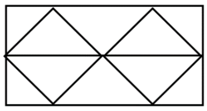
Real Test

Electrical Engineering

Q1 In the figure shown below, various horizontal and vertical segments divide the outer shape into multiple regions. How many rectangles and triangles are there in the figure?



(A) Two rectangles & Twelve triangles
(B) Five rectangles & Ten triangles
(C) Six rectangles & Twelve triangles
(D) Eight rectangles & Eleven triangles

Q2 Train P leaves station A at 08:00 hours and reaches station B at 12:00 noon. Train Q leaves station B at 09:00 hours and reaches station A at 15:00 hours. Assuming both trains travel at constant speeds, at what exact time do the two trains cross each other?

(A) 10:15 hours
(B) 10:36 hours
(C) 10:48 hours
(D) 11:30 hours

Q3 Two fair dice are thrown simultaneously. In how many possible outcomes is the number shown on the top face of the first die greater than the number on the bottom face of the second die?

(A) 18 (B) 36
(C) 6 (D) 15

Q4 Select the most appropriate meaning of the underlined idiom.

The actor decided to live life **in the fast lane**.

(A) Racing away to the moon
(B) A life of extreme speed
(C) A life filled with excitement
(D) Dropping charges of crime

Q5 Select the most appropriate synonym of the given word.

LUCID

(A) Lucky (B) Timely
(C) Clear (D) Happy

Q6 Which of the following powers of 6 is the largest factor of : 1 × 2 × 3 × 4 × 5………× 89 × 90.

(A) 6^{24} (B) 6^{44}
(C) 6^{34} (D) 6^{18}

Q7 In a bakery, Rohan can bake half as many cakes as Meera in one-sixth of the time it takes Meera. If they decide to work together, they can bake all the cakes in 10 days. How many days would Meera need to bake all the cakes by herself?

(A) 40 days (B) 25 days
(C) 30 days (D) 35 days

Q8 The given sentence contains a grammatical error. Identify the segment that contains the error.

Smitha was offered the job although having no qualifications.

(A) although having
(B) Smitha was offered
(C) the job
(D) no qualifications

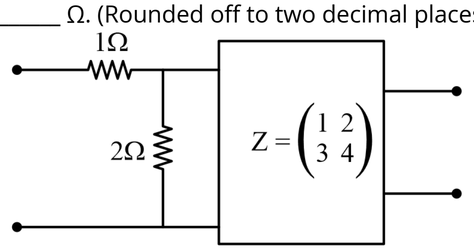
Q9 A rectangular sheet of cardboard has its sides in the ratio 1:4. Riya keeps cutting it in half along the longer side. After several cuts, she wonders: after how many cuts will the rectangle again have the same 1:4 ratio of sides?

(A) 4 cuts (B) 6 cuts
(C) 3 cuts (D) Never

Q10 A chef intends to fill a display case with 20 cupcakes, reaching its full capacity. Every 30 seconds, he adds 2 cupcakes, but a mischievous helper takes 1 cupcake out. How much time will it take for all 20 cupcakes to be in the display case for the first time?

(A) 600 seconds (B) 328 seconds
(C) 570 seconds (D) 300 seconds

Q11 Consider below given circuit, then the value of Z_{12} of the complete 2-port network will be ________ Ω. (Rounded off to two decimal places)



Q12 The buck-boost regulator has a source voltage, V_S = 20V. The switching frequency is 10 kHz with a duty ratio of 0.25. Given that load has R = 3Ω, L = 125 μH and C = 100 μF. Then the peak-to-peak output voltage ripple will be

(A) $\frac{8}{9}V$ (B) $\frac{5}{9}V$

(C) $\frac{7}{9}V$ (D) $\frac{2}{9}V$

Q13 The positive, negative and zero sequence reactance of a 3-phase generator are 0.5 pu, 0.5 p.u and 0.2 p.u respectively. For a line-to-line fault with fault impendence 0.5 p.u, the fault current is equal to single line to ground fault with zero fault impedance. Then the value of neutral grounding reactance is _________ p.u. (Assume generate is open circuit with terminal voltage of 1 pu) (Rounded off to two decimal places)

Q14 A survey was conducted among 800 College students. The results for their preference for three
subjects: Mathematics(M), Physics(P) and Chemistry(C) are as follows:

- 350 students like M, 300 students like P, 250 students like C.
- 150 students like both M and P, 100 students like both P and C.
- 120 students like both M and C.
- 70 students like all three subjects (M, P and C)

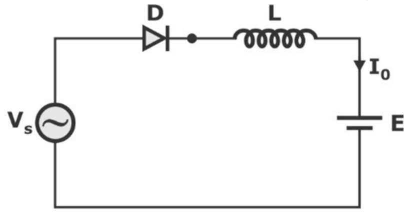
How many students do not like any of the three subjects?

(A) 600 (B) 370

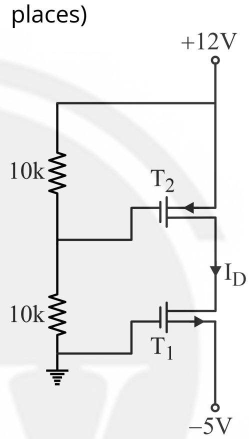
(C) 450 (D) 200

Q15 A PMMC instrument with a full scale deflection of 20 μA and internal resistance (R_m) of 2 kΩ is to be employed as an AC voltmeter with full scale deflection of 10 V (rms) (silicon devices are used), then the multiplier resistance value (R_S) required is _____ kΩ (Rounded off to two decimal places).

Q16 For the circuit shown, V_S = 230V (rms), 50 Hz, L_S = 5 mH and E = 110V. Then the peak instantaneous output current will be _____ Ampere. (Rounded off to two decimal places).



Q17 For the given MOSFET arrangement, threshold voltage $|V_T|$ = 2V and $k_n'\left(\frac{W}{L}\right)$ = 0.1 mA/V^2. The maximum value of drain current is ______mA. (Rounded off to two decimal places)



Q18 The reactance of a generator designated 'X' is given as 0.20 pu based on the generator's name plate rating of 11 kV, 100 MVA. If the base for calculations is changed to 15 kV, 200 MVA, the generator reactance 'X' on new base will be in pu __________. (Rounded off to three decimal places)

Q19 For a 3-   2.3 kV, 150 × 10^3 watts, 50 Hz salient pole synchronous motor running at speed = 1000 rpm. Its X_d = 32 Ω/phase, X_q = 20Ω/phase and losses = 0 watts. Its field excitation is adjusted such that its back emf is twice that of applied voltage. The developed torque in N-m will be, (if δ = 16°).

(A) 1114.6 (B) 1118.6

(C) 1121.2 (D) 1122.2

Q20 Which of the following is/are correct for the Cartesian co-ordinate system?

(A) For cylindrical co-ordinate system with general point p(ρ, , z). If is constant it gives a rectangular surface.

(B) In spherical co-ordinate system with general point p(r, θ,). The range of is 0 ≤ ≤ 2π.

(C) Position vector for rectangular co-ordinate system is $\overrightarrow{OP} = x\widehat{ax} + y\hat{a}y + z\hat{a}_3$

(D) For spherical Cartesian co-ordinate system, with general point p(r, θ,). is the vertical angle.

Q21 A logic circuit implements the Boolean function $F = \overline{x}y + x\overline{y}\,\overline{z} + xy\,\overline{z}$. It is found that the input combination x = z = 1 can never occur. Taking this into account, a simplified expression for F is given by

(A) x + z (B) y + z

(C) x + y (D) x + y + z

Q22 For an induction motor running above its base speed, supply frequency is made twice for speed control, then

(A) The starting torque will be decreased by 1/8th of its initial value

(B) The pull-out torque will be decreased by 1/4th of its initial value

(C) The starting torque will be increased by 1/8th of its initial value

(D) The pull-out torque may decrease or increase

Q23 Q. Which of the following statements is/are correct?

(A) A demultiplexer cannot be used as a decoder.

(B) A demultiplexer selects one of many outputs.

(C) The input to output pin ratio of a multiplexer with n control inputs is $2^n : 1$.

(D) The dual of an expression $\left(\overline{A}B + BC + \overline{C}D\right)$ is $\left(\overline{A} + B\right)\left(B + C\right)\left(\overline{C} + D\right)$.

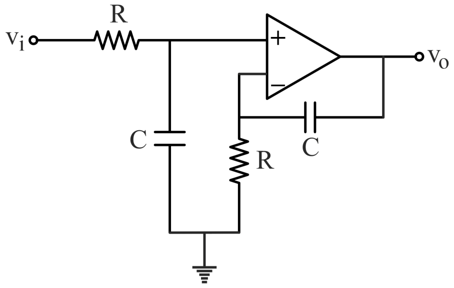
Q24 For log(1– 5z) with |z| < $\frac{1}{5}$, the Inverse Z-transform is given by $\frac{\alpha^n u(-\beta n-1)}{n}$; then the value of αβ is ______. (Rounded off to two decimal places)

Q25 $L = \lim_{x\to 0}\left(\frac{1}{x}\right)^{\tan x}$

(A) L = 0 (B) $L = \frac{1}{e}$

(C) L = e (D) L = 1

Q26 If the op-amp shown in figure below is ideal, then the circuit acts as



(A) Low pass filter

(B) Bandpass filter

(C) All pass filter

(D) High pass filter

Q27 Two generating units rated 300 MW, and 400 MW have governor speed regulations of 6% and 4% respectively from no load to full load. No load frequency is 50 Hz. If both generators are operating in parallel sharing a total load of 600 MW. Assuming free governor action, the load shared by the larger unit is

(A) 400 MW (B) 200 MW

(C) 300 MW (D) 500 MW

Q28 Plane x+ 2y = 5 carries charge of 6nc/m^2 The electric field E at (–1 , 0, 1) is

(A) $-151.7a_{\hat{x}} + 303.5\,a_{\hat{y}}\,V/m$

(B) $113a_{\hat{y}} + 303.5\,a_{\hat{z}}\,V/m$

(C) $113a_{\hat{y}} - 303.5\,a_{\hat{z}}\,V/m$

(D) $-151.7a_{\hat{x}} - 303.5\,a_{\hat{y}}\,V/m$

Q29 For a DC shunt motor for a condition when it is taking 16A observed data is

i) Rating = 60 kW, 250V

ii) Speed = 1440 rpm when running at light load

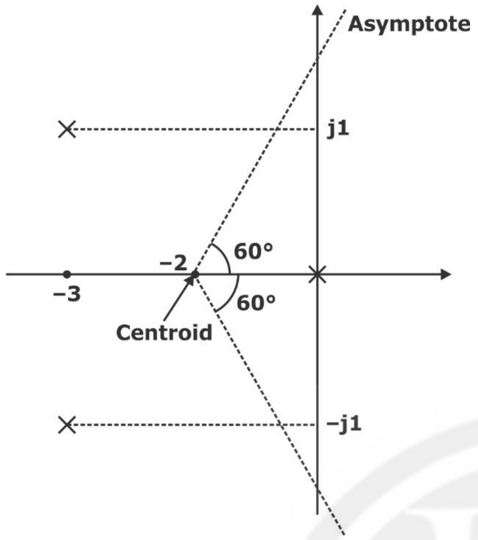
iii) Armature resistance = 0.2Ω

iv) Field resistance = 125Ω

v) Mechanical loses = 0 (Always)

If motor takes 152 A, instead of 16A, its efficiency is ___________%. (Rounded off to two decimal places)

Q30 The figure shown the asymptote root locus in real axis and location of poles and centred, then the ratio $\left(\frac{break\ in}{break\ away}\right)$ point of the root locus is ______. (Rounded off to two decimal places).



Q31 For x(n) = cos $\left(\frac{\pi n}{2}\right)$, the DTFS coefficients are represented as c_k, then choose the correct option(s):

(A) C_1 is non zero (B) C_1 is zero

(C) C_3 is non zero (D) C_7 is non zero

Q32 Let X and Y be two independent random variables. Var (X) = 4 and Var(Y) = 9. Choose the correct option(s) given below.

(A) Var(2X) = 8

(B) Var(X - Y) = 13

(C) Var(2X - 3Y) = 97

(D) Var(Y/3) = 1

Q33 Which of the following is/are correct regarding the bus matrix?

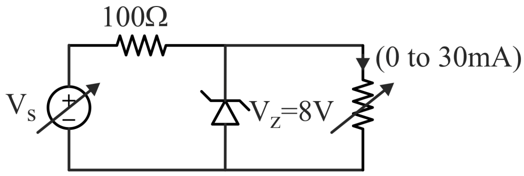
(A) It is easier to construct the Y-bus matrix as compared to Z-bus matrix.

(B) Y-bus matrix is full-matrix while Z-bus matrix is sparse matrix.

(C) Y-bus matrix is used to solve load flow study.

(D) Z-bus matrix is used to solve fault analysis.

Q34 An 8 V Zener diode voltage regulator as shown in figure below operates from a source that varies from 12 V to 18 V. The series resistance is 100 Ω and the load draws current that varies from 0 mA to 30 mA. Then which of the following is/are correct under worst-case conditions?



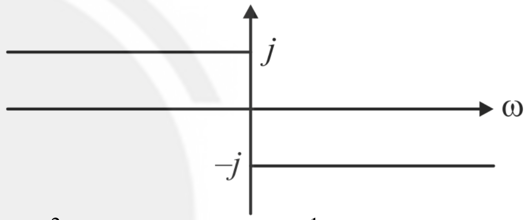
(A) $P_{Z(max)}$ = 80 mW

(B) $P_{Z(max)}$ = 800 mW

(C) $I_{Z(max)}$ =10 mA

(D) $I_{Z(max)}$ = 100 mA

Q35 Fourier transform of signal h(t) is H(ω). H(ω) is shown in the figure below. Then h(t) is



(A) $\frac{2}{\pi t}$ (B) $\frac{1}{\pi t}$

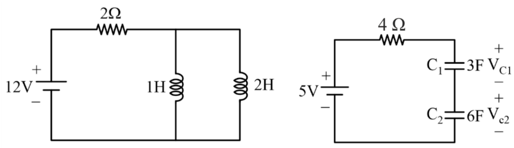
(C) $\frac{j}{\pi t}$ (D) $\frac{-j}{\pi t}$

Q36 The deflection of moving iron ammeter when 1.9 A of current flowing through will of 250 μH inductance is 39.4° and the deflection when a current of 2.4 A flowing through coil of 255.2 μH inductance is 50.2°. when 2.2 A of current flowing with deflection of 46.5°, the value of spring constant (μN-m/rad) will be

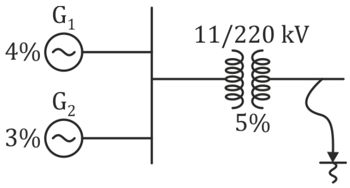
(A) 82.27 (B) 81.33

(C) 83.26 (D) 88.33

Q37 If the steady state voltage across the capacitor 6 F is $V_{c2}(\infty)$ and current in the inductor 1H is $i_1(\infty)$, then $\frac{V_{c_2}(\infty)}{i_1(\infty)}$ is ____ mΩ. (Rounded off to two decimal places).

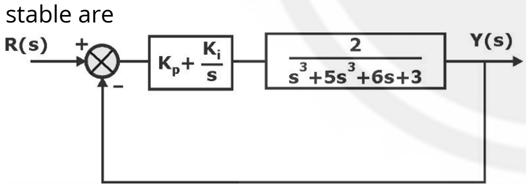


Q38 Consider the system given below which has two 11kV, 3–phase, 10 MVA generators having sub-transient reactance of 4% and 3% respectively are operating in parallel. Suppose the power loaded through a 11/220 kV, 20 MVA transformer has % equivalent reactance of 5%. The fault currant of generator 1, if a 3 – fault occurs at HV side of the transformer is ____kA [Rounded off to two decimal places]



Q39 The electric flux density is in the spherical coordinates system as $\vec{D} = r^2 \sin\theta\, \hat{a}_r + \frac{\sin\phi}{r^3}\cos\theta \hat{a}_\theta + r\cos\phi \sin\theta \hat{a}_\phi$, then the charge density of the system at $\left(I, \frac{\pi}{4}, \frac{\pi}{6}\right)$ is _____ c/m^3. (Rounded off to three decimal places).

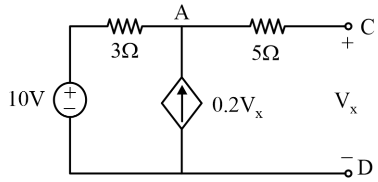
Q40 A unity feedback control system that uses proportional integral controller is shown in figure below. The stability of closed loop system is controlled by proportional integral controller. The maximum value of K_i and corresponding value of K_P for the system to be stable are



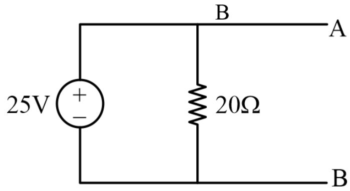
(A) $K_i = 4.5$ (B) $K_P = 6$

(C) $K_P = 13.5$ (D) $K_i = 5$

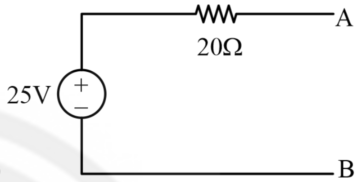
Q41 The circuit shown in figure, contains a dependent current source between A and B terminals. The Thevenin's equivalent circuit across terminals C and D.



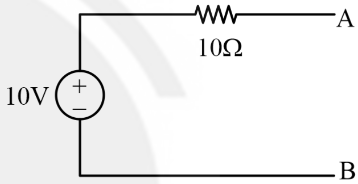
(A)



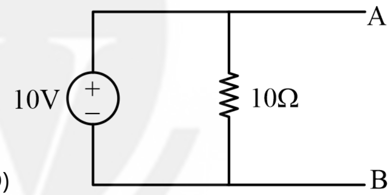
(B)



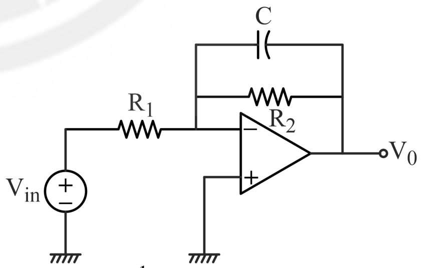
(C)



(D)



Q42 For the circuit shown below, if



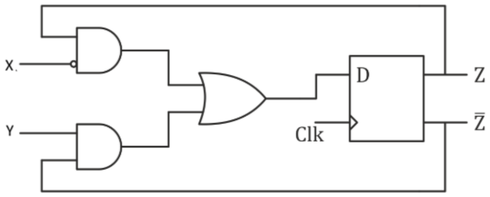
(A) $\omega >> \frac{1}{R_2C}$, circuit will because like integrator

(B) $\omega << \frac{1}{R_2C}$, circuit will behave like amplifier

(C) $\omega >> \frac{1}{R_2C}$, circuit will behave like amplifier

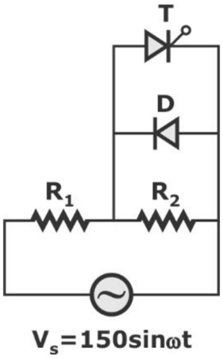
(D) $\omega << \frac{1}{R_2C}$, circuit will behave like integrator

Q43 A sequential circuit using D flip-flops and logic gates is shown below. When X and Y are the inputs and Z is the output. Then the circuit is



(A) S-R FF with inputs X = R and Y = S
(B) S-R FF with inputs X = S and Y = R
(C) J-K FF with inputs X = J and Y = K
(D) J-K FF with inputs X = K and Y = J

Q44 For the circuit shown $R_1 = R_2 = 100\Omega$, an ideal diode 'D' and an ideal Thyristor 'T' supplied from an ideal power supply of $V_s = 150 \sin\omega t$. The firing angle is 90°, the average value of current in 'R_1' for the supply cycle is _____mA. (Rounded off to two decimal places).

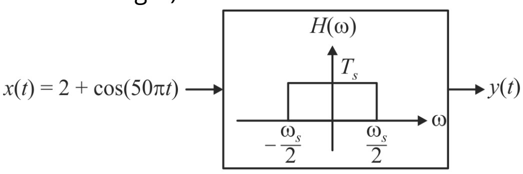


(A) – 119.4 (B) 119.4
(C) 0.1194 (D) – 0.1194

Q45 The ratio of starting to full load current for a 10kW, 400V, 3-phase induction motor with star delta starter, given the full load efficiency as 0.86, the full load pf is 0.8 and short circuit current is 30A at 100V is [Ignore Magnetizing current]

(A) 1.9 (B) 1.8
(C) 2.4 (D) 3.2

Q46 A signal x(t) is sampled at 0.01 sec, such that its output y(t) is A + cos(ωt) as shown below. The value of A is ______. (Rounded off to nearest integer)



Q47 For a synchronous generator, synchronous reactance is 0.2 p.u., negligible resistance and running at full load at 0.8 PF lagging. Then its voltage regulation (in %) will be

(A) 13.6 (B) 14.6
(C) 13.1 (D) 14.1

Q48 A 6–pole, 200V wave–connected shunt motor has 720 armature conductors and useful flux/pole is 5mWb. The armature and field resistance are 0.5 Ω and 100 Ω respectively. The motor runs at 1000 rpm and the rotational losses are 1000W. The efficiency of the motor is -------% (Rounded off to two decimal places)

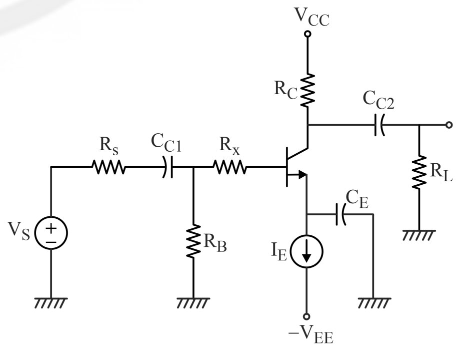
Q49 The inverse Laplace transform is given as

$$L^{-1}\left\{\frac{s+3}{s^2-4s+13}\right\} = e^{2t}\left\{\cos 3t + \alpha \cdot \sin 3t\right\}$$

The value of 'α' is _______ (Round off to three decimal places)

Q50 For a CE amplifier shown below upper 3-dB cut-off frequency is ____ kHz, provided below:

(i) Unity gain frequency = 800 MHz
(ii) C_μ = 1 pF
(iii) C_π = 7 pF
(iv) r_π = 2.5 kΩ
(v) r_0 = 100 kΩ
(vi) V_{cc} = 10 V = $-V_{EE}$
(vii) $R_s = R_L$ = 5 kΩ
(viii) R_c = 8 kΩ R_x = 50 Ω, R_B = 100 kΩ
(ix) β = 100, I_E = 1 mA



(A) 560 (B) 630
(C) 762 (D) 875

Q51 Which of the following is/ are correct for electrical machine?

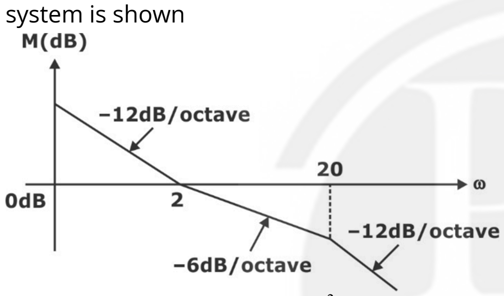
(A) To eliminate nth harmonic from generated voltage waveform, chording angle (α) is equal to $\frac{90^\circ}{n}$.

(B) For a 3-ϕ machine, a 3 – ϕ winding will produce a backward rotating fifth harmonic at the speed of $\left(\frac{1}{5}\right)$ times of synchronous speed.

(C) For a 3 - ϕ machine, a 3 - ϕ winding will produce a backward rotating seventh order harmonic at the speed of $\left(\frac{1}{7}\right)$ of synchronous speed.

(D) The 60° phase speed gives better power ratings than 120° phase speed.

Q52 The magnitude plot for a minimum phase system is shown



The steady state error for $\frac{5t^2}{2}$ input is ______. (Rounded off to two decimal places).

Q53 Consider the system of linear equations

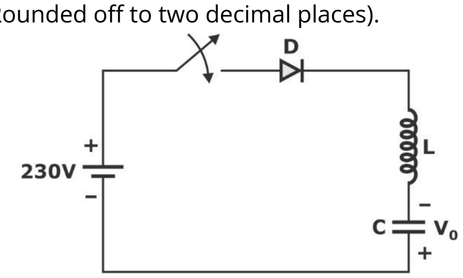
x + y + 5z = 3

x + 2y + 2z = 5

2x + 4y + 4z = k

For the system to have infinitely many solutions, the value of k is ___ (Enter in integer)

Q54 A diode is connected in series with LC circuit, if it is switched to a DC voltage source V_S = 230V, V_0 =30V, L = 0.3 mH and C = 5μF, then peak value of diode current is______ Ampere (Rounded off to two decimal places).



Q55 The value of the following series

$\frac{1}{2} - \frac{1}{6} + \frac{1}{24} - \frac{1}{120} + \ldots\ldots\ldots\ldots$ is ______

(Round off to two decimal places).

Q56 A transformer, circuit breaker is equipped with 500/5A C.Ts connected to an induction type over current relay. The relays have 125% plug setting and 0.4 as time setting. If a 3 fault current of 7500A flows from C.T. and relays. Follow characteristics given by below table at (TMS=1), then

PSM	4	8	12	16
Operating time (sec)	5	3	2.8	2.2

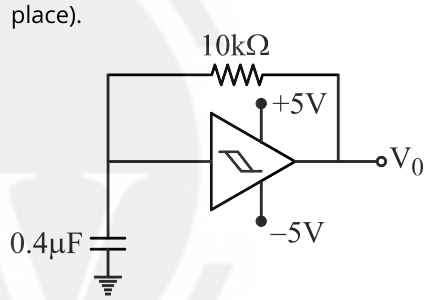
(A) PSM = 16

(B) Time of operation of relay = 1.12 sec

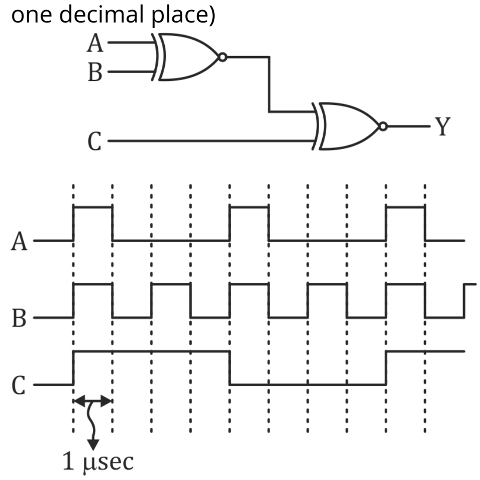
(C) PSM = 12

(D) Time of operation of relay = 0.88 sec

Q57 A hysteresis type TTL inverter is used to realize an oscillator in the circuit. V_{LT} = 0.9V, L_{UT} = 1.8V, the period for which output is 'high is _____ msec. (Rounded off to three decimal place).



Q58 The waveform of three periodic signals A, B and C are shown in the figure below. If they are applied to the two EX-NOR gate combination circuits, then the frequency of output 'Y' will be _________kHz. (Rounded off to one decimal place)



Q59 Consider the following D.E:

y" + y = sin(t)

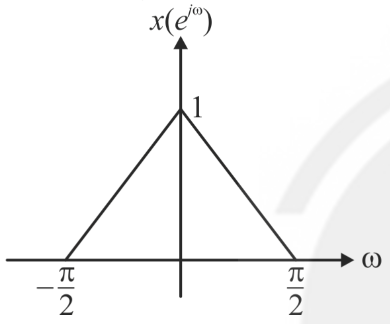
with initial conditions as y(0) = 0 and y' (0) = 0. The value of y (π) is___(Round off to two decimal places)

Q60 A 50 MVA, 15 kV, 3–ϕ synchronous generator was subjected to different types of faults. If the fault current for single line to ground fault is 3200A and for line to line (LL) fault, the fault current is 1900A. What is the per unit value of zero sequence reactance of the generator?

(A) 0.224 pu (B) 0.015 pu

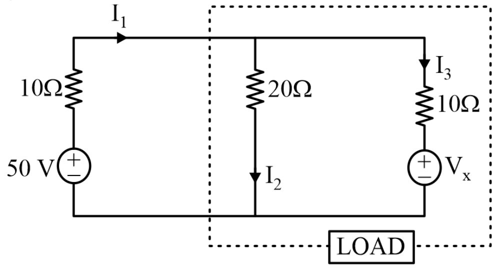
(C) 0.172 pu (D) 0.049 pu

Q61 For a signal x(n), its DTFT is shown below such that a constant A is given by $\frac{\sum_{n=-\infty}^{\infty} nX(n)}{\sum_{n=-\infty}^{\infty} X(n)}$. Then the value of A is ______. (Rounded off to nearest integer)



Q62 If a, b and c are the roots of $x^3 - 5x + 3 = 0$, then the value of the determinant $\begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}$ is equal to______.

Q63 For the circuit shown below, which of the following is/are correct so that maximum power is transferred to load?



(A) V_x = 10V (B) I_1 = 2.5 A

(C) I_2 = 1.25 A (D) I_3 = 1A

Q64 If the Fourier transform of $x_1(t) = te^{-|t|}$ is $X_1(\omega)$ and of $x_2(t) = \frac{4}{(1+t^2)^2}$ is $X_2(\omega)$ then $\frac{X_1(\omega)}{X_2(\omega)}$ at ω = π rad/sec is _____. (Rounded off to two decimal places).

Q65 For a system, CLTF = $\frac{10(s+3)}{s^3+6s^2+11s+6}$. If the state space representation of the system is x(t) =

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} x(t) + \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} u(t)$$

, y(t) = $[C_1\ C_2\ C_3]$ x(t) .

then $\frac{b_1+C_1}{b_2+C_2}$ is ______. (Rounded off to one decimal place).

(A) 2 (B) 3

(C) 4 (D) 5

Answer Key

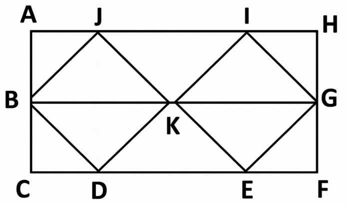
Q1	B
Q2	C
Q3	D
Q4	C
Q5	C
Q6	B
Q7	A
Q8	A
Q9	D
Q10	C
Q11	1.31~1.35
Q12	B
Q13	0.46~0.48
Q14	D
Q15	403~404
Q16	216~220
Q17	0.44~0.46
Q18	0.291~0.295
Q19	C
Q20	A, B, C
Q21	C
Q22	A, B
Q23	B, C, D
Q24	0.2~0.2
Q25	D
Q26	A
Q27	A
Q28	D
Q29	75~80
Q30	2.35~2.4
Q31	A, C
Q32	B, C, D
Q33	A, C, D
Q34	B, D
Q35	B
Q36	A
Q37	410~420
Q38	5.3~5.4
Q39	2.2~2.3
Q40	A, B
Q41	B
Q42	A, B
Q43	D
Q44	A
Q45	A
Q46	2~2
Q47	C
Q48	71~76
Q49	1.6~1.67
Q50	C
Q51	B, D
Q52	1.2~1.3
Q53	10~10
Q54	33~34
Q55	0.35~0.38
Q56	B, C
Q57	0.98~1
Q58	125~125
Q59	1.5~1.6
Q60	D
Q61	0~0
Q62	0~0
Q63	B, C
Q64	0.45~0.55
Q65	B

Hints & Solutions

Note: scan the QR code to watch video solution

Q1 Text Solution:

Pointing the figure as



The Rectangles are :

ABGH, BCFG, ACFH, BDKJ & KEGI. Total 5.

The Triangles are:

ABJ, BJK, JKI, IKG, IHG, BCD, BDK, KDE, KEG & GEF. Total 10.

Q2 Text Solution:

If the distance between Stations A and B is D km

Train P speed = D/4 (covers in 4 hours i.e. 0800 to 1200)

Train Q speed = D/6 (covers in 6 hours i.e. 0900 to 1500)

To reach the meeting point, Distance covered by Train P + Distance covered by Train Q = Total Distance (D).

Let's say they meet after 'x' hours from 0800.

Thus, x(D/4) + (x-1) (D/6) = D

Or (x/4) + (x-1 / 6) = 1

Or 3x + 2x – 2 = 12

Or 5x = 14

Thus x =14/5 = 2 and 4/5 hours = 2 hours 48 minutes

From 0800, 2 hours 48 minutes = 10:48 hours

Q3 Text Solution:

If top face of 1st die is 2, then second die is 1 (Only 1 case)

If top face of 1st die is 3, then second die is 1 or 2 (2 cases)

If top face of 1st die is 4, then second die is 1 or 2 or 3 (3 cases)

Similarly, If top face of 1st die is 5, then 4 cases

If top face of 1st die is , then 5 cases.

Total 1 + 2 + 3 + 4 + 5 = 15

Q4 Text Solution:

The idiom "live life in the fast lane" means a life filled with excitement   Option C.

Q5 Text Solution:

Lucid means easy to understand, clear, transparent in meaning or thought.

Q6 Text Solution:

As 6 is formed by the product of 3 and 2. Also number of 3's is less as compared to 2's. So, as many 3's those many 6's are formed.

To find in 90!

$\frac{90}{3}$ gives 30

$\frac{30}{3}$ gives 10

$\frac{10}{3}$ gives 3 (whole number)

$\frac{3}{3}$ gives 1

And $\frac{1}{3}$ gives 0 (whole number).

Thus total 30 + 10 + 3 + 1 = 44. Thus 90! has largest factor 6^{44}.

Q7 Text Solution:

If Meera bakes 1 cake in 1 unit time, Rohan bakes ½ cake in $\frac{1}{6}$ unit time.

Or Rohan bakes 1 cake $\frac{2}{6}$ unit time.

Comparing Time taken to do the work

Meera : Rohan = 1 : $\frac{1}{3}$ = 3 : 1

If Rohan takes x days, Meera takes 3x days.

Given that they do together the work in 10 days, i.e. $\left(\frac{1}{x}\right)+\left(\frac{1}{3x}\right)=\frac{1}{10}$

Or $\left(\frac{4}{3x}\right)=\frac{1}{10}$ Or $\frac{3x}{4}$= 10 Or x = $\frac{40}{3}$.

Thus Meera takes $3\left(\frac{40}{3}\right)$ = 40 days.

Q8 Text Solution:

"Although" is a conjunction and must be followed by a subject + finite verb (e.g., "although she had no qualifications").

Here it is incorrectly followed by just the participle "having", so the phrase is ungrammatical.

Correct versions would be:

- "Smitha was offered the job although she had no qualifications."
- "Smitha was offered the job despite having no qualifications.

Q9 Text Solution:

Initial ratio 1 : 4.

Always cutting the longer side.

1st Cut ratio 1 : 2

2nd Cut ratio 1 : 1

3rd cut ratio (any side) 2 : 1.

4th Cut ratio again 1 : 1.

Thus Never it will come again to same ratio 1 : 4.

Q10 Text Solution:

In 30 seconds net cupcakes in display = 1 (2-1)

1 cup cake in 30 seconds

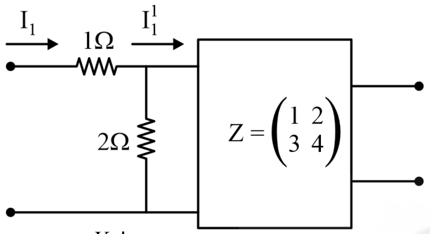
18 cupcakes in 30 × 18 = 540 seconds.

In the next 30 seconds chef adds 2 cupcakes to make it 20.

Thus total earliest time = 540 + 30 = 570 seconds.

Note: The last moment can't be withdrawal as the display holds only 20 cupcakes.

Q11 Text Solution:



$$Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0}$$

$$V_1 = V_1^1 = -2I_1^1 = 1\times I_1^1 + 2I_2$$

$$-3I_1^1 = 2I_2$$

$$\boxed{I_1^1 = \frac{-2}{3}I_2}$$

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

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

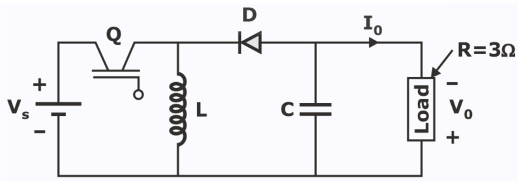
$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$$Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0} = (-2)\times\frac{-2}{3} = \frac{4}{3}$$

$$Z_{12} = \frac{4}{3} = 1.33\ \Omega$$

Q12 Text Solution:

The buck-boost regulator with the given data is as shown below



(f_s = 10 kHz, D = 0.25)

L = 125 μH, C = 100 μF

Output voltage in a buck-boost regulator $V_0 = \frac{DV_s}{(1-D)}$

$V_0 = \frac{0.25\times 20}{(1-0.25)} = \frac{20}{3}$V

Output current, $I_0 = \frac{V_0}{R} = \frac{20}{3}\times\frac{1}{3} = \frac{20}{9}\ Amp$

We know that peak to peak output ripple is voltage $\Delta V_0 = \frac{I_0 D}{fC}$

Or $\Delta V_0 = \frac{20}{9}\times\frac{0.25}{10\times10^3\times100\times10^{-6}}$

$\Delta V_0 = \frac{5}{9}$volts

Q13 Text Solution:

X_1 = j0.5 p.u, x_2 = j0.5 p.u, x_0 = j0.2 pu

$z_{f_1} = j0.5$ [line to line fault]

$z_{f_2} = 0$ [line to ground fault]

Now,

$$(I_F)_{line\ to\ line} = \frac{\sqrt{3}\cdot V}{x_1+x_2+z_{f_1}}$$

$$(I_f)_{SLG} = \frac{3V}{x_1+x_2+x_0+3z_{f_2}+3x_n}$$

$$(I_f)_{L.L} = (I_f)_{SLG}$$

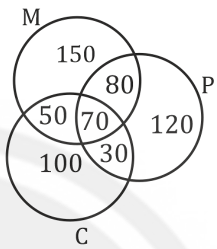
$$\frac{\sqrt{3}\times(1)}{j(0.5+0.5+0.5)} = \frac{3\times(1)}{j(05+0.5+0.2+0+3x_n)}$$

x_n = j0.466

= 0.466 p.u

Q14 Text Solution:

Total students = 800



No. of students like at least one subject

= No. of students like one subjects + No. of students like two subjects + No. of students like all three subjects

= (150 + 120 + 100) + (50 + 30 + 80) + (70) = 600

No. of students who like none of the subjects = 800 – 600 = 200

Q15 Text Solution:

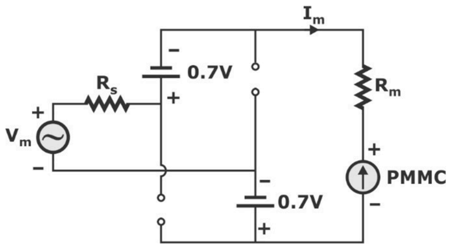
The average current flowing through the PMMC instrument is I_{avg} = 20μA

for the given full bridge rectifier,

Maximum current value, $I_m = \frac{\pi}{2}\times I_{avg} = 10\pi\ \mu A$

From KVL, $I_m = \frac{V_m - V_d}{R_m + R_s}$ (where, $V_m = \sqrt{2}$ V_{rms}) ...(i)

'V_d' = Total voltage drop = 2 × 0.7 = 1.4V



R_m = 2kΩ

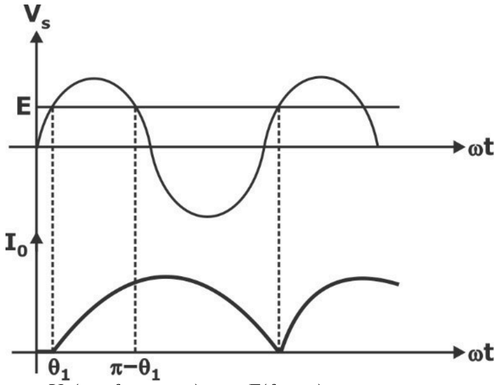
$$10\pi\times10^{-6} = \frac{10\sqrt{2}-1.4}{2000+R_s}$$ (from equation (i))

R_s = 403.59 kΩ

Q16 Text Solution:

By default, we assume ideal diode,

i_0 maximum at (π -θ_1) and the waveform will be continuous due to inductor.



$i_0 = \frac{V_m(\cos\theta_1 - \cos\omega t)}{\omega L} + \frac{E(\theta_1 - \omega t)}{\omega L}$

(when the diode is forward biased).

Here, θ_1 =

$\sin^{-1}\left(\frac{E}{V_m}\right) = \sin^{-1}\left(\frac{110}{230\sqrt{2}}\right) = 19.77°$

The output current will be at its peak at $\omega t = \pi - \theta_1$

at ωt = 180° – 19.77° = 160.23°

$$i_{0(max)} = \frac{230\sqrt{2}\,(\cos 19.77° - \cos\ 160.23°)}{2\pi\times50\times5\times10^{-3}} + \frac{110(\theta_1 - \pi + \theta_1)}{100\,\pi\times5\times10^{-3}}$$

$i_{0(max)}$ = 389.744 + $\frac{110(2\times19.77-180°)}{100\pi\times5\times10^{-3}} \times \frac{\pi}{180}$

$i_{0(max)}$ = 218.07 A

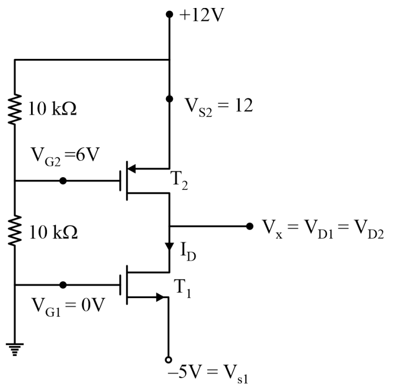
(1° = $\frac{\pi}{180}$ rad)

Q17 Text Solution:

Given for both MOSFETS, $|V_T|$ = 2V

$k_n'\left(\frac{W}{L}\right) = 0.1\ mA/V^2$

Checking the values of saturation currents of both MOSFETs to find the maximum value of I_D :-



For T_1 (NMOS):-

$V_{G1} = 0V \quad V_{S1} = -5V \quad V_{D1} = V_x\,(\text{Let})$

$(V_{GS})_{T_1} = V_{G1} - V_{S1} = 5V$

Overdrive voltage $(V_{GS} - V_T)_{T_1}$ = 5 – 2 = 3V

$(I_{D1})_{sat} = \frac{1}{2}k_n'\left(\frac{W}{L}\right)(V_{GS} - V_T)^2_{T_1}$

$= \frac{1}{2}\times 0.1\times 10^{-3}\times 9 = 0.45mA$

Condition for saturation

$(V_{DS})_{T_1} > (V_{GS} - V_T)_{T_1}$

$\Rightarrow V_x - (-5) > 3 \Rightarrow \boxed{V_x > -2V}$

For T_2 (PMOS) :-

$V_S = 12V, V_G = 6V, V_D = V_x, |V_T| = 2V$

$(V_{SG})_{T_2} = V_S - V_G = 6V$

Overdrive voltage

$(V_{SG} - |V_T|)_{T_2} = 6 - 2 = 4V$

$(I_{D2})_{sat} = \frac{1}{2}k_p'\left(\frac{W}{L}\right)(V_{SG} - |V_T|)^2$

$= \frac{1}{2}\times 0.1\times 10^{-3}\times 16 = 0.8mA$

$(I_{D1})_{sat} = 0.45mA \quad (I_{D2})_{sat} = 0.8mA$

So, PMOS is capable of supplying more current.

Condition for saturation of T_2 :-

$V_S > (V_{SG} - |V_T|)$

$\Rightarrow 12 - V_x > 4 \Rightarrow \boxed{V_x < 8V}$

As both the devices are connected in series and saturation currents for both are not equal, so they can't be in saturation simultaneously. NMOS saturation current 0.45 mA is much smaller than the saturation current of PMOS, so NMOS forces the current to reduce and hence PMOS must reduce its effective source to drain voltage V_{SD} so that it enters into its triode region.

As source is fixed at V_s = 12V, Voltage at drain of T_2, i.e., V_x will have to increase to reduce V_{SD} (= $V_S - V_D$).

Triode current euation of PMOS,

$I_{D2} = \frac{1}{2}k_p'\left(\frac{W}{L}\right)\left[2(V_{SG} - |V_T|)V_{SD} - V_{SD}^2\right]$

$= \frac{1}{2}\times 0.1\times 10^{-3}\left[2\times 4\times(12 - V_x) - (12 - V_x)^2\right]$

$= 0.05\times 10^{-3}(12 - V_x)[8 - 12 + V_x]$

$I_{D2} \Rightarrow 0.05\times 10^{-3}(12 - V_x)(V_x - 4)$

Equating drain currents of $T_1 \& T_2$ as they are in series

$0.45\times 10^{-3} = 0.05\times 10^{-3}(12V_x - 48 - V_x^2 + 4V_x)$

$\Rightarrow 9 = -V_x^2 + 16V_x - 48$

$\Rightarrow V_x^2 - 16V_x + 57 = 0$

$\Rightarrow V_x = 10.645 \text{ or } V_x = 5.354$

For $V_x = 10.645 = V_{D1} = V_{D2}$,

PMOS T_2 Triode I_{D2} = 0.45 mA

NMOS T_1 saturation I_{D1} = 0.45 mA

So all conditions are satisfied hence we can say that NMOS works in saturation and limits the value of current to 0.45 mA and PMOS follows this current being in triode region.

So the maximum possible value of drain current I_D is 0.45 mA

Q18 Text Solution:

$(V_{old})_{Base}$ = 11 kV

$(S_{old})_{Base}$ = 100 MVA

$(x_{pu})_{old}$ = 0.20 pu

$(V_{new})_{Base}$ = 15 kV

$(S_{new})_{Base}$ = 200 MVA

$$(X_{pu})_{new} = (X_{pu})_{old} \times \left(\frac{(V_{old})_B}{(V_{new})_B}\right)^2 \times \left(\frac{(S_{new})_B}{(S_{old})_B}\right)$$

$$= 0.20 \times \left(\frac{11\times10^3}{15\times10^3}\right)^2 \times \left(\frac{200\times10^6}{100\times10^6}\right)$$

= 0.293 pu

Q19 Text Solution:

$V = 2.3\,kV,$

$E_b = 2 \times 2.3kV = 4.6\,kV$

Developed power =

$$\frac{E_b V}{X_d}\sin\delta + \frac{V^2}{2}\left(\frac{1}{X_q} - \frac{1}{X_d}\right)\sin 2\delta$$

$$= \frac{(4.6\times10^3)(2.3\times10^3)}{32}\sin\left(16°\right) + \frac{(2.3\times10^3)^2}{2}\left(\frac{1}{20} - \frac{1}{32}\right)\sin(32°)$$

Developed power = 117.41 kW

$$T_{dev} = \frac{P_{dev}}{\omega_m} = \frac{117.41\times10^3}{\frac{2\pi\times1000}{60}} = 1121.21\,N-m$$

Q20 Text Solution:

Option (a), (b), (c) are correct

Option (d) is incorrect because for spherical Cartesian co-ordinate system with general point p(r, θ,). is the horizontal angle and not vertical angle.

Q21 Text Solution:

$$F = \bar{x}y + x\bar{y}\,\bar{z} + xy\,\bar{z}$$

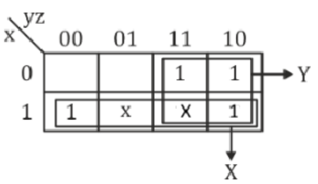
$$= \bar{x}y(z+\bar{z}) + x\bar{y}\,\bar{z} + xy\,\bar{z}$$

$$= \bar{x}yz + \bar{x}y\bar{z} + x\bar{y}\,\bar{z} + xy\,\bar{z}$$

As given x = z = 1, then it will show don't care about the truth table: -

x	y	z	F
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	×
1	1	0	1
1	1	1	×

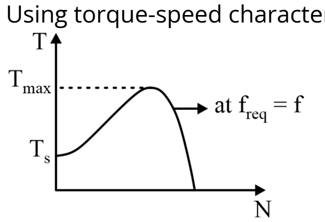
K-map:-

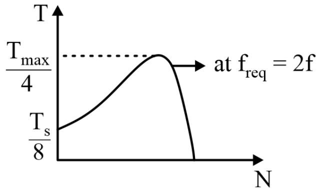


F = x + y

Q22 Text Solution:

Using torque-speed characteristics





For f' = 2f,

as speed control at above base speed

$T_{max} \propto \frac{1}{f^2}$

$T_s \propto \frac{1}{f^3}$

So, $\left(\frac{T_{max_2}}{T_{max_1}}\right) = \left(\frac{f_1}{f_2}\right)^2 = \left(\frac{f}{2f}\right)^2 = \left(\frac{1}{4}\right)$

And $\frac{T_{S_2}}{T_{S_1}} = \left(\frac{f_1}{f_2}\right)^3 = \left(\frac{f}{2f}\right)^3 = \left(\frac{1}{8}\right)$

Q23 Text Solution:

A demultiplexer selects one of many outputs, whereas a decoder selects an output corresponding to the coded input hence a demultiplexer can be used as a decoder.

Duality can be obtained of any expression by just interchanging the operator $[\bullet, +]$.

If any identity (0 or 1) is present in the expression, then interchange 0 by 1 and 1 by 0.

The input to output pin ratio of a multiplexer with n control inputs is $2^n : 1$.

Q24 Text Solution:

Let X(z) = log(1 – 5z)

$$\frac{dX(z)}{dz} = \frac{-5}{1-5z}$$

$$\frac{-z\,dx(z)}{dz} = \frac{5z}{1-5z} = \frac{-5z}{5z-1} = \frac{-1}{1-\frac{1}{5}z^{-1}}$$

Applying the Inverse Z-transform,

nX(n) = $\left(\frac{1}{5}\right)^n u\left(-n-1\right)$ since |z| < $\frac{1}{5}$

So, X(n) = $\frac{\left(\frac{1}{5}\right)^n u\left(-n-1\right)}{n}$

So, $\alpha = \frac{1}{5};\ \beta = +1$

So, $\alpha\beta = \frac{1}{5}$ = 0.2

Q25 Text Solution:

$$L = \lim_{x\to 0} \left(\frac{1}{x}\right)^{\tan x}$$

Take log both side

$$\ln L = \lim_{x\to 0} \tan x\left(-\ln x\right) = \lim_{x\to 0} \frac{-\ln x}{\cot x},\ \left(\frac{\infty}{\infty}\right)\text{form}$$

using L'hospital rule

$$\lim_{x\to 0} \frac{-\frac{1}{x}}{-\operatorname{cosec}^2 x} = \lim_{x\to 0}\left(\frac{\sin^2 x}{x}\right) = \lim_{x\to 0}\left(\frac{\sin x}{x}\cdot \sin x\right) = 0$$

$$\ln L = 0$$

$$L = e^0 = 1$$

Q26 Text Solution:

$$V^+ = \frac{V_i}{\left(R+\frac{1}{Cs}\right)}\cdot\frac{1}{Cs} = \frac{V_i}{sRC+1} \quad ...(i)$$

$$V_0 = \frac{V^+}{R}\cdot\frac{1}{Cs} + V^+ = V^+\left(1+\frac{1}{sRC}\right)$$

$$V_0 = V^+\left(\frac{sRC+1}{sRC}\right) \quad ....(ii)$$

$$\frac{V_0}{V_i} = \frac{1}{sRC}$$

It is low pass filter.

Hence, option A is correct.

Q27 Text Solution:

P_{1rated} = 300 MW

P_{2rated} = 400 MW

f = 50 Hz

R_1 = 6%, R_2 = 4%

The full load frequency of both generators will be same, because they are operating in parallel to share the load.

$$f_1 = f - \frac{R_1\times f}{P_{1\ rated}}\times P_1,\ f_2 = f - \frac{R_2\times f}{P_{2\ rated}}\times P_2$$

$f_1 = f_2$

$$f - \frac{R_1 f}{P_{1\ rated}}\times P_{1\ load} = f - \frac{R_2 f}{P_{2\ rated}}\times P_{2\ load}$$

$$\frac{6}{300}\times P_1 = \frac{4}{400}\times P_2$$

$$2P_1 = P_2 \ .....(I)$$

$$P_1 + P_2 = 600 \ .....(II)$$

From (I) and (II)

P_2 = 400 MW

Q28 Text Solution:

Surface function is f(x, y ,z) = x + 2y – 5

Normal vector to the surface = $\vec{\nabla} f$

$$= \frac{\partial f}{\partial x}a_{\hat{x}} + \frac{\partial f}{\partial y}a_{\hat{y}} + \frac{\partial f}{\partial z}a_{\hat{z}}$$

$$\vec{\nabla}_f = \frac{\partial}{\partial x}(x+2y-5)a_{\hat{x}} + \frac{\partial}{\partial y}(x+2y-5)a_{\hat{y}}$$

$$+\frac{\partial}{\partial z}(x+2y-5)a_{\hat{z}}$$

$$\vec{\nabla} f = a_{\hat{x}} + 2a_{\hat{y}}$$

Normal unit vector to the surface is

$$\hat{a}_N = \pm\frac{\vec{\nabla} f}{\left|\vec{\nabla} f\right|}$$

$$\hat{a}_N = \pm\frac{(\hat{a}_x+2\hat{a}_y)}{\sqrt{1^2+2^2}}$$

Electric field direction is Normal to the charge surface. so $\hat{a}_E = \hat{a}_N$ if electric field point is above the surface then

$$\hat{a}_E = +\left[\frac{\hat{a}_x+2\hat{a}_y}{\sqrt{5}}\right]$$

When x = 0 in the surface equation then

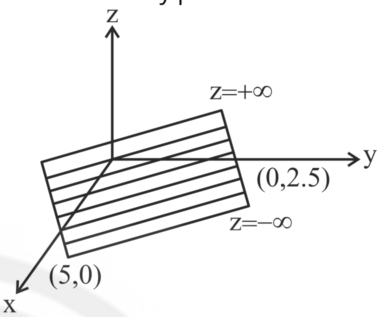
+ 2y = 5 y = 2.5

When y = 0 in the surface equation then

X + 2(0) = 5 x = 5

So surface goes through points (5, 0) and (0,2.5)

Surface on xy plane for all z is shown below



Electric field at at (–1, 0, 1)

For this point x < 5: y< 2.5 so this point is at backside of the surface.

$$\therefore \hat{a}_E = -\left[\frac{a_{\hat{x}}+2a_{\hat{y}}}{\sqrt{5}}\right]$$

$$\vec{E} = \frac{|\rho_s|}{2\varepsilon_0}a_{\hat{E}} = \frac{6\times10^{-9}}{2\left[\frac{1}{36\pi}\times10^{-9}\right]}\left\{-\left[\frac{a_{\hat{x}}+2a_{\hat{y}}}{\sqrt{5}}\right]\right\}$$

$$\therefore \vec{E} = \frac{-108\pi}{\sqrt{5}}a_{\hat{x}} - \frac{216\pi}{\sqrt{5}}a_{\hat{y}}\ V/m$$

$$\therefore \vec{E} = \frac{-108\pi}{\sqrt{5}}a_{\vec{x}} - 303.5a_{\vec{y}}\ V/m$$

$$-151.7a_{\hat{x}} - 303.5\,a_{\hat{y}}\ V/m$$

Q29 Text Solution:

$I_f = \frac{250}{125}$ = 2A field current

I_a = 16 – 2 = 14 A armature current

At no load,

E_b = 250 – (14 × 0.2) = 247.2 V

Constant losses = (247.2) × (14) + 250 × 2

P_{NL} = 3960.8 W

Let stary losses = 0 W

At full load, I_a = 152 – 2 = 150 A

Total losses = $I^2_a \times R_a + P_{NL}$

= $(150)^2$ × 0.2 + 3960.8 = 8460.8 W

Input power = 250 × 152 = 38 kW, then

$$\%\eta = \frac{Input - Losses}{Input}\times 100$$

$$= \frac{38000-8460.8}{38000}\times 100\%$$

$$= 77.73\%$$

Q30 Text Solution:

From the given root locus diagram, the OLTF can be written as, G(s)H(s) = $\frac{k}{s(s+3-j)(s+3+j)}$

(k = dc gain, s = 0 and –3 ± j are poles).

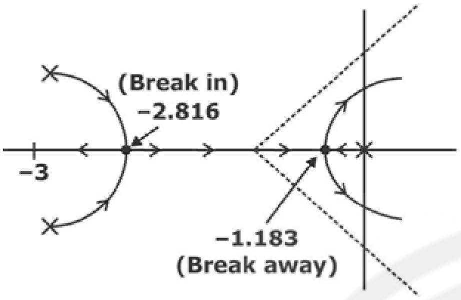
Characteristic equation is, 1 + G(s) H(s) = 0

k + s (s^2 + 6s + 10) = 0

For break point, $\frac{dk}{ds} = 0 \Rightarrow \frac{dk}{ds}$ = 3s^2 + 12s + 10 = 0

s = –1.183, –2.816

The root locus is as shown



$\frac{\text{Break in point}}{\text{Break away point}} = \frac{2.816}{1.183}$ = 2.38

Q31 Text Solution:

x(n) = cos $\left(\frac{\pi n}{2}\right)$

So, $\omega_0 = \frac{\pi}{2}$

Period = $\frac{2\pi}{\frac{\pi}{2}}$ = 4 i.e., N_0 = 4

So, x(n) = $\frac{1}{2}e^{j\omega_0 n} + \frac{1}{2}e^{-j\omega_0 n}$

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

DTFS x(n) = $\sum_{n=1}^{N_o-1} c_k\, e^{ik\omega_o n}$ ...(1)

So, DTFS indices are:

k = 0, 1, 2, 3

Compare with,

$e^{j\frac{\pi}{2}n} \Rightarrow k = 1$

$e^{-j\frac{\pi}{2}n} \Rightarrow e^{j\left(2\pi-\frac{\pi}{2}\right)n} = e^{j\frac{3\pi}{2}n} \Rightarrow k = 3$

This gives $C_1 = \frac{1}{2}$ and $C_3 = \frac{1}{2}$, both are non-zero quantities.

Q32 Text Solution:

1. $\mathrm{Var}(aX) = a^2(\mathrm{Var}(X))$

2. for independent X and Y

$\mathrm{Var}(aX \pm bY) = a^2\mathrm{Var}(X) + b^2\mathrm{Var}(Y)$

(A) $\mathrm{Var}(2X) = 2^2 \times \mathrm{Var}(X) = 4 \times 4 = 16$

(B)

$\mathrm{Var}(X - Y) = \mathrm{Var}(X) + \mathrm{Var}(Y) = 4 + 9 = 13$

(C)

$\mathrm{Var}(2X + 3Y) = 2^2\mathrm{Var}(X) + 3^2\mathrm{Var}(Y) = 4 \times 4 + 9 \times 9 = 97$

(D)

$\mathrm{Var}\left(\frac{Y}{3}\right) = \mathrm{Var}\left(\frac{1}{3}Y\right) = \left(\frac{1}{3}\right)^2 \mathrm{Var}Y = \frac{1}{9} \times 9 = 1$

Q33 Text Solution:

- Y-bus matrix is easier to construct by adding to total admittance connected to bus for diagonal element and for non-diagonal element just reversed the sign of the admittance connected between respective buses.
- While Z-bus matrix is hard to construct because of this we need to use Z-bus algorithm which consumes more time and contains lengthy calculations.
- As interconnection between the buses in power system is much lower, so Y-bus matrix is sparse on the other hand Z-bus matrix is used to solve fault analysis and Y-bus matrix is used to solve load flow study.

$[Z]_{Bus} = [Y]_{Bus}^{-1}$

- Hence Z-bus matrix is full matrix.

Q34 Text Solution:

Using the formula:

$I_{(max)} = I_{Z(max)} + I_{L(min)}$

$I_{(min)} = I_{Z(min)} + I_{L(max)}$

For the Zener diode to operate in worst case condition,

$I_{(max)} = \frac{18-8}{100} = \frac{10}{100}$ = 100 mA = $I_{Z(max)}$

$P_{Z(max)} = V_Z I_{Z(max)}$ = 100 × 8 = 800 mW

Hence, option b,d is correct.

Q35 Text Solution:

We know that,

$\mathrm{sgn}(t) \rightleftharpoons \frac{2}{j\omega}$

By using the duality property:

$\frac{2}{jt} \rightleftharpoons 2\pi \times sgn(-\omega)$

$\frac{1}{\pi t} \rightleftharpoons jsgn(-\omega)$

sgn(ω) is an odd function, then sgn(–ω) = –sgn(ω)

$\because \frac{1}{\pi t} \rightleftharpoons -j\,sgn(\omega)$

$\because h(t) = \frac{1}{\pi t} \rightleftharpoons -j\,sgn(\omega) = H(\omega)$

$h(t) = \frac{1}{\pi t}$

Q36 Text Solution:

Deflection torque I MI instrument T_d = $\frac{1}{2}I^2\frac{dL}{d\theta}$ N-m

Given, Current, I_1 = 1.9A, I_2 = 2.4A

Deflection θ_1 = 39.4°, θ_2 = 50.2°

Inductance L_1 = 250 μH, L_2 = 255.2 μH

$\frac{dL}{d\theta} = \frac{L_2-L_1}{\theta_2-\theta_1} = \frac{255.2-250}{50.2-39.4} = \frac{5.2}{10.8° \times \frac{\pi}{180}}$

= 27.59 μH/rad

Deflection torque for 202A current, 46.5° deflection is,

$$T_d = \frac{1}{2} \times (2.2)^2 \times (27.59)$$

$= 66.77 \times 10^{-6}$ N-m

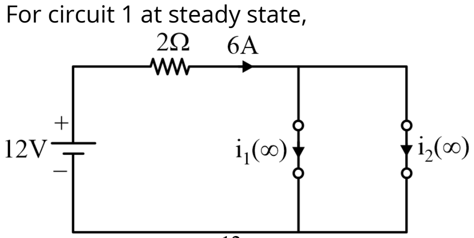
Spring constant, $k\theta = T_d$

$$k = \frac{T_d}{\theta} = \frac{66.77\times10^{-6}}{46.5\times\frac{\pi}{180}}$$

$= 82.27 \times 10^{-6}$ Nm/rad

Q37 Text Solution:

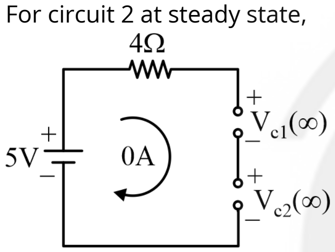
For circuit 1 at steady state,



$I(\infty) = i_1(\infty) + i_2(\infty) = \frac{12}{2} = 6A$

From current divisions $i_1(\infty) = 6 \times \frac{2}{2+1} = \frac{12}{3} =$ 4A

For circuit 2 at steady state,



From voltage division

Rule, $V_{c2}(\infty) = 5 \times \frac{3}{3+6}$

$V_{c2}(\infty) = \frac{15}{9} = \frac{5}{3}$V

$$\frac{V_{c2}(\infty)}{i_1(\infty)} = \frac{5}{3} \times \frac{1}{4} = \frac{5}{12}\Omega = 416.67 \text{ m}\Omega$$

Q38 Text Solution:

Let us assume

Common base MVA = 20MVA

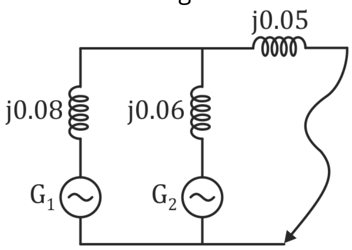
Base voltage for LV side of the transformer = 11kV

Base voltage for HV side of the transformer = 220kV

$XG_1(\text{new}) = j0.04 \times \left(\frac{20}{10}\right)\times\left(\frac{11}{11}\right)^2 = j0.08$pu

$XG_2(\text{new}) = j0.03 \times \left(\frac{20}{10}\right)\times\left(\frac{11}{11}\right)^2 = j0.06$pu

Reactance diagram will be as shown below



Equivalent reactance,

$$X = \left(\frac{j0.08\times j0.06}{j0.08+j0.06}\right)+j0.05$$

X = j0.084 pu

Fault current in pu

$$I_{f_{(pu)}} = \frac{1}{0.084} = 11.90pu$$

Now, Base current on LV. Side of transformer

$$I_B = \frac{20\times10^6}{\sqrt{3}\times11\times10^3} = 1.05\times10^3$$

Fault current in L.V. side

= Base current on L.V. side × Fault current in pu

$= (1.05 \times 10^3) \times (11.90)$

$I_f = 12.49$kA

Now fault current of generator –1 is

$I_{F_{G1}} = \frac{0.06}{0.14} \times 12.49$ [Current division]

$I_{F_{G1}} = 5.337$ kA

Q39 Text Solution:

For a spherical system,

$$\vec{V} = V_r\hat{a}_r + V_\theta\hat{a}_\theta + V_\phi\hat{a}_\phi$$

Divergence of $\vec{V}$,

$$\nabla\cdot\vec{V} = \frac{1}{r^2}\frac{\partial(r^2V_r)}{\partial r} + \frac{1}{r\sin\theta}\partial\frac{(\sin\theta\, V_\theta)}{\partial\theta} + \frac{1}{r\sin\theta}\frac{\partial(V_\phi)}{\partial\phi}$$

$$\nabla\cdot\vec{D} = \frac{1}{r^2}.\frac{\partial}{\partial r}\left(r^4\sin\theta\right)+\frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}\left(\frac{\sin\phi\ \sin\theta\cos\theta}{r^3}\right)+\frac{1}{r\sin\theta}\frac{\partial}{\partial\phi}(r\cos$$

$$\nabla\cdot\vec{D} = \frac{4r^3}{r^2}\sin\theta + \frac{\sin\phi}{r^4\sin\theta}\frac{\partial}{\partial\theta}\left(\frac{\sin 2\theta}{2}\right)+\frac{r\sin\theta}{r\sin\theta}\frac{\partial(\cos\phi)}{\partial\phi}$$

($\sin 2\theta = 2\sin\theta\cos\theta$)

$$= 4r\sin\theta + \frac{\sin\phi}{r^4\sin\theta}\times\frac{2\cos 2\theta}{2} + (-\sin\phi)$$

From Gauss law, $\oint\vec{D}\cdot d\vec{s} = q_{enc}$

(From divergence law or $\nabla\cdot\vec{D} = \rho_v$ = volume charge density).

$$\rho_v = 4r\ \sin\theta + \frac{\cos 2\theta\sin\phi}{r^4\sin\theta} - \sin\phi$$

at r = 1, $\theta = \frac{\pi}{4}$, $\phi = \frac{\pi}{6}$

$$\rho_v = 4\times\sin 45^\circ + \frac{\cos(2\times45^\circ)\times\sin 30^\circ}{1\times\sin 45^\circ} - \sin 30^\circ$$

$= 4 \times \frac{1}{\sqrt{2}} - \frac{1}{2} = 2.328$ c/m^3

Q40 Text Solution:

$$\frac{Y(s)}{R(s)} = \frac{\frac{2}{(s^3+5s^2+6s+3)}\left(\frac{K_Ps+K_i}{s}\right)}{1+\frac{2(K_Ps+K_i)}{s^4+5s^3+6s^2+3s}}$$

$$\frac{Y(s)}{R(s)} = \frac{2K_Ps+2K_i}{s^4+5s^3+6s^2+(3+2K_P)s+2K_i}$$

Characteristic Equation:

$s^4 + 5s^3 + 6s^2 + (3 + 2K_P)s + 2K_i = 0$

s^4	1	6	$2K_i$
s^3	5	$(3+2K_P)$	0
s^2	$\frac{(30-3-2K_P)}{5}$	$2K_i$	
s^1	$\frac{\left(\frac{27-2K_P}{5}\right)(3+2K_P)-10K_i}{\left(\frac{27-2K_P}{5}\right)}$	0	
s^0	$2K_i$	0	

$2K_i > 0 \quad K_i > 0$ ...(1)

$27 - 2K_P > 0 \quad K_P < 13.5$ ...(2)

$$\frac{\left(\frac{27-2K_P}{5}\right)(3+2K_P)-10K_i}{\left(\frac{27-2K_P}{5}\right)} = (3+2K_P) - \frac{50K_i}{27-2K_i} > 0$$

$$(3+2K_P) > \frac{50K_i}{27-2K_i}$$

$81 - 6K_P + 54K_P - 4K_P^2 > 50K_i$

$-4K_P^2 + 48K_P + 81 > 50K_i$

$K_i < \frac{-4K_P^2+48K_P+81}{50}$

$\frac{dK_i}{dK_P} = -8K_P + 48 = 0$

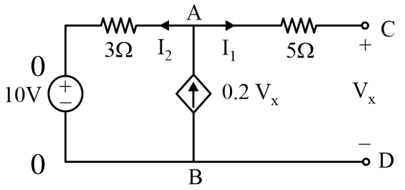
$K_P = 6$

Therefore, $K_i = 4.5$

Hence, option A and B both are correct.

Q41 Text Solution:

Calculation for V_{th}



$V_{th} = V_x$

$I_1 = 0$ [open circuit]

$I_2 = 0.2\,V_x$

$V_{AB} = V_x = V_{th}$

Apply KVL in left loop,

$-V_x + 3I_2 + 10 = 0$ ....(1)

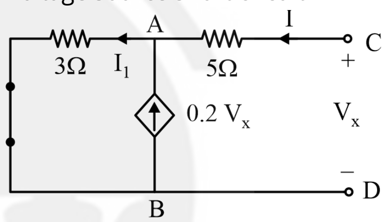
Put I_2 in equation (1)

$-V_x + 3(0.2V_x) + 10 = 0$

$V_x = 25V \quad V_{th} = 25V$

Calculation for R_{th}

Voltage source short circuit



KCL at Node A,

$I_1 = 0.2V_x + I$

Apply KVL in total loop,

$-V_x + 5I + 3(I_1) = 0$

$-V_x + 5I + 3\,(0.2V_x + I) = 0$ [$I_1 = 0.2\,V_x + I$]

$-V_x + 5I + 0.6V_x + 3I = 0$

$-0.4V_x + 8I = 0$

$0.4V_x = 8I$

$$R_{th} = \frac{V_x}{I} = \frac{8}{0.4} = 20\Omega$$

Q42 Text Solution:

$$\frac{V_0}{V_{in}} = \frac{\left(-R_2 \| \frac{1}{sC}\right)}{R_1} = \frac{-R_2/R_1}{1+sR_2C} = \frac{-R_2/R_1}{1+j\omega CR_2}$$

If $\omega >> \frac{1}{R_2C}$;

$$\frac{V_0}{V_{in}} = \frac{-R_2/R_1}{1+j\omega CR_2} = \frac{-R_2/R_1}{1+j\omega/(1/R_2C)}$$

For $\omega >> \frac{1}{R_2C}$; $[\omega/(1/R_2C)] >>> 1$, so gain can be approximated to

$$\frac{V_0}{V_{in}} = \frac{\left(-\frac{R_2}{R_1}\right)}{j\omega\, R_2C} = \frac{-1}{j\omega R_1C}$$

Or $V_0 = \frac{-1}{R_1C} \int V_{in}dt$ acts as integrator.

If $\omega << \frac{1}{R_2C}$;

$$\frac{V_0}{V_{in}} = \frac{\left(-\frac{R_2}{R_1}\right)}{1}$$

Or $\left|\frac{V_0}{V_{in}}\right| = \frac{R_2}{R_1} \Rightarrow V_0 = \left(\frac{R_2}{R_1}\right)V_{in}$ acts as amplifier.

Q43 Text Solution:

$$Q_{n+1} = D = \overline{X}\,Q_n + Y\,\overline{Q_n} \quad (Z = Q_n)$$

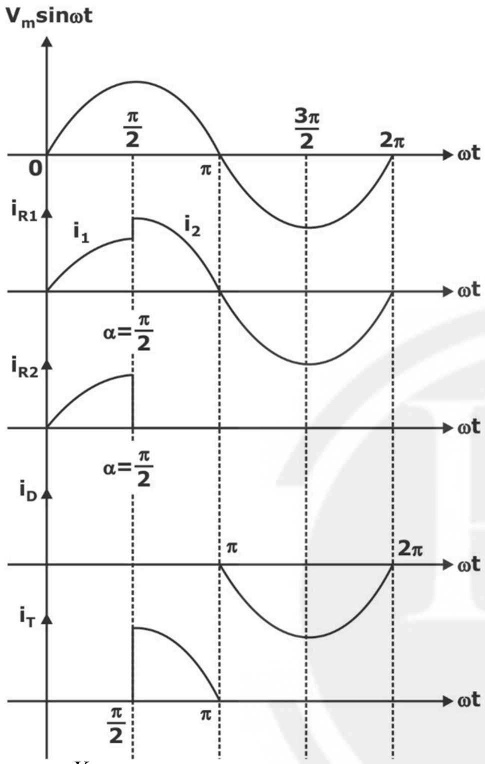
Comparing with characteristic equation of JK-FF,

$$Q_{n+1} = J\,\overline{Q_n} + \overline{K}\,Q_n$$

$$X = K,\ Y = J$$

Q44 Text Solution:

The waveforms are shown below,



$i_1 = \frac{V_m}{R_1+R_2}\sin\omega t = \frac{150}{200}\sin\omega t = \frac{3}{4}\ \sin\omega t$

$i_2 = \frac{V_m}{R_1}\sin\omega t = \frac{150}{100}\sin\omega t = \frac{3}{2}\ \sin\omega t$

I_{dc} =

$$\frac{1}{2\pi}\left[\int_0^{\pi/2}\frac{3}{4}\ \sin\omega t\ d\omega t + \int_{\pi/2}^{2\pi}\left(\frac{3}{2}\ \sin\omega t\right)\ d\omega t\right]$$

$= \frac{1}{2\pi}\ \left[0.75\ (-\cos\omega t)_0^{\pi/2} + 1.5\ (-\cos\omega t)_{\pi/2}^{2\pi}\right]$

$= \frac{1}{2\pi}$ [0.75 (1 – 0) + 1.5 (0 – 1)]

= –0.1194 Amp   or –119.4 mA

Q45 Text Solution:

Here, full load line current drawn by the Δ connected motor may be found form

$$P = \sqrt{3}V_L I_L \cos\phi$$

$$\therefore\ Input\ power\ (P) = \frac{output\ power}{efficiency}$$

$$P = \frac{10\times10^3}{0.86} = 11.627kW$$

$$\therefore\ I_L = \frac{11.627\times10^3}{\sqrt{3}\times400\times0.8} = 20.97A$$

Now, with 100V, the value of short circuit current of the Δ connected motor is .

If full normal voltage were applied, the line value of short circuit current would be

$$= 30\times\left(\frac{400}{100}\right) = 120A$$

I_{SC}(line value) = 120A

I_{SC}(phase value) = 120 / $\sqrt{3}$ A

When connected in star across 400V, the starting current per phase drawn by the motor stator during starting is

Ist per phase $= \frac{1}{\sqrt{3}}\times I_{SC}$ per phase

$$= \frac{1}{\sqrt{3}}\times\frac{120}{\sqrt{3}} = \frac{120}{3} = 40A$$

since during starting, motor is star-corrected,

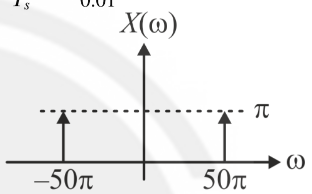
Ist per phase = line value of I_{SC} = 40A

$$\therefore\ \frac{line\ value\ of\ starting\ current}{line\ value\ of\ full\ load\ current} = \frac{40}{20.97} = 1.9$$

Q46 Text Solution:

Sampling frequency (ω_s) =

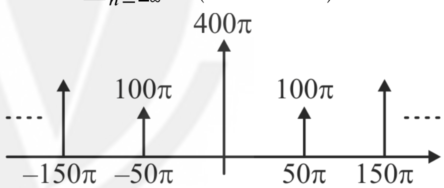
$$\frac{2\pi}{T_s} = \frac{2\pi}{0.01} = 200\pi\ \text{rad / sec}$$

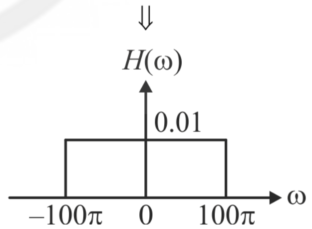


Output of samples $X_s(\omega)$ =

$$\frac{1}{T_s}\sum_{n=-\infty}^{\infty} X(\omega - 100)$$

$$= 100\sum_{n=-\infty}^{\infty} X(\omega - 200\pi n)$$





So, $Y(\omega)$ = $X(\omega)H(\omega)$ =

$$4\pi\delta(\omega) + \pi[\delta(\omega+50\pi) + \delta(\omega-50\pi)]$$

Gives y(t) after using inverse Fourier transform,

y(t) = 2 + cos(500t)

Therefore, A = 2

Q47 Text Solution:

Since

$$E_f^2 = (V_t\cos\phi + I_a R_a)^2 + (V_t\sin\phi + I_a x_x)^2$$

{since R_a = 0}

$$E_f^2 = V_t^2\left[\cos^2\phi + \left(\sin\phi + \frac{I_a x_s}{V_t}\right)^2\right]$$

$$\frac{I_a x_s}{V_t} = x_s\,(Pu) = 0.2\ \ (Given)$$

$$E_f^2 = V_t^2\left[(0.8)^2 + (0.8)^2\right]$$

$= 1.131\ V_t$

$\% \ V.R = \frac{E_f - V_t}{V_t} = \frac{1.131\ V_t - V_t}{V_t} \times 100\ \%$

$= 13.1\ \%$

Q48 Text Solution:

Given:- P = 6

A = 2(Wave connected)

Z = 720, N = 1000rpm, = 5mWb, R_a = 0.5Ω,

R_{sh} = 100 Ω, V = 200V

$\Rightarrow I_{sh} = \frac{V}{R_{sh}} = \frac{200}{100} = 2A$

Back emf (E_b) = $\frac{\phi ZNP}{60A} = \frac{5\times10^{-3}\times720\times1000\times6}{60\times2}$

E_b = 180V

Now, for shunt motor

$V = E_b + I_a R_a$

$\therefore\ Ia = \frac{V-E_b}{R_a} = \frac{200-180}{0.5}$ = 40A

Line current $I_L = I_a + I_{sh}$ = 40 + 2 = 42A

Motor input = V× I_L =200 × 42 = 8400W

Armature cu loss = $I_a^2\ R_a = (40)^2 \times (0.5)$ = 800W

Field copper loss = $I_{sh}^2 \times R_{sh} = (2)^2 \times (100)$ = 400W

Total copper losses = 800 + 400 = 1200W

Also rotational losses is 1000W

output power = input – losses

= 8400 – (1200 + 1000) = 6200W

Efficiency of motor is

$= \eta = \frac{output}{input} = \frac{6200}{8400} \times 100\%$

$\boxed{\eta = 73.80\%}$

Q49 Text Solution:

Given:

$L^{-1}\left\{\frac{s+3}{s^2-4s+13}\right\} = e^{2t}\cdot\cos 3t + \alpha\cdot e^{2t}\cdot\sin 3t$

$\Rightarrow$

$\frac{s+3}{s^2-4s+13} = L\{e^{2t}\cdot\cos 3t\} + \alpha\cdot L\{e^{2t}\cdot\sin 3t\}$

$\because L\{\sin\ at\} = \frac{a}{s^2+a^2}$

$\Rightarrow L\{e^{bt}\cdot\sin\ at\} = \frac{a}{(s-b)^2+a^2}$

Similarly

$L\{e^{bt}\cdot\cos\ at\} = \frac{s-b}{(s-b)^2+a^2}$

$\therefore\ \frac{s+3}{(s-2)^2+9} = \frac{s-2}{(s-2)^2+9} + \frac{\alpha\cdot(3)}{(s-2)^2+9}$

$\Rightarrow\ \frac{s+3}{(s-2)^2+9} = \frac{s+(3\alpha-2)}{(s-2)^2+9}$

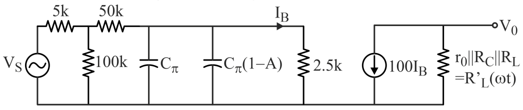
$\Rightarrow 3 = 3\alpha - 2$

$\Rightarrow\ \alpha = \frac{5}{3} = 1.667$

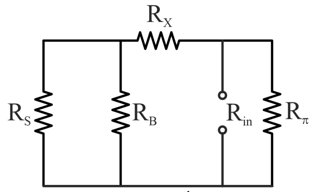
$\therefore \alpha = 1.667$

Q50 Text Solution:

Using small signal analysis



where R'_L = (100k) | | 8k | | 5k = 2.98 kΩ



$A = \frac{V_0}{V_\pi} = \frac{-\beta I_B R'_L}{I_B r_\pi} = \frac{-100\times2.98\ k\Omega}{2.5\ k\Omega}$ = –119.4

$C_{eq} = C_\pi + C_\mu(1 - A)$ = 7 + 1(1 + 119.4) = 127.4 pF

$R'_m = [[R_s\ ||\ R_B) + R_X]\ ||\ R_\pi$ = 1.64 kΩ

$f_H = \frac{1}{2\pi\ R_{in} C_{eq}}$ = 762.1 kHz

Q51 Text Solution:

Option A. To eliminate nth harmonic from generated voltage waveform, chording (α) = $\frac{180°}{n}$.

Option B. is a correct statement.

Option C. a 3 – ϕ winding will produce a forward rotating seventh order harmonic at the speed of $\left(\frac{1}{7}\right)$ of synchronous speed

Option D. It is correct because KVA_{60} = $(1.15)KVA_{120}$

Q52 Text Solution:

We know that 20 dB/decade = 6 dB/octave

So, '2' poles at origin 1 zero at ω_1 = 2 rad/sec, 1 pole at ω_2 = 20 rad/sec

(Initial slope = –40 dB/dec)

$T(s) = \frac{k\left(1+\frac{s}{2}\right)}{s^2\left(1+\frac{s}{20}\right)}$

At ω_1 = 2, magnitude = 0 dB

from approximate Bode analysis,

Gain at (ω_0) = 0 dB = 20 log(k) + slope × $\log(\omega_0)$

(ω_0 = 2 rad/sec)

0 = 20 log k – 40 log2

k = 4

So, $T(s) = \frac{4\left(1+\frac{s}{2}\right)}{s^2\left(1+\frac{s}{20}\right)}$ = G(s) for an input $\frac{5t^2}{2}u(t)$

e_{ss} for $\frac{\lambda t^2}{2}u(t) = \frac{\lambda}{k_a}$ where, $k_a = \lim\limits_{s\to0} s^2\ G(s)$

$k_a = \lim\limits_{s\to0}\ s^2 \times \frac{4}{s^2}\ \frac{\left(1+\frac{s}{2}\right)}{\left(1+\frac{s}{20}\right)} = 4$

So, for $\frac{5t^2}{2}u(t)$ $e_{ss} = \frac{5\times1}{k_a} = \frac{5}{4} =$ 1.25

Q53 Text Solution:

Given:

x + y + 5z = 3

x + 2y + 2z = 5

2x + 4y + 4z = k

A X= B

$$[A|B] = \begin{bmatrix} 1 & 1 & 5 & 3 \\ 1 & 2 & 2 & 5 \\ 2 & 4 & 4 & k \end{bmatrix}$$

For the system to have infinitely many solutions,

Rank(A) = Rank(A|B) < 3

All 3 × 3 minors of [A|B] should be zero.

consider a 3 × 3 minor of [A|B]

$$\begin{vmatrix} 1 & 5 & 3 \\ 2 & 2 & 5 \\ 4 & 4 & k \end{vmatrix} = 0$$

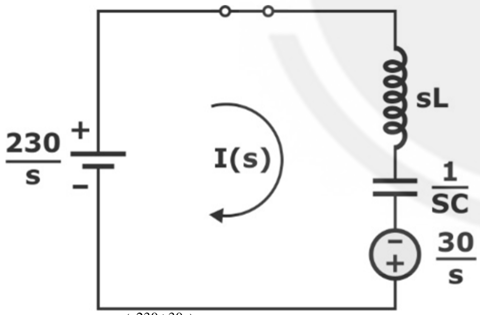
1(2k – 20) – 5(2k – 20) + 3 (0) = 0

2k – 20 = 0

k = 10

Q54 Text Solution:

From Laplace transform of the circuit, when the switch is 'ON' and diode turns 'ON' as:



$$I(s) = \frac{\left(\frac{230+30}{s}\right)}{sL+\frac{1}{sC}} = \frac{260}{s(s^2LC+1)} \times sC$$

$$= \frac{260C}{LC\left(s+\frac{1}{LC}\right)} = \frac{260}{L\left(s^2+\left(\frac{1}{\sqrt{LC}}\right)^2\right)}$$

$$I_{(s)} = \frac{260}{L}\,\frac{\frac{1}{\sqrt{LC}}}{\frac{1}{\sqrt{LC}}} \times \frac{1}{s^2+\left(\frac{1}{\sqrt{LC}}\right)^2}$$

$$i(t) = \frac{260\sqrt{LC}}{L} \times \sin\frac{t}{(\sqrt{LC})}$$

$$\left(\because \quad \sin\omega_0 t \leftrightarrow \frac{\omega_0}{\omega_0^2+s^2}\right)$$

$$i(t) = 260\sqrt{\frac{C}{L}}\,\sin\left(\frac{t}{\sqrt{LC}}\right) \text{ Amp}$$

So, peak value of diode current is $i(t)_{peak}$ =

$$260\sqrt{\frac{C}{L}} = 260\sqrt{\frac{5\times10^{-6}}{0.3\times10^{-3}}}$$

$i(t)_{(peak)}$ = 33.56 Amp

Q55 Text Solution:

$$S = \frac{1}{2} - \frac{1}{6} + \frac{1}{24} - \frac{1}{120} + \ldots..$$

$$= \frac{1}{2!} - \frac{1}{3!} + \frac{1}{4!} - \frac{1}{5!} + \ldots$$

$$= 1 - \frac{1}{1!} + \frac{1}{2!} - \frac{1}{3!} + \frac{1}{4!} - \frac{1}{5!} + \ldots$$

$$= e^{-x}\big|_{x=1} = e^{-1} = 0.3678 \approx 0.368$$

Q56 Text Solution:

Given I_f = 7500A

I_P = 500A, I_S = 5A

% PSB = 125% = 1.25

$$PSM = \frac{I_f}{\%PSB\times I_P} = \frac{7500}{1.25\times500} = 12$$

As per given table operating time for PSM = 12 is 2.8 sec

But in given question T.M.S = 0.4

Operating time of relay = T.M.S. × Time from table acc to P.S.M

= 0.4 × 2.8

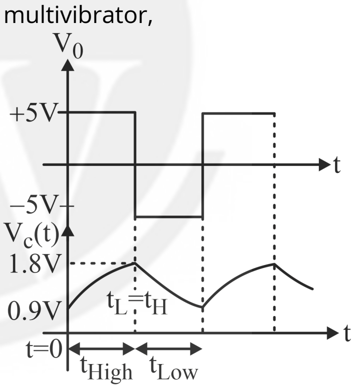
= 1.12 sec

Q57 Text Solution:

Given, V_{LT} = 0.9V, V_{UT} = 1.8V

C = 0.4 μF, R = 10k, $\pm V_{sat}$ = ±5V

The circuit is behaving as a astable multivibrator,



To find t_{High},

Assume t = 0 and t = t_H as shown,

$V_c(0^+)$ = 0.9V, $V_c(\infty)$ = +5V

$V_c(t_{High})$ = 1.8V

$V_c(t) = V_c(\infty) + [V_c(0^+) - V_c(\infty)]\, e^{-t/\tau}$

= RC = $10^4 \times 0.4 \times 10^{-6} = 0.4 \times 10^{-2}$ sec.

$V_c(t_{High}) = 5 + (0.9 - 5)\, e^{-t/RC}$

$1.8 = 5 - 4.1e^{-t/RC}$

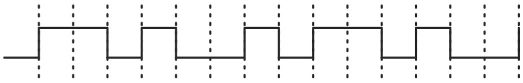
$e^{-t_H/RC}$ = 0.7805 $\quad -{}^{t_H}/RC = \ln(0.7805) =$ -0.2478

t_H = 0.2478 × 4 msec

t_H = 0.9913 msec

Q58 Text Solution:

For An EX-NOR gate output is high when Both inputs are same i.e. both 0 and both 1, Hence output waveform is



The output Y is repeating itself after 8μsec

Hence, T_0 = 8 μsec

$$f = \frac{1}{T_0} = \frac{1}{8\mu} = 125 \text{ kHz}$$

Q59 Text Solution:

Given: DE is $(D^2 + 1)\, y = \sin t$

A.E: $D^2 + 1 = 0$

$D = \pm i$

$\Rightarrow y_c = c_1 \cos t + c_2 \sin t$

$\text{PI}: \left(y_p\right) = \frac{1}{D^2+1}\sin\left(t\right)$ $\qquad D^2 \;\; - 1^2$

$= \frac{1}{-1+1}\sin(t)$ $\qquad$ (Denominator = 0)

$= \frac{t}{2D}\sin t = \frac{t}{2}\left(-\cos t\right) = -\frac{t}{2}\cos t$

$y = y_c + y_P$

$y = c_1 \cos t + c_2 \sin t - \frac{t}{2}\cos t$

$y(0) = c_1 \times 1 + 0 - 0$

$\Rightarrow \boxed{0 = c_1}$

$y' = -c_1 \sin t + c_2 \cos t - \frac{1}{2}\cos t - \frac{t}{2}\left(-\sin t\right)$

$y'\left(0\right) = -0 + c_2 - \frac{1}{2}$

$0 = c_2 - \frac{1}{2}$

$\Rightarrow \boxed{c_2 = \frac{1}{2}}$

$y = \frac{1}{2}\sin t - \frac{t}{2}\cos t$

$y(\pi) = \frac{1}{2}\sin\pi - \frac{\pi}{2}\cos\pi = \frac{\pi}{2} = 1.57$

Q60 Text Solution:

(i) for a line to line fault, fault current is given by.

$$I_{f(LL)} = \frac{\sqrt{3}\, V_{ph}}{x_1 + x_2}$$

$$\therefore \;\; 1900 = \frac{\sqrt{3}\times\left(15000/\sqrt{3}\right)}{x_1+x_2}$$

$$\therefore \;\; x_1 + x_2 = \frac{15000}{1900} = 7.895\ \Omega$$

(ii) For a line to ground fault, fault current is given by

$$I_{f(LG)} = \frac{3\, V_{pn}}{x_0 + x_1 + x_2}$$

$$\therefore \;\; 3200 = \frac{3\times\left(15000/\sqrt{3}\right)}{x_0+x_1+x_2}$$

$x_0 + x_1 + x_2 = 8.119$

$x_0 = 8.119 - 7.895$

$x_0 = 0.224\ \Omega$

Now, base impedance

$$Z_{base} = \frac{(kV)^2_{Base}}{(mVA)_{Base}} = \frac{(15)^2}{50} = 4.5\ \Omega$$

$$\therefore \;\; x_{0(pu)} = \frac{x_0}{z_{Base}} = \frac{0.224}{4.5} = 0.0497\ pu$$

For unit value of zero square reactance of the generator is 0.0497 pu

Q61 Text Solution:

$$x(n) \overset{DTFT}{\longleftrightarrow} X\left(e^{j\omega}\right)$$

$$x\left(e^{j\omega}\right) = \sum_{n=-\infty}^{\infty} x\left(n\right)\, e^{-j\omega_n}$$

$$x\left(e^{j0}\right) = \sum_{n=-\infty}^{\infty} x\left(n\right)$$

Since $nX\left(n\right) \overset{DTFT}{\longleftrightarrow} j\frac{dX\left(e^{j\omega}\right)}{d\omega}$

or $\;\; j\frac{dX\left(e^{j\omega}\right)}{d\omega} = \sum_{n=-\infty}^{\infty} nX\left(n\right) e^{-j\omega_n}$

or $\;\; j\frac{dX\left(e^{j\omega}\right)}{d\omega}\Big|_{\omega=0} = \sum_{n=-\infty}^{\infty} n\, X\left(n\right)$

So, $\;\; A = \dfrac{j\frac{dX\left(e^{j\omega}\right)}{d\omega}\Big|_{\omega=0}}{X\left(e^{j0}\right)}$

From graph given, $\frac{dX\left(e^{j\omega}\right)}{d\omega}\Big|_{\omega=0} = 0$ and $X(e^{j0})$ = 1

So, $\;\; A = \frac{0}{1} = 0$

Q62 Text Solution:

$x^3 - 5x + 3 = 0$

As sum of the root is $\left(\frac{-b}{a}\right)$

So, $a + b + c = \frac{0}{1} = 0$

$$\because \begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix}$$

$c_1 \rightarrow c_1 + c_2 + c_3$

$$\Rightarrow \begin{vmatrix} a+b+c & b & c \\ a+b+c & c & a \\ a+b+c & a & b \end{vmatrix}$$

$$\Rightarrow \left(a+b+c\right)\begin{vmatrix} 1 & b & c \\ 1 & c & a \\ 1 & a & b \end{vmatrix}$$

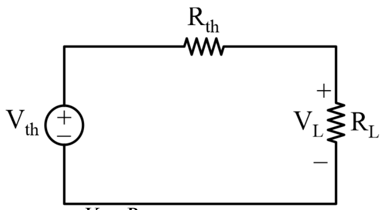
$\Rightarrow 0$

Q63 Text Solution:

For maximum power transfer,

$R_L = R_{th} = 10\Omega$

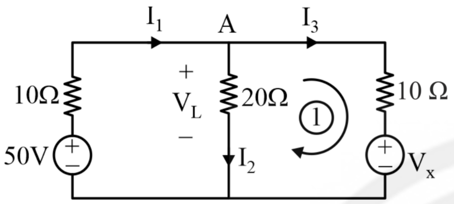
$V_{th} = 50V$



$V_L = \frac{V_{th}\times R_L}{R_L+R_{th}}$

$V_L = \frac{50\times10}{10+10} = 25V$

Now in circuit,



Voltage across 20Ω resistor = V_L = 25V

$I_1 = \frac{50-V_L}{10} = \frac{50-25}{10} = 2.5\ A$

$I_2 = \frac{V_L}{20} = \frac{25}{20} = 1.25\ A$

KCL at node A,

$I_3 = I_1 - I_2 = 2.5 - 1.25 = 1.25$ A

KVL in loop (1)

$-V_L + 10I_3 + V_x = 0$

$-25 + 10(1.25) + V_x = 0$

$V_x = 12.5$ V

Q64 Text Solution:

Given, $x_1(t) = te^{-|t|}$

$e^{-|t|} = e^{-t}u(t) + e^{t}u(-t)$

$e^{-|t|} \overset{FT}{\leftrightarrow} \frac{1}{1+j\omega} + \frac{1}{1-j\omega} = \frac{2}{1+\omega^2}$

$t\,x\left(t\right) \overset{FT}{\leftrightarrow} j\frac{d}{d\omega}X(\omega)$

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

$X_1(\omega) = \frac{-4j\omega}{\left(1+\omega^2\right)^2}$ ...(i)

Also, $x_2(t) = \frac{t}{\left(1+t^2\right)^2}$

$e^{-|t|} \overset{FT}{\leftrightarrow} \frac{2}{1+\omega^2}$

$te^{-|t|} \overset{FT}{\leftrightarrow} \frac{-j4\omega}{\left(1+\omega^2\right)^2}$

By the duality property,

$x(t) \overset{FT}{\leftrightarrow} X(\omega)$

$x(t) \overset{FT}{\leftrightarrow} 2\pi\, X(-\omega)$

$\frac{-4jt}{\left(1+t^2\right)^2} \overset{FT}{\leftrightarrow} 2\pi(-\omega)\, e^{-|\omega|}$

Or $x_2(t) = \frac{t}{\left(1+t^2\right)^2} \overset{FT}{\leftrightarrow} \frac{2\pi}{4j} \times \omega \times e^{-|\omega|}$

$X_2(\omega) = -\frac{\pi}{2}\, j\omega e^{-|\omega|}$

$\frac{X_1(\omega)}{X_2(\omega)} = \frac{-4j\omega}{\left(1+\omega^2\right)^2} \times \frac{1}{\frac{-\pi}{2}j\omega e^{-|\omega|}} = \frac{8}{\pi}\,\frac{1}{\left(1+\omega^2\right)^2} \times \frac{1}{e^{-|\omega|}}$

At $\omega = \pi$

$\frac{8}{\pi} \times \frac{1}{\left(1+\pi^2\right)^2} \times \frac{1}{e^{-\pi}} = 0.4987 \approx 0.50$

Q65 Text Solution:

Let $\frac{Y(s)}{U(s)} = \frac{10(s+3)}{\left(s^3+6s^2+11s+6\right)} \cdot \frac{X(s)}{X(s)}$

Then, $Y(s) = (s + 3) X(s)$ ...(i)

$10U(s) = (s^3 + 6s^2 + 11s + 6)\ X(s)$ ...(ii)

From inverse Laplace transform,

$\frac{d^3x(t)}{dt} + 6\frac{d^2x(t)}{dt^2} + 11\frac{dx(t)}{dt} + 6x\left(t\right) = 10u(t)$ ...(iii)

Let $\dot{x} = x_1 \Rightarrow \dot{x_1} = x_2 \Rightarrow \dot{x_2} = x_3$

So, from equation (iii),

$\dot{x_3} + 6\dot{x_2} + 11\dot{x_1} + 6x_1 = 10u(t)$ ...(iv)

$= -6x_1(t) - 11x_2(t) - 6x_3(t) + 10u(t)$

$\dot{x_2} = x_1$

$\dot{x_1} = x_1$

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix},\ B = \begin{bmatrix} 0 \\ 0 \\ 10 \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

Also, $Y(s) = (s + 3) X(s)$

$y(t) = +3x_1 = x_2 + 3x_1$

$y(t) = 3x_1(t) + x_2(t) + 0.x_3(t)$

$C = [3\ 1\ 0] = [C_1\ C_2\ C_3]$

$\frac{b_1+C_1}{b_2+C_2} = \frac{0+3}{0+1} = 3.0$