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PRE GATE - 2018
Questions with Detailed Solutions

ELECTRICAL ENGINEERING

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PRE GATE - 2018

Electrical Engineering

The GA section consists of 10 questions. Questions 1 to 5 are of 1 mark each, and

Questions 6 to 10 are of 2 marks each.

01. ***Choose the most appropriate word from the options given below to complete the following sentence:***

If I had known that you were coming, I _______________ you at the airport.

(A) would have met (B) shall have met (C) would meet (D) would have meeting

Ans: (A)

Exp: Conditional tense type three should be if clause (had+v3) and the main clause (would+have+v3)

02. ***In the following sentence certain parts are underlined and marked P, Q and R. One of the parts may contain error or may not be acceptable in standard written communication.***

Select the part containing an error. Choose D as your answer if there is no error.

They found (P) that five prisoners escaped (Q) the previous night. (R) No error (D)

(A) P (B) Q

(C) R (D) No error

Ans: (B)

Exp: In part 'Q' it should be 'prisoners had escaped' because the earlier action of the past should be in past perfect tense (had + v3).

03. ***The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair.***

LAVA : VOLCANO ::

(A) ice : glass

(B) cascade : precipice

(C) steam : geyser

(D) avalanche : ice

Ans: (C)

Exp: (DEFINING CHARACTERISTIC) A volcano gives out lava (meaning molten rock); a geyser (meaning a natural hot spring) gives out steam.

04. If “JUICE” is coded as “19-41-17-5-9”, then “TOY” will be coded as

(A) 39-29-49 (B) 41-31-51

(C) 13-23-3 (D) 15-25-5

Ans: **(A)**

Sol:

AS,

10	21	9	3	5
J	U	I	C	E
↓	↓	↓	↓	↓
10×2	21×2	9×2	3×2	5×2
↓ −1	↓ −1	↓ −1	↓ −1	↓ −1
19	41	17	5	9

Same as,

20	15	25
T	O	Y
↓	↓	↓
20×2	15×2	25×2
↓ −1	↓ −1	↓ −1
39	29	49

But in option (B)

20	15	25
T	O	Y
↓	↓	↓
20×2	15×2	25×2
↓ +1	↓ +1	↓ −1
41	31	51

It is not in that code

Option (C) and (D) are not correct

05. ***Fill in the blanks with an appropriate idiom***

Let us have your terms ____________

(A) through thick and thin

(B) in black and white

(C) ins and outs

(D) at cross-purposes

Ans: (B)

DLOA: through thick and thin means under all conditions

DLOB: correct answer - in black and white means in writing

DLOC: ins and outs means full details

DLOD: at cross-purposes means misunderstand each other

So the right option is 'B'

06. **Statement:** These apples are too expensive to be bad.

Which of the following can be logically inferred from the above statement?

I. The higher the selling price, the superior is the quality of the commodity.

II. when apples are in short supply, the prices go up.

(A) only I (B) only II

(C) I & II (D) None of the above

Ans: (A)

Exp: The second conclusion is irrelevant. The first is the meaning of the given statement. 'Too expensive to be bad' means that it can't be bad because it is expensive.

07. A postman walked 7 km north from the post office to reach Mr. Singh's house. He then took a left turn and walked 4 km to reach Mr. Kumar's house. He then took a right turn and walked 3 km to reach Mr. Sharma's house. The distance between Mr. Sharma's and Mr. Singh's house is ______

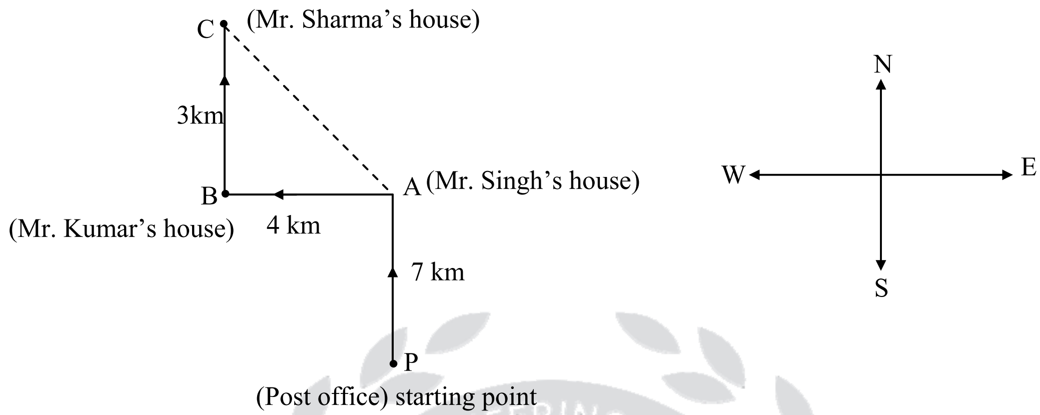
(A) 5 km (B) 6 km

(C) 4 km (D) 7 km

Ans: (A)

Sol:

Let the postman started from the point P which denote post office.



We have to find the distance between A and C so, applying Pythagoras theorem,

$AC^2 = AB^2 + BC^2 = 16 + 9$

$AC^2 = 25$

$AC = \sqrt{25} = 5$ cm

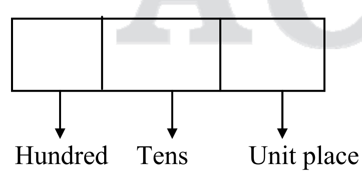
So, distance between Mr. Sharma's and Mr. Singh's house is 5 km.

08. How many 3-digit even number can be formed from the digits 1, 2, 3, 4, 5, 6, if the digits can be repeated?

(A) 216 (B) 108 (C) 96 (D) 54

Ans: (B)

Sol:



We know that, a number is called even, if its unit's place is occupied by an even digit (i.e) 2,4,6

So, for unit place, we have 3 options

For tens place, there are 6 options

For hundred place, there are 6 options

[repetition allowed]

$\therefore$ Total number of ways in which 3 digit even numbers can be formed = $3\times6\times6 = 108$

09. Examine the information given below

All the leaders are believable

Some believable persons are intelligent

Which of the following is a valid conclusion regarding the above arguments?

(A) All the leaders are intelligent

(B) some leaders are believable

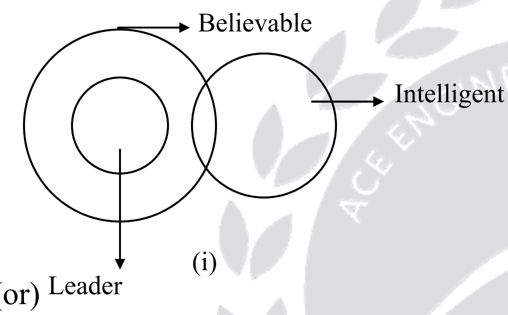
(C) All the intelligent persons are leaders

(D) some believable persons are leaders

Ans: (D)

Sol: The given statements can be represented as

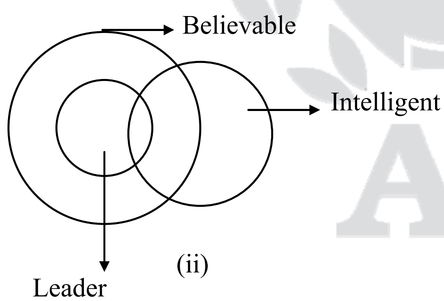
Case – I



(i)

(or)

Case – II



(ii)

From above two diagrams

Hence, option (D) is correct

10. A shopkeeper sells note books at the rate of ₹457 each and earns a commission of 4%. He also sells pencil boxes at the rate of ₹80 each and earns a commission of 20%. How much amount of commission will he earn in two weeks, if he sells 10 note books and 6 pencil boxes a day?

(A) ₹1956 (B) ₹1586

(C) ₹1496 (D) None of these

Ans: (D)

Sol: S.P of the note book = ₹457

$\therefore$ Commission on one note book = ₹ $\frac{4\times 457}{100}$

and commission on 10 note books $= \frac{10\times 4\times 457}{100}$ = ₹ 182.80

and S.P of the pencil box = ₹80

$\therefore$ Commission on one pencil box = ₹ $\frac{80\times 20}{100}$

Commission on 6 pencil boxes = $\frac{80\times 20\times 6}{100}$ = ₹96

Hence, total commission of one day = (182.80+96) = ₹ 278.80

Thus, total commission of two weeks = 278.80× 14 = ₹3903.20

Option (A) is not correct
Option (B) is not correct
Option (C) is not correct
$\therefore$ None of these is the answer

The subject specific section of EE consists of 55 questions, out of which question numbers 1 to 25 are of 1 mark each, while question numbers 26 to 55 are of 2 marks each

01. The regulation constant of 200 MW, 50 Hz generator is 0.02 Hz/MW. The machine is supplying initially 150 MW power at rated frequency. The no load frequency is

(A) 50 Hz
(B) 53 Hz
(C) 47 Hz
(D) 50.75 Hz

01. Ans: (B)

Sol: $P_D = 150$ MW, $f = f_r = 50$ Hz

if $P_D = 0$ MW, $f = ?$

$\Delta P_g = -150$ MW

$\Delta f = -R \times \Delta P_g = -0.02 \times -150$

$= 3$ Hz

$f = f_r + \Delta f = 50 + 3 \Rightarrow 53$ Hz

Distractor Logic

DLOA: Generally No load frequency assumed as rated frequency if loading condition not given.

DLOB: Correct Answer

DLOC: $\Delta f = R \times \Delta P_g$

$= 0.02 \times -150$

$= -3$Hz

$f = f_r + \Delta f = 50 - 3 = 47$ Hz

DLOD: $R = 0.02$ pu $= 2\%$

$\Delta f = 1$Hz if $\Delta P_g = 200$

$\Delta f = ?$ $\quad \Delta P_g = 150$

$$\Delta f = \frac{150 \times 1}{200} = 0.75\text{Hz}$$

$f = f_r + \Delta f = 50 + 0.75 = 50.75$ Hz

02. Characteristic equation of a system is given as $s^3+ks^2+2s+10=0$. Then the value of 'k' to obtain sustained oscillations is ______.

02. Ans: 5 (Range 5 to 5)

Sol:

s^3	1	2
s^2	k	10
s^1	$\frac{2k-10}{k}$	
s^0	10	

$2k - 10 = 0$

$k = 5$

At k = 5 system marginally stable and it will oscillates with a frequency of $\sqrt{2}$ rad/sec

03. If $A = \begin{bmatrix} -3 & 1 \\ 2 & +3 \end{bmatrix}$ then $A^{100} = ?$

(A) $11^{50}\ I$

(B) $11^{100}\ I$

(C) $11^{50}\ A$

(D) $11^{100}\ A$

03. Ans: (A)

Sol: The characteristic equation is $|A - \lambda I| = \lambda^2 - 0.\lambda - 11 = 0$

$\Rightarrow \lambda^2 - 11 = 0$

By Cayley-Hamilton theorem

$A^2 - (11)I = 0$

$A^2 = (11)I$

$A^{100} = (A^2)^{50} = (11\ I)^{50} = 11^{50}\ I$

04. A single rectangular wire loop with length 50 cm and breadth 25cm is placed in a magnetic field, such that its plane is normal to the field. The magnetic field intensity is given as H = 8 cosωt A/m. If the peak value of frequency is 10^6 C.P.S, then the maximum value of magnitude of induced emf (in millivolts) in the loop is _______. (Give the answer upto two decimal places)

04. Ans: 7895.68 (Range 7894 to 7896)

Sol: Given; Dimensions of the loop

Area, $S = 50\times25\times10^{-4}m^2$

Magnetic field intensity,

$H=8\cos\omega t$

$\omega=2\pi f = 2\pi\times10^6$ rad/sec

$B = \mu_0 H$

$B = 8\mu_0 \cos\omega t$

From Faraday's law,

$$\text{e.m.f, } e = -\frac{\partial\vec{B}}{\partial t}.\vec{S}$$

$$= -\frac{\partial B}{\partial t}\hat{a}_n.S\hat{a}_n$$

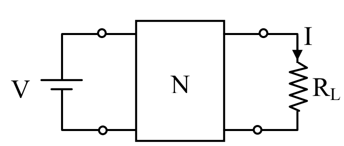
$$= 8\times\mu_0\omega \sin\omega t\times50\times25\times10^{-4}$$

$$emf/_{max} = 8\times4\pi\times10^{-7}\times2\pi\times10^6\times50\times25\times10^{-4}$$

$$= 7895.6835\times10^{-3}$$

$\therefore emf/_{max}$=7895.68 mVolt

05. Consider the following network



Network 'N' contains dependent sources with only resistances

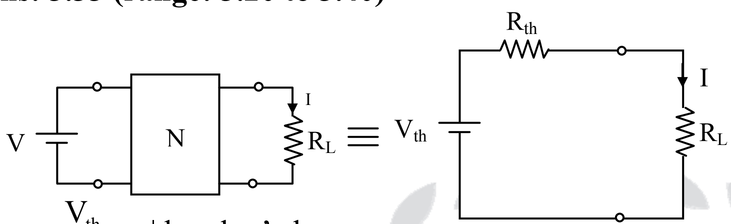
i. If V = 10 V and R_L = 0 Ω; then I =2 A

ii. If V = 10 V and R_L = 2 Ω; then I =1 A

When V = 100 V and R_L = 10 Ω, then the current 'I' in amperes is _____. (Give the answer upto two decimal places)

05. Ans: 3.33 (range: 3.20 to 3.40)

Sol:



$$I = \frac{V_{th}}{R_{th} + R_L} \text{ | by ohm's law}$$

$$\Rightarrow 2 = \frac{V_{th}}{R_{th} + 0} \text{ ..... (1)}$$

$$\Rightarrow 1 = \frac{V_{th}}{R_{th} + 2} \text{ ..... (2)}$$

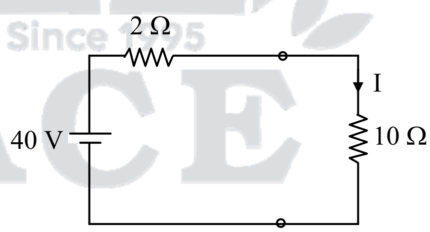
From equations (1) & (2) V_{th} = 4 V & R_{th} = 2 Ω.

By Homogeneity principle, if V = 100 V then V_{th} = 10 × 4 V = 40 V.

But R_{th} is independent of the source magnitude.

So,

$$\Rightarrow I = \left(\frac{40}{2+10}\right)A = \frac{10}{3}A = 3.33\,A$$



06. In a uniform region of free space, if the electric field intensity is given by $\vec{E} = \hat{x}4x + \hat{y}3y$ Volt/m, then the potential at X(0,2,2) with respect to Y(2,2,2) is

(A) 8 V (B) –8 V

(C) –16 V (D) 16 V

06. Ans: (A)

Sol: Potential at X with respect to Y is given by $V_{XY} = -\int_{Y(2,2,2)}^{X(0,2,2)} \vec{E}.\overrightarrow{d\ell}$

$$= -\left[\int_{2}^{0} 4x dx + \int_{2}^{2} 3y dy\right]$$

$$\therefore V_{XY} = -4\frac{X^2}{2}\Big|_{2}^{0} = 8V$$

Distractor Logic:

Option A: Correct option

Option B: If we take $V_{XY} = -\int_{X}^{Y} \vec{E}.\overrightarrow{d\ell}$

Then V_{XY} will be –8V, which is wrong answer.

Option C: $V_{XY} = -\left[\int_{0}^{2} 4x\, dx + \int_{2}^{2} 3y dy\right]$

$= -4x^2 |_0^2 = -16\text{Volt}$, which is incorrect answer

Option D: $V_{XY} = \left[\int_{0}^{2} 4x\, dx + \int_{2}^{2} 3y dy\right]$

$= 4x^2 |_0^2 = 16\text{Volt}$, which is wrong answer

07. The system poles are located on imaginary axis with multiplicity then its corresponding impulse response is

(A) A sinusoidal oscillations which decays exponentially, the system is therefore stable.

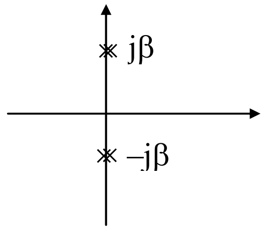
(B) A sinusoidal oscillations with time multiplies.

(C) A sinusoidal oscillations which exponentially rises with time.

(D) A sinusoidal oscillations with constant peaks.

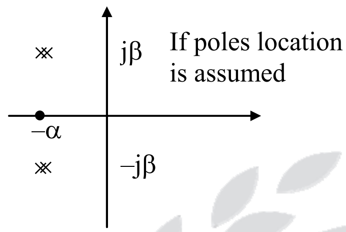
07. Ans: (B)

Sol: IR = t sin βt u(t)



Distractor Logic:

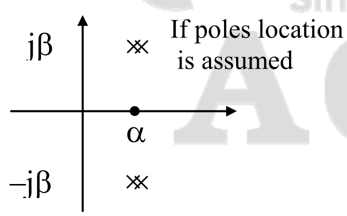
DLOA:



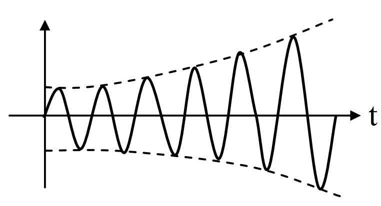
IR= $te^{-\alpha t}\sin\beta t\, u(t)$

DLOB: Correct Answer

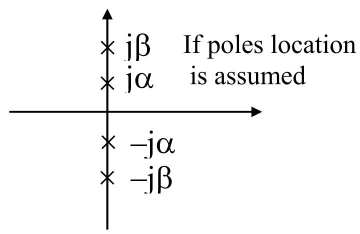
DLOC:



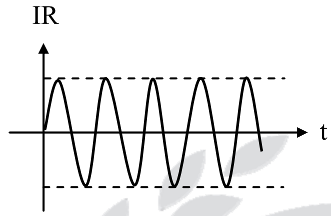
IR=$te^{\alpha t}\sin\beta t\, u(t)$



DLOD:



$IR = (\sin\alpha t + \sin\beta t)\, u(t)$



08. The value of the integral $\int_c \frac{\cos z}{(z-\pi)} dz$ where c is $|z-1| = 3$ is

(A) $-2\pi i$ (B) $2\pi i$

(C) πi (D) $-\pi i$

08. Ans: (A)

Sol: The singular point $z = \pi = 3.14$ lies inside the circle C: $|z-1| = 3$

$$\int_c \frac{\cos z}{(z-\pi)} dz = 2\pi i f(\pi) \quad \text{where } f(z) = \cos z$$

$$= 2\pi i \cos(\pi) \Rightarrow -2\pi i$$

09. A 50 kVA, 400 V, 3-phase, 50 Hz star connected squirrel cage induction motor has full load slip of 5%. Its stand still impedance is 0.866 Ω/ph. It is started using a tapped auto-transformer. If the maximum allowable supply current at the time of starting is 100 A, then the percentage of tap position (k) is __________. (Give the answer upto two decimal places)

09. Ans: 61.23 (Range: 61 to 62)

Sol: Given data: 50 kVA, I_{st} = 100A, V_L=400 V, S_{fl} = 5% = 0.05 and standstill impedance, $Z_{0_1} = 0.866\ \Omega/\text{ph}$

Short-circuit current, $I_{sc} = \dfrac{400/\sqrt{3}}{0.866} = 266.7\text{A}$

Tap position of the transformer, $k = \sqrt{\dfrac{I_{st}}{I_{sc}}}$

$$= \sqrt{\frac{100}{266.7}} = 0.6123$$

Tap position of the transformer in percentage = 61.23%

10. Let the signal be defined as $x(t) = 4\cos t - 5\sin^2 2t + 6\cos 4t$.

The total power of the signal is

(A) 38.5 W (B) 35.3 W

(C) 40 W (D) 15 W

10. Ans: (B)

Sol: $P = A_0^2 + \dfrac{1}{2}\left(A_1^2 + A_2^2 + ...\right)$

$$x(t) = 4\cos t - 5\left(\frac{1-\cos 4t}{2}\right) + 6\cos 4t$$

$$= 4\cos t - \frac{5}{2} + \frac{5}{2}\cos 4t + 6\cos 4t$$

$$\therefore\ P = \frac{25}{4} + \frac{1}{2}\left(16 + \frac{25}{4} + 36\right)$$

$$= 6.25 + \frac{1}{2}(58.25)$$

$$= 35.375\text{ W}$$

Distractor Logic:

DLOA:

$$P = A_0^2 + \frac{1}{2}\left(A_1^2 + A_2^2 + A_3^2 + ...\right)$$

$$P = 0 + \frac{1}{2}(16 + 25 + 36) = 38.5\ W$$

P = 38.5 W

DLOB:

Correct answer

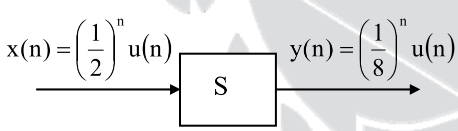
DLOC:

40 W

DLOD:

P = (4 + 5 + 6) = 15 W

11. Consider the following system 'S' where x(n) is the input and y(n) is the output



(A) The system 'S' is non-linear, TIV, unstable

(B) The system 'S' is non-linear, TIV, stable

(C) The system 'S' is linear, TV, unstable

(D) The system 'S' is linear, TV, stable

11. Ans: (B)

Sol: Bounded input is producing the bounded output $\therefore$ stable

The system is non-linear because it follows $y(n) = x^3(n)$

It is time Invariant because no-operations are made on 'n'.

Distractor Logic:

DLOA:

ROC does not induce unit circle

DLOB:

Correct Answer

DLOC:

$\therefore$ Unstable system

DLOD:

It satisfies homogeneity

$\therefore$ Linear system

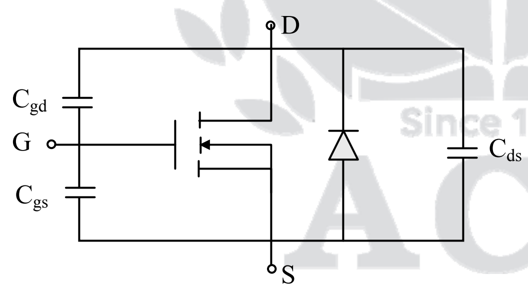
12. In power MOSFET, the switching loss can be expressed as a function of

(A) Gate to source capacitance [C_{gs}] (B) Drain to source capacitance [C_{ds}]

(C) Gate to drain capacitance [C_{gd}] (D) All the above

12. Ans: (B)

Sol:



During off state, C_{ds} will be charged to external source voltages between Drain and source. During turn-on, energy stored in C_{ds} will be dissipated through device. Hence, P_{sw} is function of C_{ds}.

Distractor Logic

DLOA:

Capacitance C_{gs} vary with the voltage across gate and source because part of capacitance is contributed by depletion layer. Hence, P_{sw} is function of C_{gs}.

DLOB:

Correct Answer

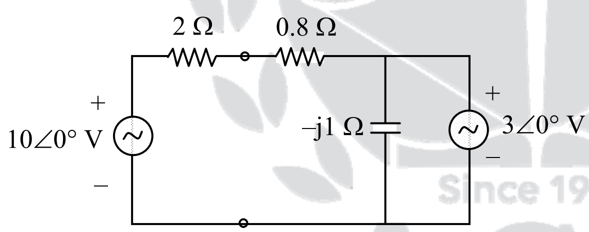
DLOC:

Capacitance C_{gd} vary with the voltage across gate and drain because part of capacitance is contributed by depletion layer. Hence, P_{sw} is function of C_{gd}.

DLOD:

- During off state, C_{ds} will be charged to external source voltage between Drain and source. During turn-on, energy stored in C_{ds} will be dissipated through device. Hence, P_{sw} is function of C_{ds}.
- Capacitance C_{gs} vary with the voltage across gate and source because part of capacitance is contributed by depletion layer. Hence, P_{sw} is function of C_{gs}.
- Capacitance C_{gd} vary with the voltage across gate and drain because part of capacitance is contributed by depletion layer. Hence, P_{sw} is function of C_{gd}.

13. Consider the following circuit.



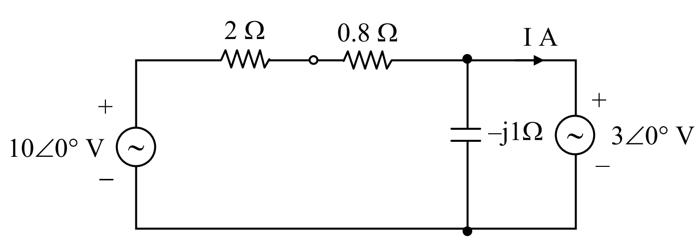
The voltage source $3\angle 0°$ V

(A) delivers 9 W (B) absorbs 7.5 W.

(C) delivers 9 VAR (D) absorbs 7.5 VAR.

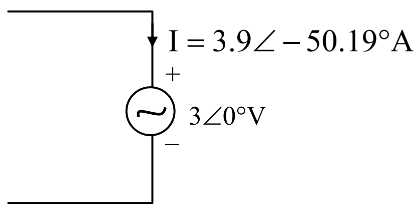
13. Ans: (B)

Sol:



$I = [2.5\angle 0°] - [3\angle 90°]A$

$I = 3.9\angle -50.19°A$



$S^* = V.I^* = [3\angle 0°][3.9\angle +50.19°]$

$= [11.7\angle +50.19°]$

$$= \underset{P}{\underset{\downarrow}{7.5}} + \underset{Q_L}{\underset{\downarrow}{j9}}$$

Absorbs real power 7.5 W

Absorbs reactive power (lagging) of 9 VAR

Distractor Logic

DLOA:

'j' is over looked and 9 W is selected as absorbed power.

DLOB:

Correct Answer.

DLOC:

Ignoring the fact that current is entering the '+' of the 3 V source, the source is selected as delivering 9 VAR.

DLOD:

Complex power absorbed by the source is taken by mistake as 3 (3 + j2.5).

14. A three-phase sinusoidal PWM inverter operates from a dc link voltage of 500V. For modulation index of 0.8, the RMS value of fundamental line to line voltage (in volt) will be equal to _____. (Give the answer upto two decimal places)

14. Ans: 244.8 (Range 244 to 246)

Sol: The line to line voltage at fundamental frequency can be written as, $\hat{v}_{ph1} \propto m_a$

The peak value of the phase voltage ($\hat{v}_{ph1}$)

$$\hat{v}_{ph1} = m_a \times \frac{V_{dc}}{2}$$

$$V_{LL1(rms)} = \frac{\sqrt{3}}{\sqrt{2}} \times m_a \times \frac{V_{dc}}{2}$$

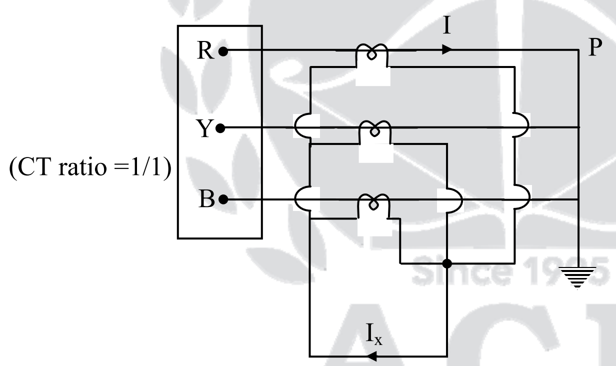
$$= 0.612 \times m_a \times V_{dc}$$

$$V_{LL\,1(rms)} = 0.612 \times m_a \times V_{dc}$$

$$= 0.612 \times 0.8 \times 500$$

$$= 244.8\text{V}$$

15. A 3-ϕ fault occurs at location ‘P’ in the system shown in below figure with line current is I = 10A



The magnitude of current I_x (in Ampere) is ______.

15. Ans: 0

Sol: As fault occurs at ‘P’ ⇒ it draws current from all 3-phases

As CT ratio is 1/1 ⇒ balanced currents $I\angle 0°$, $I\angle -120°$, $I\angle +120°$ will flow on the secondary side of CT

$I_x = 10\angle 0° + 10\angle -120° + 10\angle +120° = 0$

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18 PI
18 PI Venkatesh
19 CE Ashish
19 EE Sachin Kumar
20 EE Monika Tiwari
20 EC
20 CS
20 IN Suraj Kumar
20 IN Saurabh Pandey
... and many more

16. The solution of the differential equation $e^{x-y}\,dx + e^{y-x}\,dy = 0$ is

(A) $e^{x} + e^{-y} = c$ (B) $e^{2x} + e^{-2y} = c$

(C) $e^{2x} + e^{2y} = c$ (D) $e^{-2x} + e^{-2y} = c$

16. Ans: (C)

Sol: $e^{x-y}dx + e^{y-x}dy = 0$

$$\frac{e^x}{e^y}dx + \frac{e^y}{e^x}dy = 0$$

$$\int e^{2x}\ dx + \int e^{2y}\ dy = k$$

$$\frac{e^{2x}}{2} + \frac{e^{2y}}{2} = k$$

$$e^{2x} + e^{2y} = 2k$$

$$e^{2x} + e^{2y} = c$$

(Here c, k are constants)

17. The resistance of a moving coil voltmeter is 12 kΩ. The moving coil has 100 turns and is 4 cm long and 3 cm wide with a control spring constant 25×10^{-7} N-m/deg. The flux density in the air gap is 6×10^{-2} Wb/m^2. If 300 V, DC is applied across the meter, then the deflection of the meter(in degrees) is________.

17. Ans: 72 (Range: 72 to 72)

Sol: Given, Voltmeter resistance (R_v) = 12 kΩ ,

Spring constant , (k_c) = 25×10^{-7} N-m/deg,

Flux density (B) = 6×10^{-2} Wb/m^2 ,

Number of turns (N)= 100 and

Area (A) = 4×3 c.m^2

As the voltmeter also current deflection meter

$I \propto V$

$$I = \frac{V}{R} = \frac{300}{12\,k\Omega} = 25\ mA$$

As Controlling torque =Deflection torque

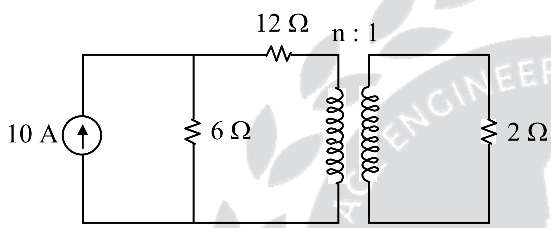
$T_c = T_d$

$k_c\theta = BINA$

$$25\times10^{-7}\times\theta = 6\times10^{-2}\times25\times10^{-3}\times100\times12\times10^{-4}$$

$\theta = 72°$

18. Consider the following network. The value of 'n' for maximum power in 2 Ω resistor is



(A) 3

(B) 1/3

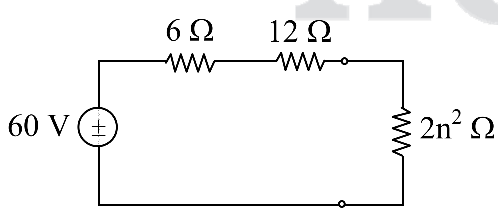
(C) $\sqrt{2}$

(D) $\frac{1}{\sqrt{2}}$

18. Ans: (A)

Sol: Load resistance referred to primary = $2n^2\ \Omega$.

Converting the practical current source of the question into an equivalent voltage source and assuming the transformer to be ideal, the following circuit is obtained.



For maximum power transfer to the load, $2n^2 = 6 + 12 = 18 \Rightarrow n = 3$.

Distractor Logic:

DLOA:

Correct answer

DLOB:

If transformation is taken as $\frac{N_1}{N_2} = n$

$$\Rightarrow \frac{R_L}{n^2} = 18$$

$$\Rightarrow \frac{2}{n^2} = 18$$

$$\Rightarrow n = \frac{1}{3}$$

DLOC:

If source resistance is taken as

$$R_s = \frac{6\times12}{6+12} = \frac{6\times12}{18} = 4\ \Omega$$

$$\Rightarrow 2n^2 = 4$$

$$\Rightarrow n = \sqrt{2}$$

DLOD:

If source resistance is taken as

$$R_s = \frac{6\times12}{6+12} = 4\ \Omega$$

$$\Rightarrow \frac{2}{n^2} = 4 \Rightarrow n = \frac{1}{\sqrt{2}}$$

19. As the air-gap is increased for any power angle, the synchronizing power coefficient of a 3-phase synchronous machine operating on an infinite bus

(A) increase

(B) decreases

(C) remains unchanged

(D) increases for generator operation but decreases for motor operation.

19. Ans: (A)

Sol: Synchronizing power coefficient per phase = $\frac{EV}{X_s}\cos\delta = P_{sy}$

For a given power angle (δ), cosδ is constant. Field current can be assumed to be constant, so E is constant. Bus voltage V is constant.

As air-gap is increased, the reluctance of the armature flux path increases and so more mmf and hence more current is needed to produce a given flux. Synchronous inductance and hence synchronous reactance X_s decrease. P_{sy} increases.

Distractor Logic:

DLOA:

Correct Answer

DLOB:

As air-gap is increased, the field poles and stator mmf are loosely coupled. Hence synchronizing power decreases.

DLOC:

Based on the prime mover input (or shaft load), a certain power has to be exchanged between the machine and the bus. It has nothing to do with the machine air-gap.

DLOD:

$\bar{E}$ always leads $\bar{V}$ for generator operation, while it lags for motor operation. So, as air-gap increases, if the synchronizing power increases in one type of operation, it has to decreases in the other type.

20. Three single phase transformers are connected to form a 3-phase Δ/Δ connection and feeding a balanced rated load. If one of the transformer is disconnected and load is reduced by 20%. Now the percentage of each transformer in open delta connection is over loaded by __________. (Give the answer upto two decimal places)

20. Ans: 38.50 (Range: 38 to 39)

Sol:

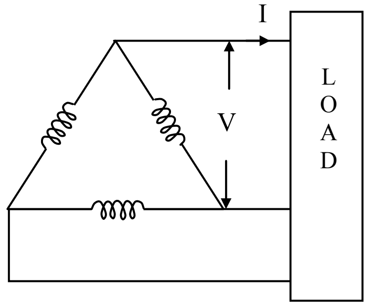


Fig: Closed delta connection

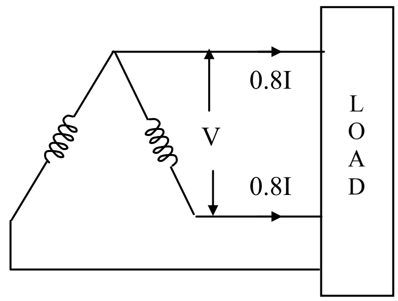


Fig: Open delta connection

In closed delta:

$$VA_{LOAD} = \sqrt{3}VI$$

$$VA_{each}\text{transformer} = (V)\left(\frac{I}{\sqrt{3}}\right)$$

In closed delta connection each transformer current is $\frac{I}{\sqrt{3}}$, i.e 0.577 I.

In open delta:

$$VA_{LOAD} = (0.8)\sqrt{3}VI$$

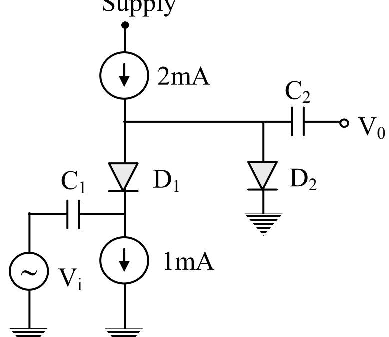
$$= (1.38)(VI)$$

In open delta connection, each transformer current is 0.8 I.

$$\frac{I_{V-V}}{I_{\Delta-\Delta}} = \frac{0.8I}{0.577I} = 1.385$$

$\therefore$ Each transformer is over loaded by 38.5 %

21. In the circuit shown D_1 and D_2 diodes with $\eta = 1$, $V_T = 25$ mV and C_1, C_2 large capacitors. For very small input signal (V_i), the value of $\left(\frac{V_0}{V_i}\right)$ is



(A) 0.33 (B) 0.66

(C) 12.5 (D) 0.5

21. Ans: (D)

Sol: DC Analysis:

C_1 & C_2 very large and they behave like open circuit, DC current of 1 mA passes through both D_1 & D_2 then $R_{ac} \cong \frac{\eta V_T}{I_D} \approx 25\Omega$.

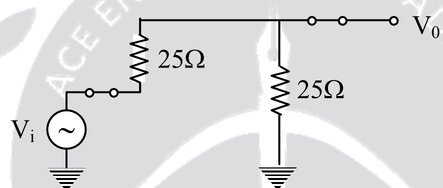
A.C anlysis:

For a.c operation both capacitors are short circuited and the diodes are replaced by their ac resistance.

Then AC equation circuit is

$$V_0 = V_i\left(\frac{25}{25+25}\right)$$

$$\Rightarrow \frac{V_0}{V_i} = 0.5$$



Distractor Logic

DLOA:

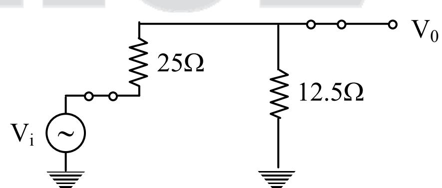
DC analysis :

C_1 & C_2 very large and they behave like open circuit, DC current of 1 mA passes through D_1 and 2 mA passes through diode D_2.

$$R_{ac1} \cong \frac{\eta V_T}{I_D}$$

$$= \frac{25mV}{1mA} \Rightarrow 25\Omega$$

$$R_{ac2} = \frac{25\,mV}{2\,mA} \Rightarrow 12.5\Omega$$



AC analysis:

For a.c operation both diodes are short circuited and the diodes are replaced by their ac resistance.

$$V_0 = V_i\left[\frac{12.5}{25+12.5}\right]$$

$$\frac{V_0}{V_i} = 0.33$$

DLOB:

DC analysis :

C_1 & C_2 very large and they behave like open circuit, DC current of 2 mA passes through D_1 and 1 mA passes through diode D_2.

$$R_{ac1} \cong \frac{\eta V_T}{I_D}$$

$$= \frac{25\,mV}{2\,mA} = 12.5\,\Omega$$

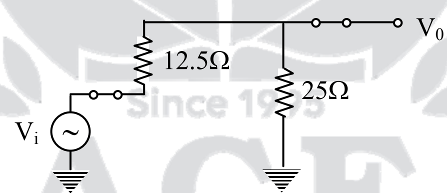
$$R_{ac2} = \frac{25\,mV}{1\,mA} \Rightarrow 25\,\Omega$$

AC analysis:

For a.c operation both diodes are short circuited and the diodes are replaced by their ac resistance

$$V_0 = V_i\left[\frac{25}{25+12.5}\right]$$

$$\frac{V_0}{V_i} = 0.66$$



DLOC:

$$\frac{V_0}{V_1} = \frac{25\times 25}{25+25}$$

$$= \frac{625}{50}$$

$$= 12.5$$

DLOD:

Correct Answer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25 EE
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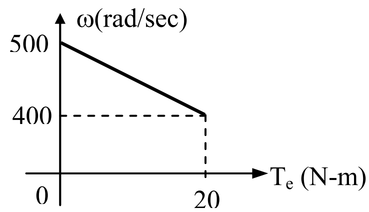
28 EE Abhinav Kumar
28 ME Suhas M
28 ME
29 EE
30 E&T
30 EE
31 ME Umakanth
32 E&T
32 EE Ajita Mohanty
33 CE
34 E&T Satpal
34 EE
35 EE
36 EE Prasanth shekar
37 CE Ajay Narwal
37 E&T Ranjeet Kumar
38 E&T Rajesh Kumar
38 EE M Raquib Anjum
39 E&T
39 EE
39 ME Amit
40 ME Ujjwal
TOTAL SELECTIONS 188
CE 82
ME 42
EE 35
E&T 29

22. The following characteristic is drawn for a 200 V dc shunt motor between speed and torque



If an additional resistance of 1 Ω is added into armature circuit, the stalling torque is

(A) 8.88 N-m (B) 25 N-m

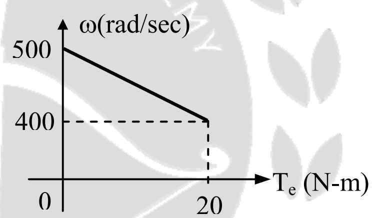
(C) 26.66 N-m (D) 44.44 N-m

22. Ans: (D)

Sol: Given data: No-load speed = 500 rad/sec , $E_b = V_t = 200$ V and additional resistance = 1Ω

$E_b = 200 = (k_a \phi)(500)$

$k_a\phi = \frac{2}{5} = 0.4$



$$\text{slope} = \frac{\omega}{\tau} = \frac{E_b/(k_a\phi)}{(k_a\phi)I_a} = \frac{I_a r_a}{(k_a\phi)^2 I_a} = \frac{r_a}{(k_a\phi)^2}$$

$$\text{From diagram, slope} = \frac{500-400}{20} = \frac{100}{20} = 5.0$$

$r_a = (5.0)(0.4)^2 = 0.8\Omega$

If 1Ω is added extra into armature under stalling condition (ω = 0), the back emf, $E_b = 0$

$$I_a = \frac{V_t}{r_a+1} = \frac{200}{0.8+1} = 111.11\text{A}$$

$\therefore T_{stalling} = (k_a\phi)I_a$

$= (0.4)\,(111.11)$

$= 44.44$ N-m

Distractor Logic:

DLOA:

No load speed = 500 rad/sec and $E_b = V_t = 200$ V

$E_b = 200 = (k_a \phi)(500)$

$$k_a\phi = \frac{2}{5} = 0.4$$

Armature current at torque 20 N-m with 400 rad/sec speed is,

$\tau = (k_a\phi)I_{a1}$

$$\Rightarrow I_{a1} = \frac{20}{0.4} = 50A$$

Also $E_{b1} = \frac{\omega_1}{\omega_0} \times E_{b0} = \frac{400}{500} \times 200 = 160$ V

Armature resistance $r_a = \frac{V - E_{b1}}{I_{a1}} = \frac{200-160}{50} = \frac{4}{5}\Omega$

New current after adding one ohm resistance is, $I_{a2} = \frac{V - E_{b1}}{(r_a + 1)} = \frac{200-160}{1.8} = 22.2$ A

Therefore, stalling torque, $\tau = (k_a\phi)I_{a2} = 0.4 \times 22.2 = 8.88$ N-m

DLOB:

We know that, $P = \omega\times\tau$

With constant power , $\omega\times\tau$ = constant

$$\therefore \frac{\omega_1}{\omega_2} = \frac{\tau_1}{\tau_2}$$

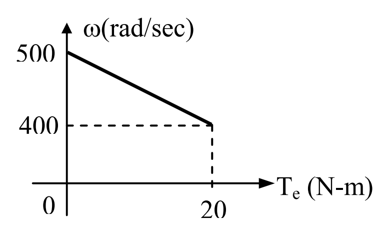
$$\Rightarrow \tau_2 = \frac{500}{400} \times 20 = 25 \text{ N-m}$$

DLOC:

At No-load: speed = 500 rad/sec and $E_b = V_t = 200$ V

$E_b = 200 = (k_a\,\phi)(500)$

$$k_a\phi = \frac{2}{5} = 0.4$$



$$\text{slope} = \frac{\omega}{\tau} = \frac{r_a}{(k_a\phi)}$$

From diagram, $\text{slope} = \frac{500-400}{20} = \frac{100}{20} = 5.0$

$r_a = (5.0)(0.4) = 2\ \Omega$

If 1Ω is added extra into armature under stalling condition (ω = 0), the back emf, $E_b = 0$

$$I_a = \frac{V_t}{r_a + 1} = \frac{200}{2+1} = 66.67\,A$$

$\therefore\ T_{stalling} = (k_a\phi)I_a$

$= (0.4)\ (66.67)$

$= 26.66$ N-m

DLOD:

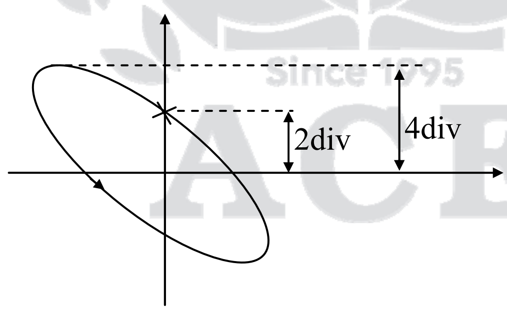
Correct answer

23. In X-Y display mode of operation, an anticlockwise rotating Ellipse is displayed on the CRO whose major axis is in 2 and 4 quadrants. This Ellipse intersects the Y-Axis at 2 divisions and its peak y deflection is 4 divisions. The Horizontal input signal has a frequency of 1000 Hz. Then what is the frequency of vertical input signal and also what is the phase difference between both signals?

(A) 500 Hz & 150°
(B) 1000 Hz & 210°
(C) 1000 Hz & 150°
(D) 500 Hz & 210°

23. Ans: (B)

Sol:



$$dy = dx \times \frac{2}{2}$$

$= 1000\text{ Hz} \times 1$

$= 1000$ Hz

The ellipse is rotating in anti-clockwise direction and major axis is in 2 and 4^{th} quadrants so it will be in third quadrant.

$$\phi = 180° + \sin^{-1}\left(\frac{2\,\text{div}}{4\,\text{div}}\right)$$

$= 180° + 30° \Rightarrow 210°$

Distractor Logic:

DLOA:

$$dy = dx \times \frac{1}{2}$$

$$= 1000\text{ Hz} \times \frac{1}{2}$$

$$= 500\text{ Hz}$$

If assumed ellipse is in second quadrant

$$\phi = 180° - \sin^{-1}\left(\frac{2\,\text{div}}{4\,\text{div}}\right)$$

$$= 180° - 30°$$

$$= 210°$$

DLOB:

Correct Answer

Option C:

$$dy = dx \times \frac{2}{2}$$

$$= 1000\text{ Hz} \times 1$$

$$= 1000\text{ Hz}$$

If assumed ellipse is in second quadrant

$$\phi = 180° - \sin^{-1}\left(\frac{2\,\text{div}}{4\,\text{div}}\right)$$

$$= 180° - 30° \Rightarrow 150°$$

DLOD:

$$dy = dx \times \frac{1}{2}$$

$$= 1000\text{ Hz} \times \frac{1}{2}$$

$$= 500\text{ Hz}$$

If assumed ellipse is in third quadrant

$$\phi = 180° + \sin^{-1}\left(\frac{2\,\text{div}}{4\,\text{div}}\right)$$

$$= 180° + 30° \Rightarrow 210°$$

24. The 2's complement representation of $(35)_8 - (74)_8$ using 8 bits is ______.

24. Ans: 11100001 (Range: 11100001 to 11100001)

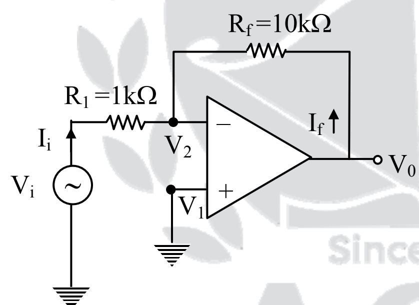
Sol: $(35)_8 - (74)_8 = -(37)_8$

$= (-31)_{10}$

$+31 \Rightarrow 00011111$

-31 in 2's complements representation $\Rightarrow 11100001$

25. In the op-amp circuit shown in below figure, the op-Amp has poor open loop gain of 10, $R_i = \infty$ and $R_0 = 0$. The overall input resistance, will be



(A) ∞

(B) 1.9 kΩ

(C) 1 kΩ

(D) 0

25. Ans: (B)

Sol: **NOTE:** Since open-loop gain of op-Amp used in the circuit is finite $(A_{OL} = 10)$, Virtual ground concept is not valid.

Step (1): KCL at (V_2)

$I_i + I_f = 0$…… (1)

$$\Rightarrow \frac{V_0 - V_2}{10\,k} = -I_i \;\ldots..\;(2)$$

$\Rightarrow I_i\, 10\text{ k} = V_2 - V_0$ …. (3)

Step (2):

General formula for output in op-Amp:

$V_0 = A_{OL}V_{id} = 10[V_1 - V_2] = -10V_2$ …. (4) $[\because V_1 = 0]$

Step (3):

Equation (4) in equation (3)

$\Rightarrow I_i 10\text{k} = V_2 + 10V_2 = V_2[11]$……. (5)

Step (4): From the circuit,

$\frac{V_i - V_2}{1\text{k}} = I_i$ ……. (6)

$\Rightarrow V_i = I_i\, 1\text{ k} + V_2$ …. (7)

$= I_i 1\text{k} + I_i \frac{10\text{k}}{11}$ …….. (8)

$\therefore \frac{V_i}{I_i} = R_i = 1\text{k} + 0.9\text{k} = 1.9\text{k}\Omega$ …….. (9)

$\left[\text{General formula } R_i = R_1 + \frac{R_f}{1 + A_{OL}}\right]$…….. (10)

Distractor Logic:

DLOA:

$\because$ The current into op-Amp is zero, if the student assumes that $I_i = 0$,

$R_i = \frac{V_i}{I_i} = \frac{V_i}{0} = \infty$

DLOB:

$R_i = \frac{V_i}{I_i} = 1.9\text{k}\Omega$ is the correct answer

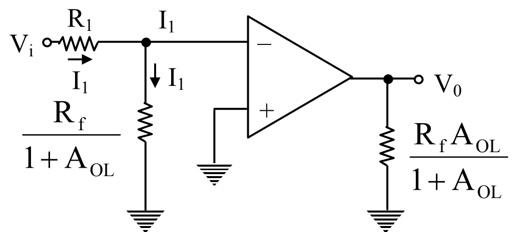
DLOC:

If the op-Amp is ideal with gain of ∞,

$$R_i = R_1 + \frac{R_f}{\infty} = R_1 = 1k\Omega$$

DLOD:

If the op-Amp is ideal with $A_{OL} = \infty$. Using Millers theorem



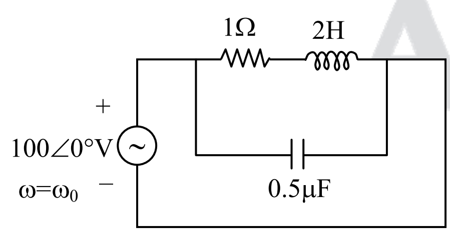
If the student wrongly considered R_1 & $\frac{R_f}{1+A_{OL}}$ are parallel

$$R_i = \frac{V_i}{I_1} = R_1 \| 0 = 0$$

26. A 0.5 μF capacitor is connected in parallel with coil whose resistance and inductance are 1 Ω and 2 H respectively. The parallel circuit is supplied by a 100 V sinusoidal generator. The current supplied by the source at resonance in μA is __________.

26. Ans: 25 (Range: 25 to 25)

Sol:



This is a practical tank circuit. The dynamic impedance offered at resonance

$$Z_{dynamic} = \frac{L}{RC}$$

So, current = $\frac{V}{Z_{dynamic}}$

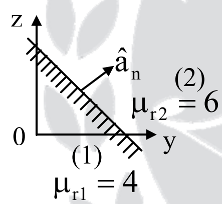
$$= \frac{100}{L/RC}$$

$$= 100\left[\frac{RC}{L}\right]$$

$$= 100\left[\frac{1\times\frac{1}{2}\times10^{-6}}{2}\right]$$

$= 25\ \mu A$

27. In Region-1, where $\mu_{r1} = 4$, is the side of the plane y+z = 1 containing the origin (shown in figure). In region-2 μ_{r2} =6. If the magnetic flux density in regions-1 is $\overrightarrow{B_1} = 2\hat{a}_x + \hat{a}_y$ (Tesla), then the magnetic flux density (in Tesla) in region-2 is



Fig

(A) $\overline{B} = 3\hat{a}_x + 1.75\hat{a}_y + 0.25\hat{a}_z$
(B) $\overline{B} = 3\hat{a}_x + 1.25\hat{a}_y - 0.25\hat{a}_z$
(C) $\overline{B} = 1.33\hat{a}_x + 0.8\hat{a}_y - 0.2\hat{a}_z$
(D) $\overline{B} = 2\hat{a}_x + 1.5\hat{a}_y$

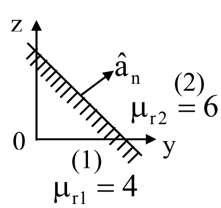
27. Ans: (B)

Sol: The unit vector normal to the plane y + z=1 is given by

$$\hat{a}_n = \frac{\hat{a}_y + \hat{a}_z}{\sqrt{2}}$$

$$B_{n1} = \overrightarrow{B_1}.\hat{a}_n$$

$$= (2\hat{a}_x + \hat{a}_y).\frac{(\hat{a}_y + \hat{a}_z)}{\sqrt{2}}$$



Fig

$$B_{n1} = \frac{1}{\sqrt{2}}$$

$$\vec{B}_{n1} = B_{n1}\ \hat{a}_n = \frac{1}{\sqrt{2}}\left(\frac{\hat{a}_y + \hat{a}_z}{\sqrt{2}}\right)$$

$$\vec{B}_{n1} = 0.5\hat{a}_y + 0.5\hat{a}_z$$

$$\vec{B}_{n2} = \vec{B}_{n1} = 0.5\hat{a}_y + 0.5\hat{a}_z$$

$$\vec{B}_{t1} = \vec{B}_1 - \vec{B}_{n1}$$

$$= (2\hat{a}_x + \hat{a}_y) - (0.5\hat{a}_y + 0.5\hat{a}_z)$$

$$\vec{B}_{t1} = 2\hat{a}_x + 0.5\hat{a}_y - 0.5\hat{a}_z$$

$$\frac{B_{t_1}}{\mu_1} = \frac{B_{t_2}}{\mu_2}$$

$$\vec{B}_{t_2} = \left(\frac{\mu_2}{\mu_1}\right)\vec{B}_{t_1}$$

$$= \left(\frac{3}{2}\right)\left[2\hat{a}_x + 0.5\hat{a}_y - 0.5\hat{a}_z\right]$$

$$\vec{B}t_2 = 3\hat{a}_x + 0.75\hat{a}_y - 0.75\hat{a}_z$$

$$\vec{B}_2 = 3\hat{a}_x + 1.25\hat{a}_y - 0.25\hat{a}_z \qquad [\because \vec{B}_2 = \vec{B}t_2 + \vec{B}n_2]$$

Distractor Logic:

DLOA:

If $\hat{a}_n = -\left(\frac{\hat{a}_y + \hat{a}_z}{\sqrt{2}}\right)$

$$B_{n1} = \overline{B}_1 . \hat{a}_n$$

$$B_{n1} = -0.5\,\hat{a}_y - 0.5\,\hat{a}_z$$

$$B_{n2} = B_{n1}$$

$$B_{n2} = -0.5\,\hat{a}_y - 0.5\,\hat{a}_z$$

$$\overline{B}_{t1} = \overline{B}_1 - \overline{B}_{n1}$$

$$\overline{B}_{t1} = 2\,\hat{a}_x + \hat{a}_y + 0.5\,\hat{a}_y + 0.5\,\hat{a}_z$$

$\overline{B}_{t1} = 2\hat{a}_x + 1.5\hat{a}_y + 0.5\hat{a}_z$

$\overline{B}_{t2} = \frac{\mu_2}{\mu_1}(B_{t1})$

$B_{t2} = \frac{3}{2}[2\hat{a}_x + 1.5\hat{a}_y + 0.5\hat{a}_z]$

$B_{t2} = 3\hat{a}_x + 2.25\hat{a}_y + 0.75\hat{a}_z$

$\overline{B}_2 = B_{n2} + B_{t2}$

$\overline{B}_2 = 3a_x + 1.75a_y + 0.25a_z$

DLOB:

Correct answer

DLOC:

$\hat{a}_n = -\left(\frac{\hat{a}_y + \hat{a}_z}{\sqrt{2}}\right)$

$B_{n1} = \overline{B}_1.\hat{a}_n$

$B_{n1} = 0.5\hat{a}_y + 0.5\hat{a}_z$

$B_{t1} = B_1 - B_{n1}$

$B_{t1} = 2\hat{a}_x + 0.5\hat{a}_y - 0.5\hat{a}_z$

$B_{n2} = B_{n1}$

$B_{n2} = 0.5\hat{a}_y + 0.5\hat{a}_z$

$B_{t2} = \left(\frac{\mu_1}{\mu_2}\right)B_{t1}$

$B_{t2} = \frac{2}{3}[2\hat{a}_x + 0.5\hat{a}_y - 0.5\hat{a}_z]$

$B_{t2} = 1.33\hat{a}_x + 0.3\hat{a}_y - 0.3\hat{a}_z$

$\overline{B}_2 = B_{t2} + B_{n2}$

$B_2 = 1.33\,\hat{a}_x + 0.85\,\hat{a}_y - 0.2\,\hat{a}_z$

DLOD:

If $\hat{a}_n = \hat{a}_x$

$B_{n1} = 2\,\hat{a}_x$

$B_{t1} = \hat{a}_y$

$B_{n2} = B_{n1}$

$B_{n2} = 2\,\hat{a}_x$

$B_{t2} = \frac{\mu_2}{\mu_1} B_{t1}$

$B_{t2} = \frac{3}{2}\left(\hat{a}_y\right)$

$B_{t2} = 1.5\,\hat{a}_y$

$B_2 = B_{t2} + B_{n2}$

$B_2 = 2\,\hat{a}_x + 1.5\,\hat{a}_y$

28. A 200 V dc shunt motor has a no load speed of 1000 rpm. The speed reduced to 800 rpm when load torque is increased to 100 N-m. For the same load torque, the speed of the motor if 1 Ω is added into armature circuit is

(A) 738 rpm (B) 590 rpm

(C) 538 rpm (D) 300 rpm

28. Ans: (C)

Sol: Given data, at No-load $E_b = V_t = 200V$, $N_0 = 1000$ rpm , $N_2 = 800$ rpm, Torque = 100N-m and $r_{se} = 1\Omega$.

$$k_a\phi\omega = 200V \Rightarrow k_a\phi = \frac{200}{\left[\frac{2\pi \times 1000}{60}\right]} = 1.909$$

When load torque is 100 N-m, $N_2 = 800$ rpm;

$T = k_a\phi I_a$

$$\Rightarrow I_a = \frac{100}{1.909} = 52.3A$$

$E_{b2} = k_a\phi\omega_2$

$$= (1.909)\left[\frac{2\pi\times 800}{60}\right] = 159.92$$

$$\therefore r_a = \frac{V_t - E_{b2}}{I_a} = \frac{200-159.92}{52.23} = 0.766\ \Omega$$

If 1Ω is added in series with armature,

$E_b = V_t - I_a\ (r_a + r_{se})$

$= 200 - 52.3(0.766+1)$

$= 107.63V$

$$\frac{E_{b_3}}{E_{b_2}} = \frac{N_3}{N_2} \Rightarrow \frac{107.63}{159.92} = \frac{N_3}{800}$$

$N_3 = 538.46$ rpm

Distractor Logic:

DLOA:

No-load $E_b = V_t = 200V$

$$k_a\phi\omega = 200V \Rightarrow k_a\phi = \frac{200}{\left[\frac{2\pi\times 1000}{60}\right]} = 1.909$$

When load torque is 100 N-m, $N_2 = 800$ rpm;

$T = k_a\phi I_a$

$$\Rightarrow I_a = \frac{100}{1.909} = 52.3A$$

$E_{b2} = k_a\phi\omega_2$

$$= (1.909)\left[\frac{2\pi\times 800}{60}\right] = 159.92$$

$$\therefore r_a = \frac{V_t - E_{b2}}{I_a} = \frac{200-159.92}{52.23} = 0.766\ \Omega$$

If 1Ω is added in series with armature,

$E_b = V_t - I_a(r_{se}) = 200 - 52.3(1) = 147.7V$

$$\frac{E_{b_3}}{E_{b_2}} = \frac{N_3}{N_2} \Rightarrow \frac{147.7}{159.92} = \frac{N_3}{800}$$

$N_3 = 738.86$ rpm

DLOB:

No-load $E_b = V_t = 200V$

$$\frac{E_{b1}}{E_{b2}} = \frac{N_1}{N_2}$$

$$E_{b2} = \frac{200 \times 800}{1000} = 160 \text{ V}$$

When load torque is 100 N-m

$P = \omega T$

$$E_{b1} I_a = \frac{2\pi \times 800}{60} \times 100$$

$$\Rightarrow I_a = \frac{2\pi \times 800}{60 \times 200} \times 100 = 41.88 \text{ A}$$

$$\therefore r_a = \frac{V_t - E_{b2}}{I_a} = \frac{200 - 160}{41.88} = 0.955\Omega$$

If 1Ω is added in series with armature,

$E_b = V_t - I_a(r_a + r_{se})$

$= 200 - 41.88(0.955+1)$

$= 118.12$ V

$$\frac{E_{b_3}}{E_{b_2}} = \frac{N_3}{N_2} \Rightarrow \frac{118.12}{160} = \frac{N_3}{800}$$

$N_3 = 590.62$ rpm

DLOC:

Correct answer

DLOD:

No-load $E_b = V_t = 200V$

When load torque is 100 N-m, $N_2 = 800$ rpm;

$T \propto I_a$

Therefore take armature current is 100 A and is constant even after added one ohm resistance.

$$\frac{E_{b1}}{E_{b2}} = \frac{N_1}{N_2}$$

$$E_{b2} = \frac{200 \times 800}{1000} = 160 \text{ V}$$

$$\therefore r_a = \frac{V_t - E_{b2}}{I_a} = \frac{200 - 160}{100} = 0.4\ \Omega$$

If 1Ω is added in series with armature,

$$E_b = V_t - I_a (r_a + r_{se})$$

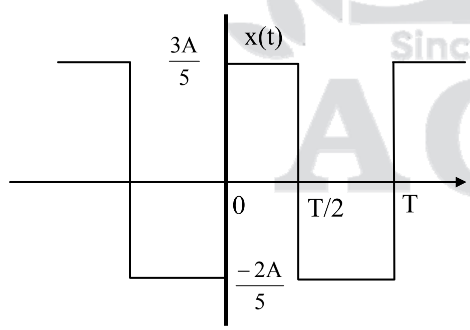
$$= 200 - 100(0.4+1)$$

$$= 60 \text{ V}$$

$$\frac{E_{b_3}}{E_{b_2}} = \frac{N_3}{N_2} \Rightarrow \frac{60}{160} = \frac{N_3}{800}$$

$N_3 = 300$ rpm

29. Consider the following signal x(t), which of the following statements are true



(A) The Fourier series of x(t) consists of only odd harmonics but dc component is zero.

(B) The magnitude spectrum is even and phase spectrum is odd and consists of only odd harmonics along with dc component.

(C) The magnitude spectrum is even and phase spectrum does not exist

(D) The Fourier series x(t) consists for both even and odd harmonics along with the dc component

29. Ans: (B)

Sol: 0 to T/2 area > T/2 to T area

$\therefore$ DC component exists.

Because hidden symmetry exists

$\therefore$ $a_n = 0$; b_n = exists $\forall$ 'n'

And also Half wave symmetry exists

$\therefore$ n = odd

$\therefore$ Magnitude spec is even

phase spectrum is odd

DC component exists.

30. The directional derivative of $\phi(x, y, z) = xy^2z + 4yz^2$ at the point P(1, 2, –1) along $\bar{i} - 2\bar{j} + \bar{k}$ is

(A) –16

(B) $\dfrac{1}{\sqrt{6}}$

(C) $\dfrac{-16}{\sqrt{6}}$

(D) $\dfrac{16}{\sqrt{7}}$

30. Ans: (C)

Sol: Given that $\phi(x, y, z) = xy^2z + 4yz^2$

Let $\bar{a} = \bar{i} - 2\bar{j} + \bar{k}$ & P = (1, 2, –1)

Now $\nabla\phi$ = grad ϕ = $\bar{i}\dfrac{\partial\phi}{\partial x} + \bar{j}\dfrac{\partial\phi}{\partial y} + \bar{k}\dfrac{\partial\phi}{\partial x}$

$\Rightarrow \nabla\phi = \bar{i}(y^2z) + \bar{j}(2xyz + 4z^2) + \bar{k}(xy^2 + 8yz)$

$\Rightarrow (\nabla\phi)_P = (-4)\ \bar{i} + (0)\ \bar{j} + (-12)\ \bar{k}$

Now the directional derivative of the function $\phi(x, y, z)$ in the direction of a vector $\bar{a}$ at the point P

$= (\nabla\phi)_P \cdot \dfrac{\bar{a}}{|\bar{a}|}$

$$= \left((-4)\bar{i} + (0)\bar{j} + (-12)\bar{k}\right).\frac{\left(\bar{i} - 2\bar{j} + \bar{k}\right)}{\sqrt{(1)^2 + (-2)^2 + (1)^2}}$$

$$= \frac{(-4)(1) + (0)(-2) + (-12)(1)}{\sqrt{1+4+1}}$$

$$= \frac{-16}{\sqrt{6}}$$

31. Let x(n) and x(2n) be the two sequences with Z-transforms of X(z) and Y(z) respectively. Then Y(z) in terms of X(z) is

(A) $Y(z) = \frac{1}{|2|}X\left(\frac{z}{2}\right)$ (B) $Y(z) = \sqrt{2}X\left(\sqrt{z}\right)$

(C) $Y(z) = \frac{1}{2}\left[X\left(\sqrt{z}\right) + X\left(-\sqrt{z}\right)\right]$ (D) can not be determined

31. Ans: (C)

Sol: $$Y(z) = \sum_{n=-\infty}^{\infty} x(2n)z^{-n} = \sum_{n=-\infty}^{\infty} x(k).z^{-\frac{k}{2}}$$

$$= \sum_{k=-\infty}^{\infty}\left[\frac{x(k) + (-1)^k x(k)}{2}\right]z^{-k/2}$$

$$= \frac{1}{2}\sum_{k=-\infty}^{\infty} x(k).z^{-k/2} + \frac{1}{2}\sum_{k=-\infty}^{\infty} x(k).\left(-z^{1/2}\right)^k$$

$$= \frac{1}{2}\left[X\left(\sqrt{z}\right) + X\left(-\sqrt{z}\right)\right]$$

Distractor Logic:

DLOA:

$x(t) \leftrightarrow x(\omega)$

$x(at) \leftrightarrow \frac{1}{(a)}x\left(\frac{\omega}{a}\right)$ …… (1)

$\therefore\ x(2n) \leftrightarrow \frac{1}{2}x\left(\frac{z}{a}\right)$

Equation (1) is valid for only continuous time domain not valid for discrete time domain

$\therefore$ (A) is wrong

DLOB:

Scaling in time domain compress frequency domain $\therefore \sqrt{2}$ times can be compressed but wrong. In discrete time domain it is treated like interpolation & Decimation

Option C:

Correct answer

Option D:

Can not be determined

32. A 230V, 50Hz single phase energy meter has a constant of 200 revolutions per kWh. While supplying a non inductive load of 4.4A at normal voltage, the meter takes 3 minutes for 10 revolutions. Then the percentage error in the instrument is

(A) 1.18% slow (B) 1.20% fast

(C) 1.18% fast (D) 1.20% slow

32. Ans: (A)

Sol: $(\text{E.C})_t = \dfrac{V_L I_L \cos\phi . t}{1000} = \dfrac{230 \times 4.4 \times 1}{1000} \times \dfrac{3}{60}$

$= 0.0506$ kWh

$(\text{E.C})_m =$ kWh $= \dfrac{\text{revolutions}}{\text{meter constant}} = \dfrac{10}{200}$

$= 0.05$ kWh

$\%\text{ error} = \dfrac{\text{measured value} - \text{true value}}{\text{true value}} \times 100$

$= \dfrac{0.05 - 0.0506}{0.0506} \times 100 = -1.186\%$

Negative sign refers 1.18% slow

Distractor Logic:

DLOA:

This is correct option

DLOB:

If we find percentage error by using formula $= \dfrac{\text{true value} - \text{measured value}}{\text{measured value}} \times 100$

$$\frac{0.0506 - 0.05}{0.05} \times 100 = 1.20\%$$

Therefore, 1.20 % fast

DLOC:

If we find percentage error by using formula $= \dfrac{\text{true value} - \text{measured value}}{\text{true value}} \times 100$

$$\frac{0.0506 - 0.05}{0.0506} \times 100 = 1.186\%$$

Therefore, 1.18% fast

DLOD:

If we find percentage error by using formula $= \dfrac{\text{measured value} - \text{true value}}{\text{measured value}} \times 100$

$$\frac{0.05 - 0.0506}{0.05} \times 100 = -1.20\%$$

Therefore, 1.20 % slow

33. The particular integral of $2x^2 \dfrac{d^2y}{dx^2} + 3x\dfrac{dy}{dx} - 3y = x^3$ is

(A) $\dfrac{x^3}{6}$ (B) $\dfrac{x^3}{12}$

(C) $\dfrac{x^3}{16}$ (D) $\dfrac{x^3}{18}$

33. Ans: (D)

Sol: Given differential equation is

$$2x^2 \frac{d^2y}{dx^2} + 3x\frac{dy}{dx} - 3y = x^3 \text{ …….. (1)}$$

General solution for Cauchy-Euler DC is

$$\left.\begin{aligned} y &= cx^n \\ y' &= cnx^{n-1} \\ y'' &= cn(n-1)x^{n-2} \end{aligned}\right\} \ldots\ldots\ldots. (2)$$

Substitute (2) in (1) we get,

$2x^2$ [c n(n–1)x^{n-2}] + 3x [c nx^{n-1}]–3c x^n = x^3

2cn (n–1) x^n + 3cn x^n – 3cx^n = x^3

(2c n(n –1) + 3cn – 3c – 3c)x^n = 1 (x^3)

Comparing LHS and RHS

$x^n = x^3$	$2c\,3(3-1) + 3c(3) - 3c = 1$
$n = 3$	$c[12 + 9 - 3] = 1$

$$c = \frac{1}{18}$$

$$\therefore y = \frac{1}{18}x^3 \Rightarrow y = \frac{x^3}{18}$$

2nd method:

The given Euler-Cauchy's form can be converted to

$$2D(D-1)y + 3Dy - 3y = e^{3z} \text{ (where } D = \frac{d}{dz}, x = e^z \text{ \& } z = \log x)$$

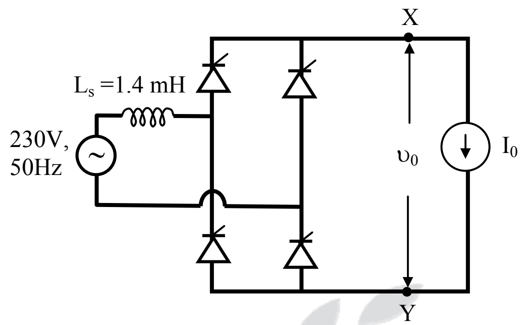
$$(2D^2 + D - 3)y = e^{3z}$$

$$\therefore y_p = \frac{e^{3z}}{(2D^2 + D - 3)}$$

$$= \frac{e^{3z}}{(2D+3)(D-1)}$$

$$= \frac{e^{3z}}{(6+3)(3-1)} = \frac{e^{3z}}{18} = \frac{x^3}{18}$$

34. A single-phase full converter circuit is shown in the figure. Assume the load current is constant and power delivered to the load is 3kW. The converter is operated at α = 30°. The RMS value of fundamental component of source current in ampere is ______.(Give the answer upto two decimal places)



34. Ans: 15.47 (Range: 14.5 to 16.5)

Sol: $P_0 = V_0 . I_0 = 3000W$

$$\Rightarrow \left[\frac{2V_m}{\pi}\cos\alpha - \frac{2\omega L_s}{\pi} I_0\right] I_0 = 3000$$

$$\Rightarrow \left[\frac{2\times 230\sqrt{2}}{\pi}\times\frac{\sqrt{3}}{2} - \frac{2\times 100\pi\times 1.4\times 10^{-3}}{\pi}\times I_0\right] I_0 = 3000$$

$$\Rightarrow 179.33 I_0 - 0.28 I_0^2 - 3000 = 0 \Rightarrow I_0 = 17.19A$$

$$\cos(\alpha+\mu) = \cos\alpha - \frac{2\omega L_s}{V_m} I_0 = \frac{\sqrt{3}}{2} - \frac{2\times 100\pi}{230\sqrt{2}}\times\frac{1.4}{1000}\times 17.19$$

$$\Rightarrow \alpha + \mu = 34.96° \Rightarrow \mu = 4.96°$$

$$\text{DPF} = \cos\left[\alpha + \left(\frac{\mu}{2}\right)\right] = 0.843 \text{ lag}$$

$\Rightarrow$Power balance equation $\Rightarrow$ $V_{S1}\times I_{S1}\cos\phi_1 = P_0$

$$\Rightarrow 230\times I_{S1}\times 0.843 = 3000$$

$$\Rightarrow I_{S1} = \frac{3000}{230\times 0.843} = 15.47A$$

35. A 230V, 50Hz, resistor-start single phase induction motor has the following data at stand still.

Main winding impedance, $Z_m = 5.2 + j10.1\Omega$.

Auxiliary winding impedance, $Z_a = 12.7+j9.2\Omega$.

The value of external resistance in ohms that should be inserted in series with the auxiliary winding so that maximum torque at starting is obtained, is_______. (Give the answer upto two decimal places)

35. Ans: 2.38 (Range 2 to 3)

Sol: Given data: 230V, $Z_m = 5.2 + j10.1\Omega$ and $Z_a = 12.7+j9.2\Omega$.

Total auxiliary winding resistance is $r_a + R_{ext} = \left(\frac{X_a}{X_m}\right)(r_m + Z_m)$

$= \frac{9.2}{10.1}(5.2+11.36) = 15.08$

$R_{ext} = 2.38\ \Omega$

Method-II:

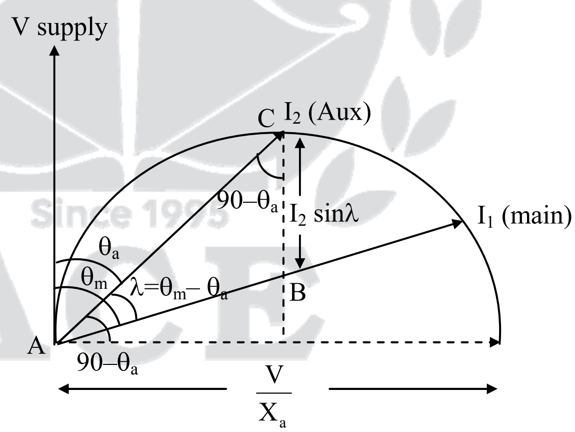


Fig: Locus Diagram of Auxiliary Circuit with variable resistance

$T_{st} \propto I_1 I_2 \sin\lambda$

From triangle ABC,

$\theta_m - \theta_a + 90 + 90 - \theta_a = 180$

$\Rightarrow 2\theta_a = \theta_m \Rightarrow \theta_a = \theta = \frac{\theta_m}{2}$

The above condition must be satisfied to make ($I_2 \sin\lambda$) maximum

$\theta_m = \tan^{-1}\left(\frac{10.1}{5.2}\right) = 62.75^o$

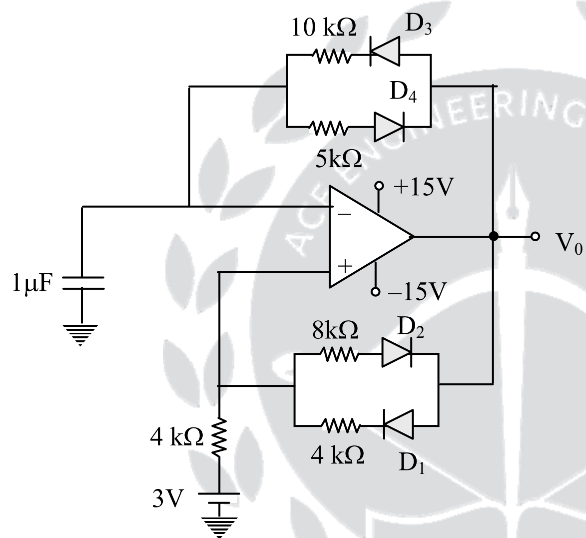
$\therefore \theta_a = \frac{62.75}{2} = 31.37$

$$\theta_a = \tan^{-1}\left(\frac{X_a}{r_a + r_{ex}}\right)$$

$$\tan(31.37) = \frac{9.2}{12.7 + r_{ex}}$$

$$R_{ex} = 2.40\ \Omega$$

36. Considering diodes and Op-Amps are ideal, the duration in which the Op-Amp in positive saturation region (in msec), is_______.



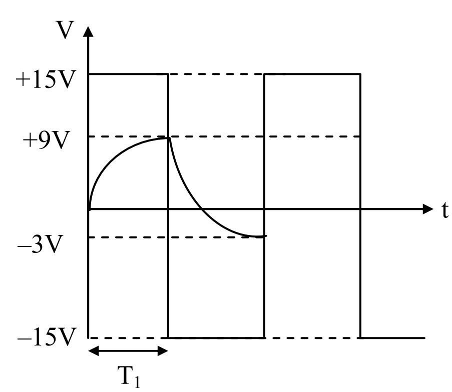
36. Ans: 11 (Range: 10.72 to 11.3)

Sol: When Op-Amp in +Ve saturation region

D_1 – ON, D_2 –OFF

D_3 – ON, D_4 –OFF

The output waveform is shown in figure



$$V_{UTP} = 3 + (15-3)\times\frac{4}{8}$$

$$= 3 + (12)(1/2)$$

$$= 9V$$

$$V_{LTP} = 3 + (-15-3)\times\frac{4}{12}$$

$= 3 - 18 \times \frac{1}{3}$

$= -3V$

The voltage across capacitor $V_c = V_c$ (Final) + [V_c (initial) – V_c (final)] $e^{-t/\tau}$

$V_f = 15V$, $V_i = -3V$,

$\tau = R_{equ} C_{equ}$

during charging $R_{equ} = 10\ k\Omega$

$\tau = 10$msec,

at $t = T_1$, $V_c = 9V$

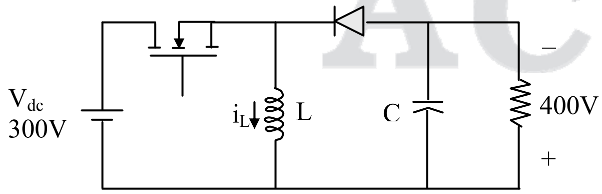
T_1: To Calculate T_1 consider charging period of capacitor $t = \tau\ \ell n\left(\frac{V_f - V_i}{V_f - V_c}\right)$

$$T_1 = 10 \times 10^{-3} \ell n\left[\frac{15+3}{15-9}\right]$$

$$= 10 \times 10^{-3} \ell n(18/6)$$

$\cong 11$ msec

37. A Buck-Boost converter is shown in figure. Assume that inductor and capacitor are large enough to treat i_L and V_0 are ripple free. MOSFET has ON resistance of 0.5Ω during its conduction. To maintain output voltage of 400V at 10A to the load, the duty cycle ratio of converter will be

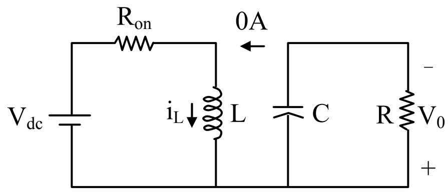


(A) $\frac{4}{7}$ (B) 0.983

(C) 0.5813 (D) None

37. Ans: (C)

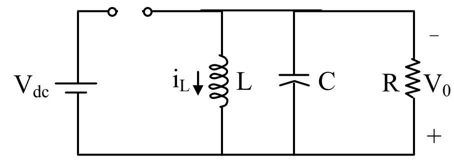
Sol: During MOSFET ON :



$$\text{KVL}: R_{on} i_L + L\frac{di_L}{dt} = V_{dc} \ldots\ldots (1)$$

$$\text{KCL}: C\frac{d\nu_0}{dt} + \frac{\nu_0}{R} = 0 \ldots.. (2)$$

During MOSFET OFF:



$$\text{KVL}: L\frac{di_L}{dt} = -V_0 \ldots\ldots (1)$$

$$\text{KCL}: C\frac{d\nu_0}{dt} + \frac{\nu_0}{R} = i_L \ldots\ldots. (2)$$

Flux balance equation from KVL $\Rightarrow R_{on}.I_L.D + 0 = D.V_{dc} - V_0(1-D) \ldots\ldots..(1)$

Charge balance equation from $\text{KCL} \Rightarrow \frac{V_0}{R} = I_L(1-D) \ldots\ldots (2)$

By substituting I_L value from equation (2) into equation (1), we will get

$$\Rightarrow R_{on}.\frac{V_0}{R(1-D)}D + V_0(1-D) = D.V_{dc}$$

$$\Rightarrow V_0\left[\frac{R_{on}}{R} \times \frac{D}{1-D} + (1-D)\right] = DV_{dc}$$

$$\Rightarrow \frac{V_0}{V_{dc}} = \frac{D}{\frac{R_{on}}{R}.\frac{D}{1-D} + (1-D)}$$

Now, substitute the given data

$$\frac{400}{300} = \frac{D}{\frac{0.5}{40} \times \frac{D}{1-D} + (1-D)}$$

$$\Rightarrow 560D^2 - 876D + 320 = 0$$

$\Rightarrow$ D = 0.983 (or) 0.5813

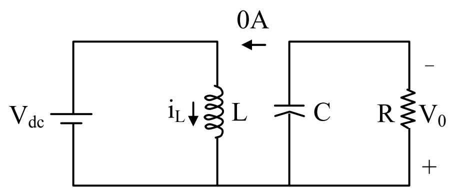
If D is near to unity, buck-boost converter will be unstable. Hence choose, 0.5813.

Distractor Logic:

DLOA:

If the MOSFET on state resistance is not considered.

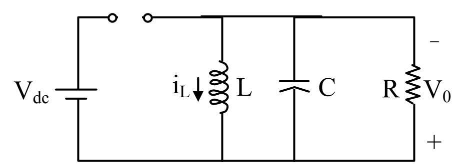
During MOSFET ON :



$$KVL : L\frac{di_L}{dt} = V_{dc} \ldots\ldots (1)$$

$$KCL : C\frac{d\nu_0}{dt} + \frac{\nu_0}{R} = 0 \ldots.. (2)$$

During MOSFET OFF:



$$KVL : L\frac{di_L}{dt} = -V_0 \ldots\ldots (1)$$

$$KCL : C\frac{d\nu_0}{dt} + \frac{\nu_0}{R} = i_L \ldots\ldots. (2)$$

Flux balance equation from KVL

$$\Rightarrow 0 = D.V_{dc} - V_0(1-D)$$

$$V_0 = \frac{DV_{dc}}{1-D}$$

Now, substitute the given data

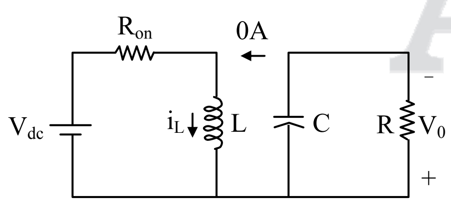
$$400 = \frac{300 \times D}{1-D}$$

4 – 4D=3D

$$D = \frac{4}{7}$$

DLOB:

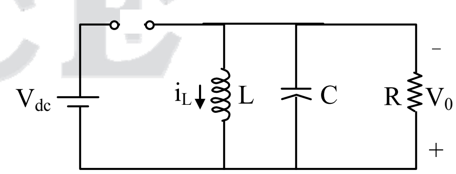
During MOSFET ON :



$$KVL : R_{on}i_L + L\frac{di_L}{dt} = V_{dc} \ldots\ldots (1)$$

$$KCL : C\frac{d\nu_0}{dt} + \frac{\nu_0}{R} = 0 \ldots.. (2)$$

During MOSFET OFF:



$$KVL : L\frac{di_L}{dt} = -V_0 \ldots\ldots (1)$$

$$KCL : C\frac{d\nu_0}{dt} + \frac{\nu_0}{R} = i_L \ldots\ldots. (2)$$

Flux balance equation from KVL $\Rightarrow R_{on}.I_L.D + 0 = D.V_{dc} - V_0(1-D) \ldots\ldots..(1)$

Charge balance equation from KCL $\Rightarrow \frac{V_0}{R} = I_L(1-D)$ …… (2)

Substitute I_L value from equation (2) into equation (1)

$$\Rightarrow R_{on}\cdot\frac{V_0}{R(1-D)}D + V_0(1-D) = D.V_{dc}$$

$$\Rightarrow V_0\left[\frac{R_{on}}{R}\times\frac{D}{1-D}+(1-D)\right] = DV_{dc}$$

$$\Rightarrow \frac{V_0}{V_{dc}} = \frac{D}{\frac{R_{on}}{R}\cdot\frac{D}{1-D}+(1-D)}$$

Now, substitute the given data

$$\frac{400}{300} = \frac{D}{\frac{0.5}{40}\times\frac{D}{1-D}+(1-D)}$$

$$\Rightarrow 560D^2 - 876D + 320 = 0$$

$\Rightarrow$ D = 0.983 (or) 0.5813

If high value of D= 0.983 is selected option 'b' is the correct answer.

$\Rightarrow$ D = 0.983 (or) 0.5813

If high value of D= 0.983 is selected option 'b' is the correct answer.

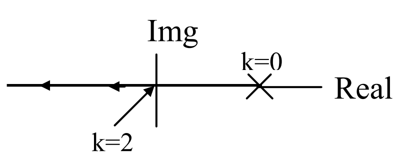
DLOC:

Correct Answer

DLOD:

None

38. Root loci diagram of a system is given below ($0 < k < \infty$)



Then the value of 'k' at s = – 2 is _______.

38. Ans: 4 (Range 4 to 4)

Sol: Loop T.F $= \dfrac{k}{s-2}$

$$\therefore k\,|_{s=-2} = \left|\dfrac{1}{\dfrac{1}{s-2}}\right| = |s-2|_{s=-2} = |-2-2| = 4$$

$\therefore k = 4$

39. A 230kV long transmission line of 180 km length have the series impedance and shunt admittances per km of z = j0.38 Ω/km, and y = j3.2 μs/km. The line was loaded by 120 MW unity power factor load at receiving end side. To maintain flat voltage profile for this loading on transmission line series and shunt compensations are provided for the line with degrees k_1 and k_2 respectively. The values at k_1 and k_2 approximately are ________

(A) $k_1 = 0.4, k_2 = 0$ (B) $k_1 = 0, k_2 = 0.4$

(C) $k_1 = 0.4, k_2 = 0.2$ (D) $k_1 = 0, k_2 = 0$

39. Ans: (B)

Sol: 230 kV line have z = j0.38 Ω/km, y = j3.2 μs/km

The given line is a lossless line.

Characteristic impedance of lossless line (or) surge impedance, $z_c = \sqrt{\dfrac{z}{y}}$

$$z_c = \sqrt{\dfrac{j0.38}{j3.2\times10^{-6}}} = 344.6\Omega$$

Loading on transmission line=120MW, UPF

Surge impedance loading (SIL) = $\dfrac{V^2}{Z_c} = \dfrac{(230)^2}{344.6}$ MW = 153.5MW

To make flat voltage profile loading on the line and SIL values must be matched.

But from the data loading < SIL , to make loading = SIL,

The SIL value has to be reduced by increasing surge impedance, for this purpose compensation has to be provided.

Surge impedance value with series and shunt compensations

$$Z_{c_{new}} = Z_{c_{old}} \sqrt{\frac{1-k_1}{1-k_2}}$$

$Z_{c_{new}}$ required will be , $Z_{c_{new}} = \frac{V^2}{\text{loading}} = \frac{(230)^2}{120} = 440.83\Omega$

$Z_{c_{new}} > Z_{c_{old}}$, shunt compensation has to be provided for the line.

So $k_1 = 0$ and $k_2 \neq 0$

Now,

$$440.83 = 344.6 \times \sqrt{\frac{1-0}{1-k_2}}$$

$k_2 = 0.4$

Answer is $k_1 = 0$, $k_2 = 0.4$

Distractor Logic:

DLOA:

From data given loading < SIL, to make flat voltage profile shunt compensation (shunt reactor) has to be provided. If series compensation is provided, SIL be comes high. So $k_1 = 0.4$ and $k_2 = 0$ is wrong answer.

DLOB:

Correct Answer

DLOC:

$$Z_{c_{new}} = Z_{c_{old}} \sqrt{\frac{1-0.4}{1-0.2}} = 0.866 Z_{old}$$

$Z_{c_{new}} < Z_{c_{old}}$,SIL increases in this compensated line. So it is not suitable for the given requirement in the question.

DLOD:

$Z_{c_{new}} = Z_{c_{old}}$, as $k_1 = 0$, $k_2 = 0$

No change in SIL and no flat profile can be achieved.

40. A person goes to office either by car, scooter, bus or train, the probability of which being $\frac{1}{7}, \frac{3}{7}, \frac{2}{7}$ and $\frac{1}{7}$ respectively. Probability that he reaches office late, if he takes car, scooter, bus or train are $\frac{2}{9}, \frac{1}{9}, \frac{4}{9}$ and $\frac{1}{9}$ respectively. Given that he reached office in time, then the probability that he travelled by car is

(A) $\frac{1}{5}$
(B) $\frac{1}{6}$
(C) $\frac{1}{7}$
(D) $\frac{1}{8}$

40. Ans: (C)

Sol: $P(C) = \frac{1}{7}$, $P(S) = \frac{3}{7}$ $P(B) = \frac{2}{7}$ $P(T) = \frac{1}{7}$

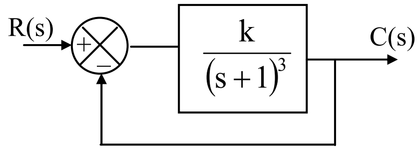
Let E be the event that he reaches office in time.

$$P(E\,|\,C) = \frac{7}{9}, P(E\,|\,S) = \frac{8}{9}$$

$$P(E\,|\,B) = \frac{5}{9}; P(E\,|\,T) = \frac{8}{9}$$

$$P(C\,|\,E) = \frac{\frac{1}{7}\times\frac{7}{9}}{\left(\frac{1}{7}\times\frac{7}{9}\right)+\left(\frac{3}{7}\times\frac{8}{9}\right)+\left(\frac{2}{7}\times\frac{5}{9}\right)+\left(\frac{1}{7}\times\frac{8}{9}\right)} = \frac{1}{7}$$

41. Consider the system as given below



If the phase margin of the system is 45°. Then the value of k is _______. (Give the answer upto two decimal places)

41. Ans: 2.832 Range: (2.8 to 2.9)

Sol: $PM = 180° + \angle \left.\frac{k}{(j\omega+1)^3} = 45°\right|_{\omega=\omega_{gc}}$

$$-3\tan^{-1}\omega_{gc} = -135°$$

$$\omega_{gc} = 1 \text{ rad/sec}$$

$$\left|\frac{k}{(j\omega_{gc}+1)^3}\right|_{\omega_{gc}=1} = 1$$

$$\left|\frac{k}{(j1+1)^3}\right| = 1$$

$$\frac{k}{(\sqrt{2})^3} = 1$$

$$k = 2\sqrt{2} = 2.832$$

42. By applying Newton-Raphson method, the second approximation of the required root of the equation $(x^3 - 5x + 3) = 0$ with initial guess $x_0 = 1$ is _______. (Give the answer upto two decimal places)

42. Ans: 0.64 (Range 0.62 to 0.65)

Sol: Let $f(x) = (x^3 - 5x + 3)$

$f'(x) = (3x^2 - 5)$

From N-R method,

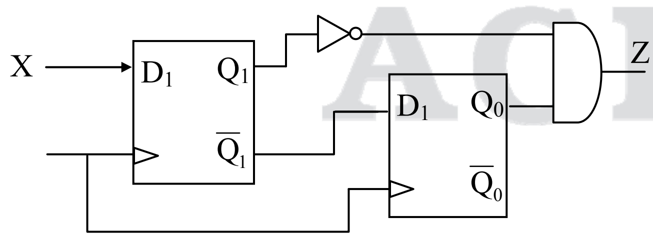
$$x_1 = x_0 - \frac{f(x_0)}{f'(x_0)}$$

$$= 1 - \frac{(-1)}{-2} = 1 - 0.5 = 0.5$$

$$\therefore\ x_2 = x_1 - \frac{f(x_1)}{f'(x_1)}$$

$$= 0.5 - \frac{0.625}{-4.25} = 0.6471$$

43. In the following sequential circuit, the serial input data x = 0100010001 is applied in 10 consecutive clock cycles. Assuming initially all the FF's are in reset condition, the number of times z is 1, is



(A) 1 (B) 2

(C) 3 (D) 4

43. Ans: (D)

Sol: The circuit is to find 00 in two adjacent clock cycles.

If it is observed 00 and over lapping 4 no.of times z is 1.

Distractor Logic:

DLOA:

If it is assumed 10 sequence

DLOB:

If it is 00 but not overlapping

DLOC:

If it is assumed 01 sequence

DLOD:

Correct answer.

44. A 3-phase, 4-pole, 400 V, 3.6 kVA star connected alternator with a synchronous impedance per phase of j25 Ω is delivering a power of 2.4 kW at unity power factor to a 400 V, 50 Hz 3-phase bus bars.

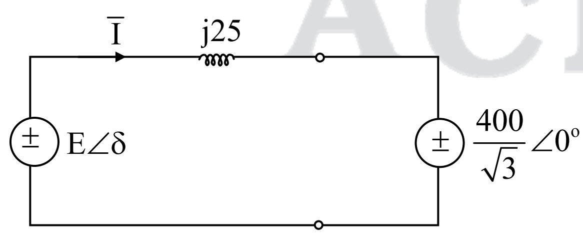
If the power delivered to the bus is kept constant while the excitation of the alternator is increased by 1.5 times, the new value of the power angle (in elec degrees) is

(A) −13.54° (B) – 55.91°

(C) 13.54° (D) 36.87°

44. Ans: (C)

Sol: 1. Equivalent circuit per phase:



$\bar{I}$ direction in the fig. chosen to leave $\bar{E}$ at its positive terminal.

$\therefore$ $\bar{E}$ delivers $\bar{I}$ (generator action)

2. KVL equation: $E\angle\delta = \frac{400}{\sqrt{3}}\angle 0^o + j25\,\bar{I}$.

3. Initial operation: Power delivered to the bus per phase is = $\frac{2400}{3} = \frac{400}{\sqrt{3}}I$

where $I\angle 0 = \bar{I}$

$I = 2\sqrt{3}$, $\bar{I} = 2\sqrt{3}\angle 0^o$ A

Value of $\bar{E}$: $E = \sqrt{\left(\frac{400}{\sqrt{3}}\right)^2 + \left(50\sqrt{3}\right)^2}$

$= 246.6$ V

4. After increasing excitation:

Neglecting saturation, $E = 246.6 \times 1.5 = 369.9$ V

Since prime mover input is not changed, and losses are not changed, power received by bus is unchanged.

In phase component of current remains unchanged at $2\sqrt{3}$ A.

With an increase in excitation, generator delvers a lagging current

$\therefore\ \bar{I}_{new} = 2\sqrt{3} - jI_1$.

$\frac{400}{\sqrt{3}}\angle 0^o + \left(2\sqrt{3} - jI_1\right)j25 = 369.9\angle\delta$ --------- (1)

With generator operation, if we select (+δ) in above, δ will work out to be positive.

Equating the imaginary parts on both sides of equation(1), $\delta = 13.54°$ elec

Distractor Logic:

DLOA:

Wrong application of KVL:

$369.9\angle\delta + \left(2\sqrt{3} - jI_1\right)j25 = 230.9\angle 0°$.

Equating the imaginary parts on both sides,

$369.9\sin\delta + 50\sqrt{3} = 0$

$\sin\delta = \frac{-50\sqrt{3}}{369.9} = -0.2341$

$\delta = -13.54°$ elec.

DLOB:

Assume that power angle = power factor angle

From equation (1), $\frac{400}{\sqrt{3}}\angle 0^\circ + \left(2\sqrt{3} - jI_1\right) j25 = 369.9\angle\delta$

$$\left[\frac{400}{\sqrt{3}}\angle 0^\circ + 25I_1\right] = 369.9\cos\delta$$

$$= 369.9 \cos 13.94^\circ$$

$$\Rightarrow I_1 = 5.12 \text{ A}$$

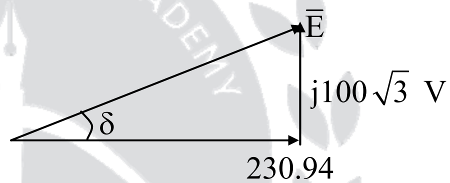
Current = $(2\sqrt{3} - j5.12)$

Power angle = -55.91°

DLOD:

Since excitation is double, phase current also doubles, new current = $4\sqrt{3}\angle 0^\circ$ A.

$$\delta = \tan^{-1}\frac{100\sqrt{3}}{230.94} = 36.87^\circ.$$



45. The below program is processed by 8085.

```
MAIN:  XRA   A
CMA
MVI   B,01H
CALL  LOGIC
PUSH   PSW
XTHL
HLT
LOGIC: XRI     FFH
ADD   B
CMP   B
RET
```

Assume status of undefined flags as 0's. What will be the contents of HL pair?

(A) 0044H (B) 0140H

(C) 0144H (D) 0040H

45. Ans: (C)

- (A) ∀ (A) ⇒ (A) = 00H
- Complement Accumulator ⇒(A)=FFH
- (B) = 01H
- Subroutine LOGIC called
- (A) ∀ FFH ⇒ contents of ACC will be complemented.

  (A) = 00H

- $$\begin{array}{l} (A) = 00H \\ \underline{(B) = 01H} \\ (A) = 01H \end{array}$$

- $$\left.\begin{array}{r} (A) = 01H \\ \underline{-(B) = 01H} \\ -00H \end{array}\right\} \begin{array}{l} \text{But result not stored and flags updated} \\ \rightarrow cy = 0, P = 1, AC = 0, Z = 1, S = 0 \end{array}$$

(flag reg) = 01×0×1×0

= 0100 0100

= 44H

(A) = 01H

(PSW) = 0144H

- Return to main program
- (PSW) =0144H pushed to stack to P

- $$\left.\begin{array}{ccc} (HL) & \xleftrightarrow{\text{exchanged}} & (\text{Top of stack}) \\ XXXXH & & 0144H \\ 0144H & & XXXXH \end{array}\right| \text{ \& Halted}$$

Distractor Logic:

DLOA:

- $$\left.\begin{array}{r} (A) = 01H \\ \underline{-(B) = 01H} \\ -00H \end{array}\right\} \begin{array}{l} \text{But if result is stored and flags updated} \\ \rightarrow cy = 0, P = 1, AC = 0, Z = 1, S = 0 \end{array}$$

(flag reg) = 01×0×1×0

= 0100 0100 = 44H

After CMP B operation

If the result is stored in the accumulator A

Accumulator will be (A) =00H

(A) = 00 H

(PSW) = 0044H

The result will be 0044H

DLOB:

$$\left.\begin{array}{r} (A) = 01H \\ -(B) = 01H \\ \hline -00H \end{array}\right\} \begin{array}{l} \text{But result not stored and flags updated} \\ \rightarrow cy = 0, P = 0, AC = 0, Z = 1, S = 0 \end{array}$$

Instead of considering even parity if we take odd parity P=0 taken

(flag reg) = 01 × 0 × 0 × 0

= 0100 0000

= 40H

(A) = 01 H

(PSW) = 0140H

The result will be 0140H

DLOC:

Correct answer

DLOD:

$$\left.\begin{array}{r} (A) = 01H \\ -(B) = 01H \\ \hline -00H \end{array}\right\} \begin{array}{l} \text{But if result is stored and flags updated} \\ \rightarrow cy = 0, P = 0, AC = 0, Z = 1, S = 0 \end{array}$$

Instead of considering even parity bit if we take odd parity P=0 taken

(flag reg) = 01×0×0×0

= 0100 0000

= 40H

After CMP B operation

If the result is stored in operation accumulator A

Accumulator will be (A) =00H

(PSW) = 0040H

The result will be 0040H

46. Two identical generators rated 50 MVA, 11 kV connected to common bus bar. One of the generators neutral is grounded by an impedance of j0.05p.u. and other neutral is isolated from ground. Sequence impedance of each generator are $Z_1 = Z_2 = j0.15$p.u. and $Z_0 = j0.05$p.u.. A transmission line rated as 50 MVA and 11 kV is connected from bus bar to carry the power. Sequence impedances of transmission line are $Z_1 = Z_2 = j0.1$p.u. and $Z_0 = j0.3$p.u.. A line to ground fault takes place at the middle of transmission line with zero fault impedance. The magnitude of zero sequence current flowing through the faulted portion of line in kA is ________.

(A) 13.12 (B) 4.37 (C) 7.56 (D) 17.2

46. Ans: (B)

Sol: Ratings of G_1 and G_2 are 50 MVA, 11 kV.

Ratings of Transmission line are 50 MVA, 11 kV.

Sequence impedances of G_1 and G_2 are $Z_1 = Z_2 = j0.15$ and $Z_0 = j0.05$

Sequence impedances of transmission line are $Z_1 = Z_2 = j0.1$ and $Z_0 = j0.3$

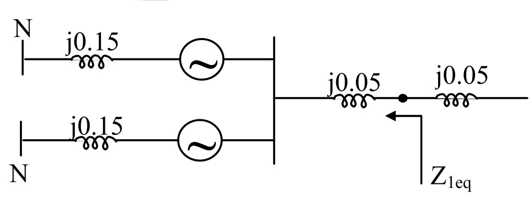
Choose the base values as 11kV(LL), 50MVA(3-ϕ). All the apparatus impedances are given in p.u. on common base.

LG fault occur at mid point of transmission line:

For LG fault all three sequence networks will exist in fault analysis.

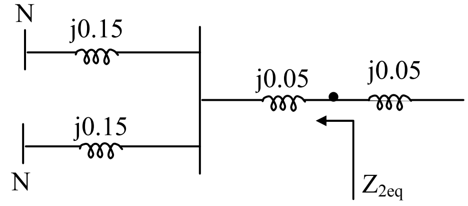
(i) Positive sequence network:

$$Z_{1eq} = (j0.15 \parallel j0.15) + j0.05$$
$$= j0.125 \text{ p.u.}$$



(ii) Negative sequence network:

$$Z_{2eq} = (j0.15 \parallel j0.15) + j0.05$$
$$= j0.125 \text{ p.u.}$$

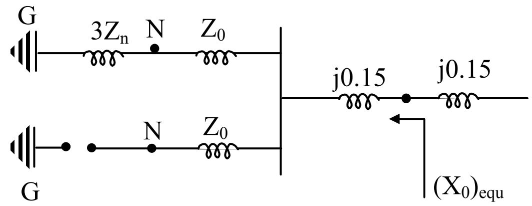


(iii) Zero sequence network:

$\Rightarrow (X_0)_{equ} = (3Z_n + Z_0) + (j0.15)$

$Z_{0eq} = (j0.15 + j0.05 + j0.15)$

$= j0.35$ p.u.



During LG fault, zero sequence current will be

$$I_{R0} = \frac{E_{R_1}}{(Z_1)_{epu} + (Z_2)_{epu} + (Z_0)_{epu}} = \frac{1}{j0.125 + j0.125 + j0.35}$$

$$= \frac{1}{0.6} = -j1.667 \text{ p.u.}$$

$$I_{R0}(kA) = I_{R0}(p.u.) \times I_{base}(kA) = -j\ 1.667 \times \frac{50\times10^6}{\sqrt{3}\times11\times10^3} \text{ A}$$

$$= -j\ 4.37 \text{ kA}$$

Distractor Logic:

DLOA:

It fault current in taken instead of zero sequence current

$$(I_f) = 3(I_{R0}) = 3\times\frac{1}{0.6} = 5 \text{ pu}$$

$$(I_f)_{actual} = 5\times\frac{50\times10^6}{\sqrt{3}\times11\times10^3} = 13.12 \text{ kA}$$

DLOB:

Correct answer

DLOC:

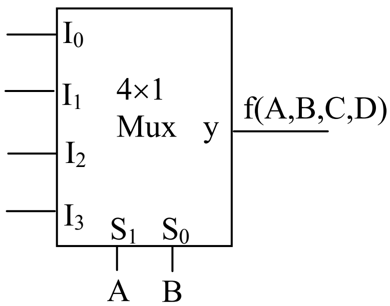
If the calculation of zero sequence current. If voltage is taken as 11 kV

$$(I_{R0})_{actual} = 1.667 \times \frac{50\times10^6}{11\times10^3} = 7.57 \text{ kA}$$

DLOD:

Calculated as L-L-G fault.

47. The minimum number of 2 input NOR gates required to implement the function $f(A,B,C,D) = \Sigma m(1,2,5,8,9,11,12,15)$ additionally with following MUX circuit is



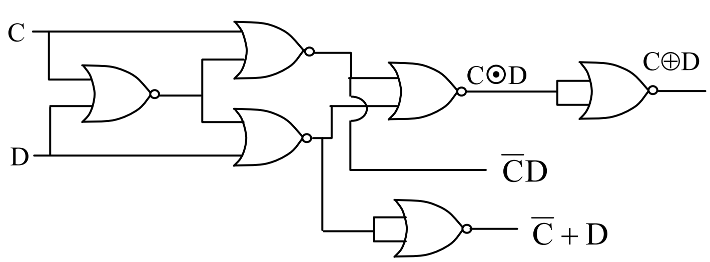
(A) 14 (B) 10

(C) 8 (D) 6

47. Ans: (D)

Sol:

AB	I_0	I_1	I_2	I_3
S_1S_0	00	01	10	11
$\overline{C}\,\overline{D}$ (00)	0	4	⑧	⑫
$\overline{C}D$ (01)	①	⑤	⑨	13
$C\overline{D}$ (10)	②	6	10	14
CD (11)	3	7	⑪	⑮
	$C \oplus D$	$\overline{C}D$	$\overline{C} + D$	$C \odot D$



Total 6 two input NOR gates required to implement given function.

Distractor Logic:

DLOA:

$C \oplus D \Rightarrow 5$

$\overline{C}D \Rightarrow 2$

$\overline{C} + D \Rightarrow 3$

$C \odot D \Rightarrow 4$

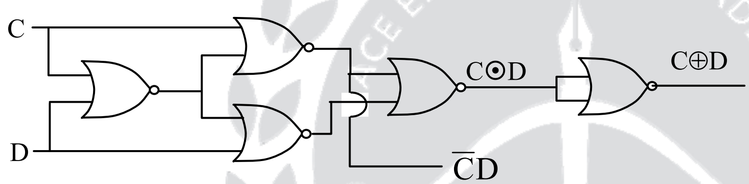
DLOB:

$C \oplus D$ & $C \odot D \Rightarrow 5$

$\overline{C}D \Rightarrow 2$

$\overline{C} + D \Rightarrow 3$

DLOC:



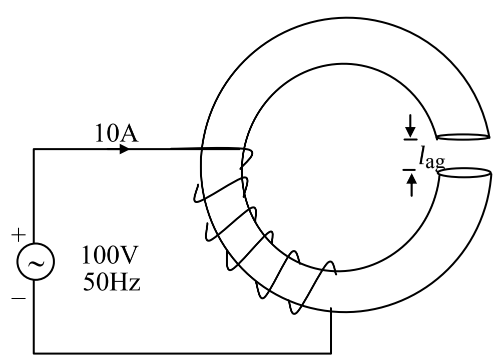
And for $\overline{C} + D$ implementation, 3 needed.

So, total gates 8.

DLOD:

Correct Answer

48. The following figure shows an inductor wound for 500 turns and operating with a maximum flux density of 1.2 Wb/m^2



Determine the length of air gap, if inductor is drawing 10 A (rms) when supplied from 100V(rms). Assume 10% MMF drops in magnetic core. Neglect fringing and leakage flux.

(A) 4.71 mm (B) 6.66 mm

(C) 7.41 mm (D) 5.24 mm

48. Ans: (B)

Sol: $E = 4.44\ B_m A_c\ f\ N$

$100 = 4.44 \times 1.2 \times A_c \times 50 \times 500$

$A_c = 7.50\ cm^2$

$$B_m = \frac{\phi_m}{A_c}$$

$\Rightarrow \phi_m = 1.2 \times 7.50 \times 10^{-4}$

$\phi_m = 0.90$ mWb

$$\phi = \frac{MMF}{R}$$

As 10% MMF drops across core, therefore air-gap MMF = 90%

$$\phi_m.R = (0.9)\left[500 \times \sqrt{2} \times 10\right]$$

$$0.90 \times 10^{-3} \times \frac{\ell_{ag}}{\mu_0 \times A_c} = 0.9 \times 500 \times \sqrt{2} \times 10$$

$$\ell_{ag} = \frac{4\pi \times 10^{-7} \times 7.50 \times 10^{-4} \times 0.9 \times 500 \times \sqrt{2} \times 10}{0.9 \times 10^{-3}} = 6.66\text{ mm}$$

Distractor Logic:

DLOA:

Net mmf in the core = (N × 10) 0.9

= 500 × 10 × 0.9

= 4500 A.T

Mmf = Hl_{ag}

$$\Rightarrow 4500 = \frac{B}{\mu_{0H}} \ell_{ag}$$

$$\Rightarrow l_{ag} = \frac{4500\times4\pi\times10^{-7}}{1.2} = 4.71 \text{ mm}$$

DLOB:

Correct answer

DLOC:

Mmf across air-gap is Hl_{ag}

Mmf =H l_{ag}

$$\Rightarrow 500 \times 10 \times \sqrt{2} = \frac{1.2\,\ell_{ag}}{4\pi\times10^{-7}}$$

$\Rightarrow l_{ag}$ = 7.4 mm

DLOD:

E = 4.44 B_mA_c f N

$100\times \sqrt{2} = 4.44 \times1.2\times A_c \times 50 \times500$

$A_c = 10.61 \text{ cm}^2$

$$B_m = \frac{\phi_m}{A_c} \Rightarrow \phi_m = (1.2)(10.61\times10^{-4})$$

ϕ_m = 1.27 mWb

$$\phi = \frac{MMF}{R}$$

As 10% MMF drops across core,

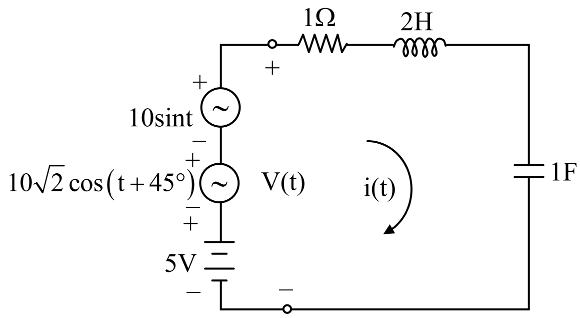
Air-gap MMF = 90%

$$\phi_m.R = (0.9)\left[500\times\sqrt{2}\times10\right]$$

$$1.27\times10^{-3}\times\frac{\ell_{ag}}{\mu_0\times A_c} = 0.9\times500\times\sqrt{2}\times10$$

$$\ell_{ag} = \frac{4\pi\times10^{-7}\times10.61\times10^{-4}\times500\times10}{1.27\times10^{-3}} = 5.24 \text{ mm.}$$

49. Consider the following circuit.



The complex power absorbed in the steady state by the passive elements of the circuit is

(A) $\frac{50}{\sqrt{2}}$ VA (B) $50\sqrt{2}$ VA

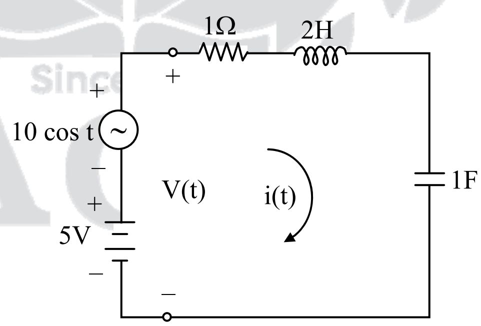
(C) $25\sqrt{2}\angle 45°$VA (D) $25\sqrt{2}\angle -45°$VA

49. Ans: (C)

Sol: By KVL $\Rightarrow 5+10\sqrt{2}\cos(t+45°)+10\sin t - V(t) = 0$

$$\Rightarrow V(t) = 5+10\sqrt{2}\left[\cos t.\frac{1}{\sqrt{2}} - \sin t.\frac{1}{\sqrt{2}}\right]+10\sin t$$

$= 5 + 10\cos t$ V



Apply super position theorem

→DC source only

$I' = 0A$

→AC source only

$$I'' = \frac{\frac{10}{\sqrt{2}}\angle 0°}{1+j2-j1} = \frac{\frac{10}{\sqrt{2}}\angle 0°}{1+j}$$

$I'' = 5\angle -45$ A

So,

$I = I' + I'' = 0 + 5\angle -45°$ A

$I = 5\angle -45°$ A

Complex power, $S^* = VI^* = \frac{10\angle 0^o}{\sqrt{2}} \times 5\angle +45^o$

$= 25\sqrt{2}\angle +45^o$ VA

Distractor Logic:

DLOA:

Voltage and currents rms values are multiplied.

DLOB:

Maximum values of voltage and current are multiplied.

DLOC:

Correct Answer.

DLOD:

Complex power is taken as $\overline{V}\,\overline{I}$.

50. The Jordon form of the state space representation of a SISO system with the transfer function, $\frac{Y(s)}{U(s)} = \frac{2s^2+6s+7}{(s+1)^2(s+2)}$ can be expressed as

(A) $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}-1 & 1 & 0\\ 0 & -1 & 0\\ 0 & 0 & -2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 1\\ 1\end{bmatrix}[U], [Y] = [3 \quad -1 \quad 3]\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$

(B) $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}-1 & 0 & 0\\ 0 & -1 & 0\\ 0 & 0 & -2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}1\\ 1\\ 1\end{bmatrix}[U], [Y] = [3 \quad -1 \quad 3]\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$

(C) $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -2 & -5 & -4\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}[U], [Y] = [7 \quad 6 \quad 2]\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$

(D) $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & -2 \\ 1 & 0 & -5 \\ 0 & 1 & -4 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 7 \\ 6 \\ 2 \end{bmatrix}[U], [Y] = [0 \quad 0 \quad 1]\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$

50. Ans: (A)

Sol: $\dfrac{Y(s)}{U(s)} = \dfrac{2s^2+6s+7}{(s+1)^2(s+2)} = \dfrac{3}{(s+1)^2} + \dfrac{-1}{(s+1)} + \dfrac{3}{(s+2)}$

$y = 3x_1 - 1x_2 + 3x_3$

Where $x_1 = \dfrac{U}{(s+1)^2}, x_2 = \dfrac{U}{(s+1)}, \quad x_3 = \dfrac{U}{(s+2)}$

$x_1 = \dfrac{x_2}{s+1}, \quad x_2 = \dfrac{U}{s+1}, \quad x_3 = \dfrac{U}{s+2}$

$\dot{x}_1 = x_2 - x_1 \quad \dot{x}_2 = U - x_2 \quad \dot{x}_3 = U - 2x_3$

Jordan Block

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & -2 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix}[U], [Y] = [3 \quad -1 \quad 3]\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

Distractor Logic:

DLOA:

(Correct option) it is a Jordon cannonical form. It is the required form. Hence it is a correct answer.

DLOB:

It is in Diagnolization cannonical form. It is not a required form

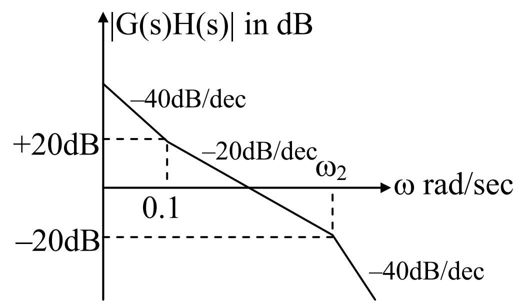
DLOC:

It is in controllable cannonical form. It is not a required form

DLOD:

It is in observable cannonical form. It is not a required form.

51. The Bode plot of a certain minimum phase system is given below. The transfer function of a given system is



(A) $\frac{0.1(s+0.1)}{s^2(s+10)}$ (B) $\frac{(s+0.1)}{s^2(s+10)}$ (C) $\frac{10(s+0.1)}{s^2(s+10)}$ (D) $\frac{(s+0.1)}{s^2(s+1)}$

51. Ans: (C)

Sol: Calculations for $\omega_2, -20 = \frac{-20-20}{\log\omega_2 - \log 0.1}$

$$\Rightarrow \log\omega_2 + 1 = \frac{-40}{-20} = 2$$

$$\Rightarrow \omega_2 = 10\text{rad/sec}$$

Transfer function, $G(s)H(s) = \frac{K\left(1+\frac{s}{0.1}\right)}{s^2\left(1+\frac{s}{10}\right)}$

Calculations for K

$$20|_{\omega=0.1\text{ rad/sec}} = 20\log K - 40\log 0.1$$

$$\Rightarrow -20 = 20\log K$$

$$\Rightarrow K = 0.1$$

$$\therefore G(s)H(s) = \frac{0.1\left(1+\frac{s}{0.1}\right)}{s^2\left(1+\frac{s}{10}\right)} = \frac{10(s+0.1)}{s^2(s+10)}$$

Distractor Logic:

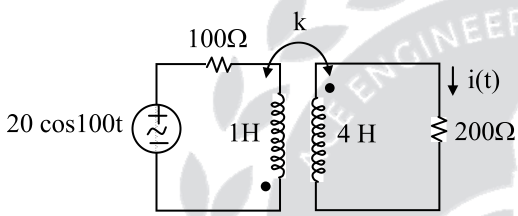
DLOA: If Transfer function G(s)H(s) directly write in pole –zero form.

DLOB: If LCM is not correct

DLOC: Correct option

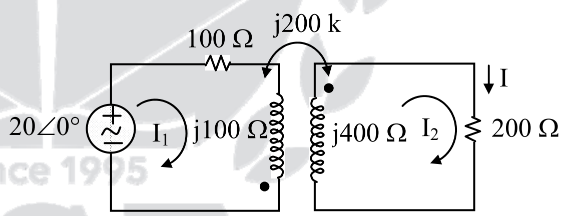
DLOD: If ω_2 is calculate wrong

52. The current flowing in 200 Ω load is 165° lagging with the 20V source. The coupling coefficient 'k' is _____. (Give the answer upto two decimal places)



52. Ans: 0.94 (Range 0.92 to 0.96)

Sol: $\omega = 100$ rad/sec



$$M = k\sqrt{L_1L_2} = k\sqrt{(1)(4)} = 2k$$

KVL: $(100 + j100)I_1 + j200\,kI_2 = 20$

$j200k\,I_1 + (200 + j400)\,I_2 = 0$

So, $(1+j)I_1 + j2kI_2 = 0.2$

$jkI_1 + (1+j2)I_2 = 0$

Solve I_2:

$$I_2 = \frac{\begin{vmatrix} 1+j & 0.2 \\ jk & 0 \end{vmatrix}}{\begin{vmatrix} 1+j & j2k \\ jk & 1+j2 \end{vmatrix}} = \frac{-j0.2k}{1+j+j2-2+2k^2}$$

$$I_2 = \frac{j0.2k}{1-2k^2-j3}$$

$$I_2 = \frac{(0.2k)\angle 90^\circ}{\left[\sqrt{(1-2k)^2+9}\right]\angle \tan^{-1}\left(\frac{-3}{1-2k^2}\right)}$$

$$\text{So, } 90^\circ - \tan^{-1}\left[\frac{-3}{1-2k^2}\right] = -165^\circ$$

$$\tan^{-1}\left[\frac{-3}{1-2k^2}\right] = 255^\circ$$

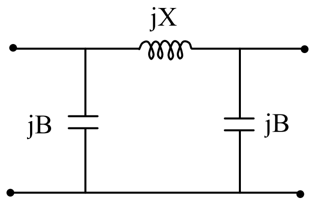
$$\frac{-3}{1-2k^2} = \tan(255^\circ) = 3.732$$

$$1-2k^2 = \frac{-3}{3.732}$$

$$2k^2 = 1+0.803$$

$$k = 0.949$$

53. A 3-ϕ, 50 Hz lossless transmission line has the line constants L = 1 mH/km and C = 9.7 nF/km. The length of line is 300 km and it was represented in equivalent –π model as shown in the figure. The value of ‘B’ given in the figure is ______ micro $\mho$.



53. Ans: 459.8 (Range: 457.50 – 461.50)

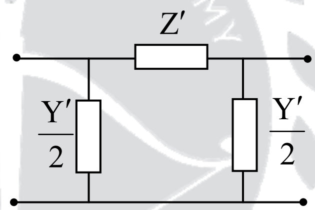
Sol: Line constants are L = 1 mH/km

C = 9.7 nF/km

Length of transmission line, l = 300 km

Let us take equivalent – π model in standard form.

In this model $\frac{Y'}{2}$ has to be calculated



For this model $A = 1 + \frac{Z'Y'}{2}, B = Z'$

From these two equation, $\frac{Y'}{2} = \frac{A-1}{B}$

Where ‘A’ and ‘B’ for lossless long line given in the data. For lossless long line. A = cosβl, B = jz_c sinβl

$\beta = \omega\sqrt{LC} \quad = 2\pi \times 50 \times \sqrt{1\times10^{-3} \times 9.7\times10^{-9}} = 0.978\times10^{-3}$ rad/km

$Z_c = \sqrt{\frac{L}{C}} = \sqrt{\frac{1\times10^{-3}}{9.7\times10^{-4}}} = 321.08\Omega$

Now for line, A = cos $(0.978\times10^{-3}\times300)$ = 0.9573

B = j 321.08 × sin$(0.978\times10^{-3} \times 300)$ = j92.86Ω

$\frac{Y'}{2} = \frac{A-1}{B} = j4.598\times10^{-4}\,\mho$

From given model $\frac{Y'}{2} = jB \Rightarrow B = 459.8\mu\mho \;= 459.8\mu\mho$

54. A Synchronous generator is connected to an infinite bus bar through a stepup transformer and double circuit line. The power delivered by generator is 1.0 pu. The internal emf of generator is 1p.u. and infinite bus voltage is 1.1 p.u.. A symmetrical fault takes place on one of the line in double circuit and makes the transfer admittance from generator to infinite bus as 0.5p.u.. The transfer admittances in prefault and post fault are 2.0 p.u. and 1.4 p.u. respectively. The critical clearing angle made by the rotor in electrical degrees is_______. (Give the answer upto two decimal places)

54. Ans: 72.21 (Range: 70 to 73)

Sol: $P_s = P_{e1} = 1.0$

$$P_{m1} = \frac{EV}{X_{1eq}} = EVy_{1\,eq} = 1.1 \times 1.0 \times 2.0 = 2.2 \text{ pu}$$

$$P_{m2} = \frac{EV}{X_{2eq}} = EVy_{2\,eq} = 1.1 \times 1.0 \times 0.5 = 0.55$$

$$P_{m3} = \frac{EV}{X_{3eq}} = EVy_{3eq} = 1.1 \times 1.0 \times 1.4 = 1.54$$

$$\delta_0 = \sin^{-1}\left(\frac{P_s}{P_{m1}}\right) = \sin^{-1}\left(\frac{1.0}{2.2}\right) \text{ elec. deg} = 27.03$$

$$\delta_{0\,(rad)} = \delta_0 \text{ elec deg} \times \frac{3.14}{180} = 0.4716$$

$$\delta_m = 180 - \sin^{-1}\left(\frac{P_s}{P_{m3}}\right) = 180 - \sin^{-1}\left(\frac{1.0}{1.54}\right) \text{ elec. deg} = 139.5$$

$$\delta_{m\,(rad)} = \delta_m \times \frac{3.14}{180} = 139.5 \times \frac{3.14}{180} = 2.435$$

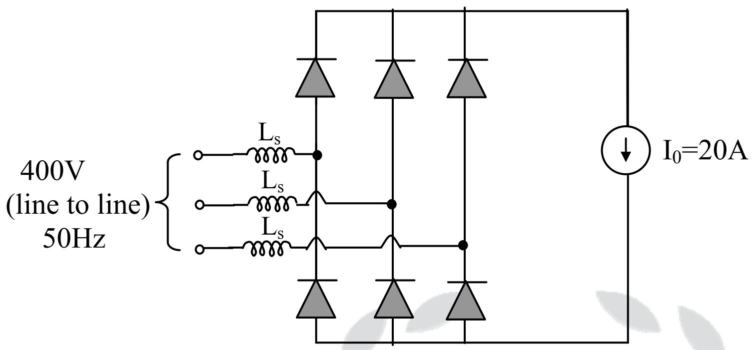
$$\delta_c = \cos^{-1}\left[\frac{P_s(\delta_m - \delta_0) + P_{m3}\cos\delta_m - P_{m2}\cos\delta_0}{P_{m3} - P_{m2}}\right] \text{ elec. deg}$$

$$= \cos^{-1}\left[\frac{1.0(2.4345 - 0.4716) + 1.54 \times \cos(139.5) - 0.55 \times \cos(27.03)}{1.54 - 0.55}\right]$$

$$= \cos^{-1}(0.3055)$$

$\delta_c = 72.21°$

55. A three-phase diode bridge rectifier is shown in figure. Input voltage to the bridge is 400V at 50Hz and source has inductance of 1.5mH per phase. The fundamental input power factor is _____ lag. (Give the answer upto three decimal places).



55. Ans: 0.983 (Range: 0.9 to 0.988)

Sol: Average output voltage $V_0 = \frac{3V_{m\ell}}{\pi} - \frac{3\omega L_s}{\pi} I_0$

$$= \frac{3\times 400\sqrt{2}}{\pi} - \frac{3\times 100\pi}{\pi}\times\frac{1.5}{1000}\times 20$$

$$= 540.19 - 9 = 531.19\text{V}$$

Rms value of fundamental source current $I_{s_1} = \frac{\sqrt{6}}{\pi} I_0$

$$I_{S1} = \frac{\sqrt{6}}{\pi}\times 20 = 15.594\text{A}$$

As per power balance, $P_{in} = P_0$

$\Rightarrow \sqrt{3}V_s I_{s1}\cos\phi_1 = V_0 \times I_0$

$\Rightarrow \sqrt{3}\times 400\times 15.594\times\cos\phi_1 = 531.19\times 20$

$\Rightarrow \cos\phi_1 = \frac{531.19\times 20}{\sqrt{3}\times 400\times 15.594}$

$= 0.983$ lag

NEW BATCHES - 2019
ADMISSIONS OPEN

CENTER	COURSE	BATCH TYPE	DATE
HYDERABAD - Abids	GATE + PSUs – 2019	Morning Batch	20th January 2018
HYDERABAD - Abids	GATE + PSUs – 2019	Weekend Batch	20th January 2018
HYDERABAD - Abids	ESE + GATE + PSUs – 2019	Morning Batch	20th January 2018
HYDERABAD - DSNR	GATE + PSUs – 2019	Morning Batch	19th January 2018
HYDERABAD - DSNR	GATE + PSUs – 2019	Evening Batch	19th January 2018
HYDERABAD - DSNR	ESE + GATE + PSUs – 2019	Morning Batch	19th January 2018
HYDERABAD - DSNR	ESE + GATE + PSUs – 2019	Evening Batch	19th January 2018
HYDERABAD - Kukatpally	GATE + PSUs – 2019	Morning Batch	19th January 2018
HYDERABAD - Kukatpally	GATE + PSUs – 2019	Evening Batch	19th January 2018
HYDERABAD - Kukatpally	ESE + GATE + PSUs – 2019	Morning Batch	19th January 2018
HYDERABAD - Kukatpally	ESE + GATE + PSUs – 2019	Evening Batch	19th January 2018
Delhi	GATE + PSUs – 2019	Weekend Batch	13th & 27th January 2018
Delhi	GATE + PSUs – 2019	Regular Batch (Evening)	24th February 2018
Delhi	ESE + GATE + PSUs – 2019	Weekend Batch	13th & 27th January 2018
Delhi	ESE + GATE + PSUs – 2019	Regular Batch (Evening)	24th February 2018
Bhopal	GATE + PSUs – 2019	Morning & EveningBatch	29th January 2018
Bhopal	GATE + PSUs – 2020	Morning & EveningBatch	29th January 2018
Bhopal	ESE+GATE + PSUs – 2019	Morning & Evening Batch	29th January 2018
Bhopal	ESE+GATE + PSUs – 2020	Morning & Evening Batch	29th January 2018
Pune	GATE + PSUs – 2019	Weekend Batch	20th January 2018
Pune	GATE + PSUs – 2019	Evening Batch	22nd January 2018
Pune	ESE+GATE + PSUs – 2020	Weekend Batch	20th January 2018
Bengaluru	GATE + PSUs – 2019	Weekend Batch	20th January 2018
Vijayawada	GATE + PSUs – 2019&20	Weekend Batch	21st January 2018
Kolkata	GATE + PSUs – 2019	Weekend Batch	20th January 2018
Kolkata	GATE + PSUs – 2020	Weekend Batch	20th January 2018