{I_{rms}}\cos\phi_1$$

$I_{1(rms)}$ is rms values of fundamental component of current and I_{rms} is the rms value of converter current.

$$pf = \frac{10}{\sqrt{10^2 + 5^2 + 2^2}}\cos\pi/3 \quad = 0.44$$

Hence (C) is correct option.

SOL 1.49 Only the fundamental component of current contributes to the mean ac input power. The power due to the harmonic components of current is zero.

So, $P_{\text{in}} = V_{rms} I_{1rms}\cos\phi_1$

$$= 100 \times 10\cos\pi/3$$
$$= 500 \text{ W}$$

Hence (B) is correct option.

SOL 1.50 Power delivered by the source will be equal to power dissipated by the resistor.

$$P = V_s I_s \cos \pi/4$$

$$= 1 \times \sqrt{2} \cos \pi/4 = 1\,\text{W}$$

Hence (B) is correct option.

SOL 1.51

$$\overline{I_C} = \overline{I_s} - \overline{I_{RL}} = \sqrt{2}\,\underline{/\pi/4} - \sqrt{2}\,\underline{/-\pi/4}$$

$$= \sqrt{2}\left\{(\cos\pi/4 + j\sin\pi/4) - (\cos\pi/4 - j\sin\pi/4)\right\}$$

$$= 2\sqrt{2}\,j\sin\pi/4$$

$$\overline{I_C} = 2j$$

Hence (D) is correct option.

SOL 1.52 For generator G_1

$$X''_{G_1} = 0.25 \times \frac{100}{250} = 0.1\,\text{pu}$$

For generator G_2

$$X''_{G_1} = 0.10 \times \frac{100}{100} = 0.1\,\text{pu}$$

$$X_{L_2} = X_{L_1} = 0.225 \times 10 = 2.25\,\Omega$$

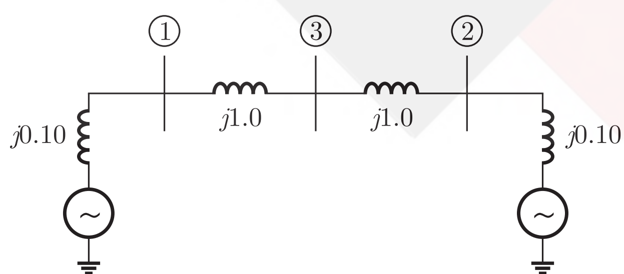
For transmission lines L_1 and L_2

$$Z_{\text{base}} = \frac{kV_{\text{base}}^2}{MVA_{\text{base}}} = \frac{15 \times 15}{100} = 2.25\,\Omega$$

$$\therefore \quad X''_{L_2}(\text{pu}) = \frac{2.25}{2.25} = 1\,\text{pu}$$

$$X''_{L_1}(\text{pu}) = \frac{2.25}{2.25} = 1\,\text{pu}$$

So the equivalent pu reactance diagram



Hence (A) is correct option.

SOL 1.53 We can see that at the bus 3, equivalent thevenin's impedance is given by

$$X_{th} = (j0.1 + j1.0) \,||\, (j0.1 + j1.0)$$

$$= j1.1 \,||\, j1.1$$
$$= j0.55 \text{ pu}$$

Fault MVA $= \dfrac{\text{Base MVA}}{X_{th}}$

$$= \frac{100}{0.55} = 181.82 \text{ MVA}$$

Hence (D) is correct option.

SOL 1.54 Output voltage of 3-phase bridge converter

$$V_0 = \frac{3\sqrt{3}}{\pi} V_{ph} \cos\alpha$$

Maximum output

$$(V_0)_{\max} = \frac{3\sqrt{3}}{\pi} V_{ph} \quad \cos\alpha = 1$$
$$= \frac{3\sqrt{3}}{\pi} \times \frac{400 \times \sqrt{2}}{\sqrt{3}}$$
$$= 540.6 \text{ V}$$

Resistance of filter choke is $10\,\Omega$, So

$$(V_0)_{\max} = E + IR_{\text{chock}}$$
$$540.6 = 400 + I(10)$$
$$I \simeq 14 \text{ A}$$

Hence A is correct option.

SOL 1.55

$$\text{kVA rating} = \sqrt{3}\, V_L I_L = \sqrt{3} \times 400 \times \frac{\sqrt{6}}{\pi} \times 14$$
$$= 7.5 \text{ kVA}$$

Hence (D) is correct option.

SOL 1.56 Let us assume total voters are 100. Thus 40 voter (i.e. 40 %) promised to vote for P and 60 (rest 60 %) promised to vote fore Q.

Now, 15% changed from P to Q (15 % out of 40)

Changed voter from P to Q $\quad \dfrac{15}{100} \times 40 = 6$

Now Voter for P $\quad 40 - 6 = 34$

Also, 25% changed form Q to P (out of 60%)

Changed voter from Q to P $\quad \dfrac{25}{100} \times 60 = 15$

Now Voter for P $\quad 34 + 15 = 49$

Thus P P got 49 votes and Q got 51 votes, and P lost by 2 votes, which is given.

Therefore 100 voter is true value.
Hence (A) is correct option.

SOL 1.57 The sentence implies that technocrats are counterproductive (negative). Only (C) can bring the same meaning.
Hence (C) is correct option.

SOL 1.58 Periodicity is almost similar to frequency. Gradualness means something happening with time. Persistency is endurance. Rarity is opposite to frequency.
Hence (B) is correct option.

SOL 1.59 Available is appropriate because manipulation of genes will be done when other treatments are not useful.
Hence (D) is correct option.

SOL 1.60 A gladiator performs in an arena. Commutators use trains. Lawyers performs, but do not entertain like a gladiator. Similarly, teachers educate. Only dancers performs on a stage.
Hence (A) is correct option.

SOL 1.61 Since fuel consumption/litre is asked and not total fuel consumed, only average speed is relevant. Maximum efficiency comes at 45 km/hr, So least fuel consumer per litre in lap Q
Hence (B) is correct option.

SOL 1.62

Let total no of toffees be x. The following table shows the all calculations.

	Friend	Bowl Status
R	$=\frac{x}{3}-4$	$=\frac{2x}{3}+4$
S	$=\frac{1}{4}\left[\frac{2x}{3}+4\right]-3$ $=\frac{x}{6}+1-3=\frac{x}{6}-2$	$=\frac{2x}{3}+4-\frac{x}{6}+2$ $=\frac{x}{2}+6$
T	$=\frac{1}{2}\left(\frac{x}{2}+6\right)-2$ $=\frac{x}{4}+1$	$=\frac{x}{2}+6-\frac{x}{4}-1$ $=\frac{x}{4}+5$

Now, $\frac{x}{4}+5=17$

or $\frac{x}{4}=17-5=12$

$x=12\times 4=48$

Hence (C) is correct option.

SOL 1.63

$$f(y) = \frac{|y|}{y}$$

Now $\quad f(-y) = \frac{|-y|}{y} = -f(y)$

or $|f(q) - f(-q)| = |2f(q)| = 2$

Hence (D) is correct option.

SOL 1.64

$$4 + 44 + 444 + \text{.............} \; 4(1 + 11 + 111 + \text{.......})$$
$$= \frac{4}{9}(9 + 99 + 999 + \text{............})$$
$$= \frac{4}{9}[(10 - 1) + (100 - 1) + \text{........}]$$
$$= \frac{4}{9}[10(1 + 10 + 10^2 + 10^3) - n]$$
$$= \frac{4}{9}\left[10 \times \frac{10^n - 1}{10 - 1} - n\right]$$
$$= \frac{4}{81}[10^{n+1} - 10 - 9n]$$

Hence (C) is correct option.

SOL 1.65 Option B fits the sentence, as they built up immunities which helped humans create serums from their blood.
Hence (B) is correct option.

ANSWER KEY

1. (D)	**26.** (B)	**51.** (D)
2. (A)	**27.** (C)	**52.** (A)
3. (B)	**28.** (C)	**53.** (D)
4. (D)	**29.** (D)	**54.** (A)
5. (A)	**30.** (A)	**55.** (D)
6. (B)	**31.** (A)	**56.** (A)
7. (A)	**32.** (A)	**57.** (C)
8. (A)	**33.** (A)	**58.** (B)
9. (A)	**34.** (C)	**59.** (D)
10. (A)	**35.** (D)	**60.** (D)
11. (D)	**36.** (A)	**61.** (A)
12. (D)	**37.** (D)	**62.** (C)
13. (C)	**38.** (B)	**63.** (D)
14. (D)	**39.** *	**64.** (C)
15. (D)	**40.** (C)	**65.** (B)
16. (A)	**41.** (C)	
17. (A)	**42.** (B)	
18. (C)	**43.** (C)	
19. (A)	**44.** (B)	
20. (C)	**45.** (A)	
21. (B)	**46.** (C)	
22. (C)	**47.** (C)	
23. (C)	**48.** (C)	
24. (A)	**49.** (B)	
25. (C)	**50.** (B)	