

GATE 2015 – A Brief Analysis
(Based on student test experiences in the stream of EC on 31st
January, 2015 – (First Session))

Section wise analysis of the paper

Section Classification	1 Mark		2 Marks		Total No of Questions
	MCQ	Numeric	MCQ	Numeric	
Engineering Mathematics	3	2	2	1	8
Networks	2	1	2	1	6
Electronic Devices	3	1	2	1	7
Analog Circuits	1	1	2	1	5
Digital Circuits	2	1	3	1	7
Signals and Systems	1	1	3	1	6
Control Systems	1	1	2	1	5
Communication	2		1	3	6
Electromagnetics	1	1	2	1	5
Verbal Ability	3	0	3		6
Numerical Ability	1	1	1	1	4
	20	10	23	12	65

Questions from the Paper

Aptitude

1. $\log_x^{5/7} = \frac{-1}{3}$

Find x.

Key: (2.74)

Exp: $\frac{5}{7} = x^{-1/3} \Rightarrow \frac{7}{5} = x^{1/3} \Rightarrow \left(\frac{7}{5}\right)^3 \Rightarrow x = 2.74$

2. Frog

- (A) Croak (B) Roar (C) Hiss (D) Patter

Key: (A)

Exp: Frogs make 'croak' sound.

3. Synonym of 'Educe'

- (A) exert (B) educate (C) extract (D) extend

Key: (C)

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4. Principal presents chief guest with _____ as a token of gratitude.
 (A) Momento (B) Memento (C) Momentum (D) Moment

Key: (B)

5. If \square , \diamond and \rightarrow are defined as

$$a \square b = \frac{a-b}{a+b}$$

$$a \diamond b = \frac{a+b}{a-b}$$

$$a \rightarrow b = ab$$

then find $(66 \square 6) \rightarrow (66 \diamond 6)$

- (A) -1 (B) -2 (C) 1 (D) 2

Key: (C)

Exp: $66 \square 6 = \frac{66-6}{66+6} = \frac{60}{72} = \frac{5}{6}$

$$66 \diamond 6 = \frac{66+6}{66-6} = \frac{72}{60} = \frac{6}{5}$$

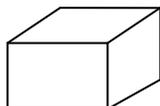
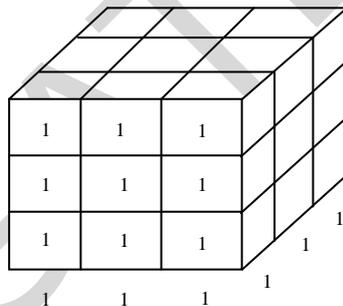
$$(66 \square 6) \rightarrow (66 \diamond 6) = \frac{5}{6} \times \frac{6}{5} = 1$$

6. Cube of side 3 unit is constructed using cube of side 1 unit. The ratio of no. of visible faces to non-visible faces is

- (A) 1:3 (B) 1:4 (C) 1:2 (D) 2:3

Key: (C)

Exp:



Number of faces per cube = 6

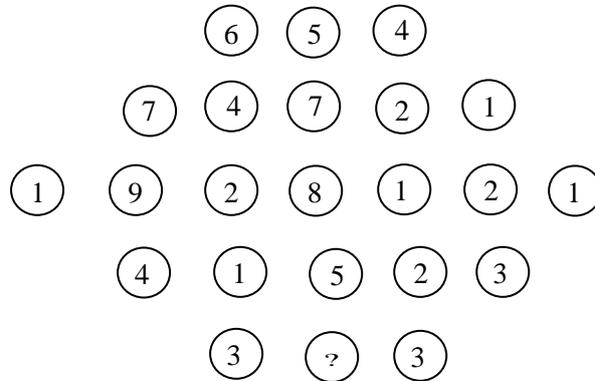
$$\text{Total number of cubes} = 9 \times 3 = 27$$

$$\therefore \text{Total number of faces} = 27 \times 6 = 162$$

$$\therefore \text{Total number of non visible faces} = 162 - 54 = 108$$

$$\therefore \frac{\text{Number of visible faces}}{\text{Number of non visible faces}} = \frac{54}{108} = \frac{1}{2}$$

7. Question based on rephrasing sentence.
8. Question based on paragraph conclusion.
9. Find the missing number _____



Key: (6)

Exp: There are

Five	1
Four	2
Four	3
Two	5
Two	7
One	8
One	9

∴ Number of 6 should be more or equal to number of 7.

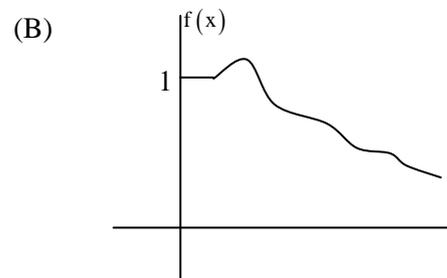
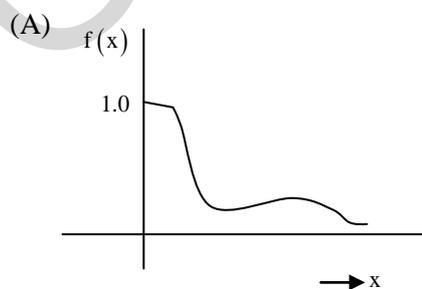
∴ Number of 6 should be atleast two.

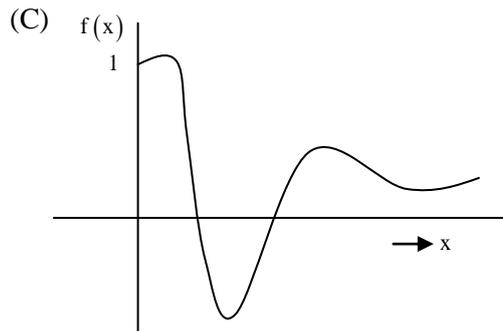
There is only one 6. ∴ The missing number is '6'.

Technical

1. Which of the following wave forms represent given function?

$$f(x) = e^{-x}(x^2+x+1)$$





(D) None

Key: (B)

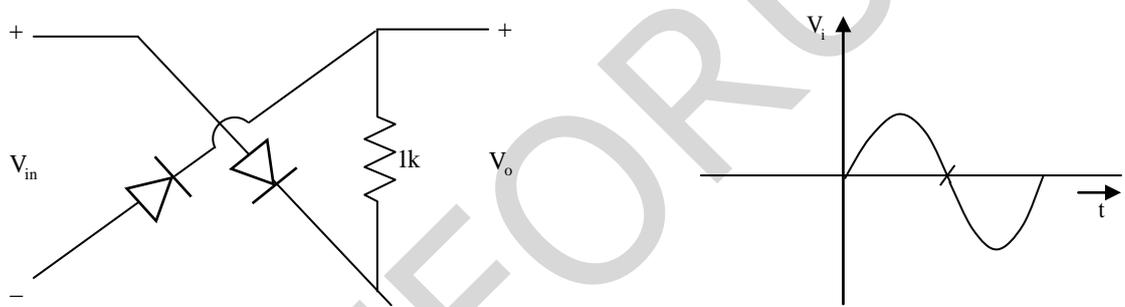
Exp: $f(x) = e^{-x(x^2+x+1)}$

$f(0) = 1$

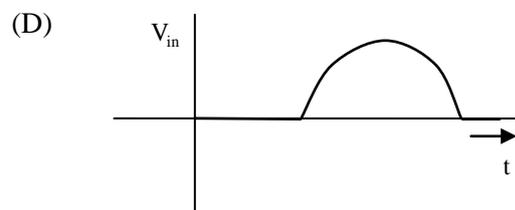
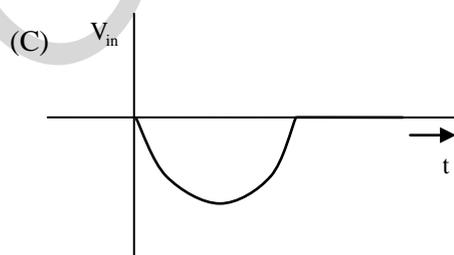
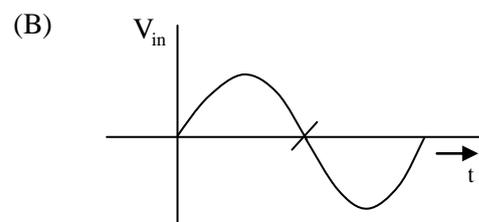
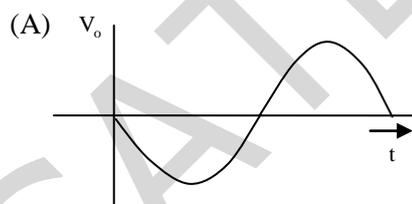
$f(0.5) = 1.067$

For positive values of x , function never goes negative.

2.



Which of the following represents output?

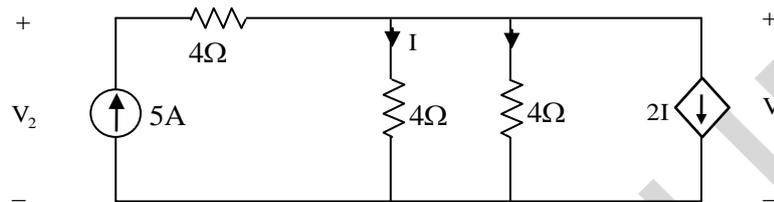


- 3 The result of convolution of the signal $x(-t)*\delta(-t-t_0)$ is
 (A) $x(t-t_0)$ (B) $x(t+t_0)$ (C) $x(-t+t_0)$ (D) $x(-t-t_0)$

Key: (D)

Exp: $x(-t)*\delta(-t-t_0) = x(-t)*\delta(t+t_0)$
 $= x(-t(t+t_0))$
 $= x(-t-t_0)$

4. What are values of V_1 and V_2 ?



- (A) 5, 25 (B) 25, 30 (C) 5, 5 (D) 25, 25

Key: (A)

Exp: By nodal analysis
 $-5 + I + I + 2I = 0$
 $4I = 5$
 $I = \frac{5}{4} \text{ A}$
 $V_1 = 4I = 5 \text{ volts}$
 $V_2 = 4(5) + V_1$
 $= 20 + V_1 = 25 \text{ volts}$

5. In a lead-network, the feed forward path contain R parallel with C and transfer function is given as $G(s) = \frac{s+2}{s+4}$. The value of RC is _____.

Key: 0.5

Exp: Given $G(s) = \frac{s+2}{s+4}$
 Zero = $2 = \frac{1}{\tau} = \frac{1}{RC}$
 Pole = $4 = \frac{1}{\alpha\tau} = \frac{1}{RC\tau}$
 So, $RC = 0.5$

6. The polar plot of transfer function $G(s) = \frac{10(s+1)}{s+10}$ for $0 \leq \omega \leq \infty$ will be in
 (A) First quadrant (B) Second quadrant
 (C) Third quadrant (D) Fourth quadrant

Key: (A)

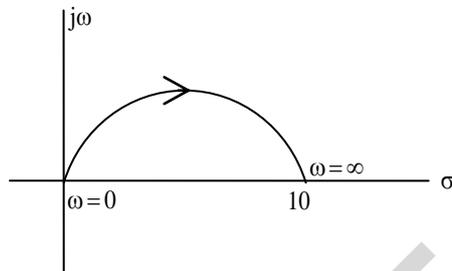
Exp: $G(s) = \frac{10(s+1)}{s+10}$

Put $s = j\omega$

$$G(j\omega) = \frac{10(j\omega+1)}{(j\omega+10)}$$

$$\omega = 0, \quad M = 1 < 0$$

$$\omega = \infty, \quad M = 10 < 0$$



So, zero is nearer to imaginary axis. Hence plot will move clockwise direction.
 It is first quadrant.

7. Differential equation is given $\frac{d^2y}{dt^2} + \frac{2dy}{dt} + y = 0$; $y(0) = y'(0) = 1$.

The output $y(t)$ is

- (A) $(2+t)e^{-t}$ (B) $(1-2t)e^{-t}$ (C) $(2-t)e^{-t}$ (D) $(1+2t)e^{-t}$

Key: (D)

Exp: D.E is $\frac{d^2y}{dt^2} + 2\frac{dy}{dt} + y = 0$

Initial conditions are $y(0) = y'(0) = 1$

By complementary solutions

$$(D^2 + 2D + 1)y = 0$$

$$D = -1, 1$$

$$\text{So, } y(t) = (c_1 + c_2t)e^{-t}$$

By initial conditions

$$y(t) = (c_1 + c_2t)e^{-t}$$

$$y(0) = 1 = c_1$$

$$y'(t) = -c_1 e^{-t} - e^t c_2 t + c_2 e^{-t}$$

$$y'(0) = -c_1 + c_2$$

$$c_2 = 1 + 1 = 2$$

Solution is $y(t) = (1 + 2t)e^{-t}$

8. A complex function is given $z = x + iy$. Which of the following is **not** true?

- (A) \bar{z} is an analytic function
- (B) Residue of $\frac{z}{z^2 - 1}$ at $z = 1$ is $\frac{1}{2}$
- (C) $\oint_c z^2 dz$ value is 0
- (D) None of above

Key: (A)

Exp: Residue $\frac{z}{z^2 - 1}$

$$\lim_{z \rightarrow 1} (z - 1) \frac{z}{(z + 1)(z - 1)} = \frac{1}{2}$$

$$\bar{z} = x - iy$$

$$u = x, v = -y$$

$$u_x = 1, v_x = 0$$

$$u_y = 0, v_y = -1$$

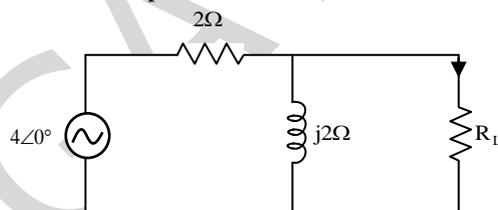
By C-R equations

$$u_x \neq v_y$$

$$u_y \neq -v_x$$

So it is not an analytic function.

9. Maximum power transfer to load is _____ W.



Key: 1.03

Exp: $V_{Th(rms)} = \frac{4 \times 2j}{2 + 2j} = 2\sqrt{2} \angle 45^\circ$; $V_{Th(mq)} = 2 \angle 45^\circ$

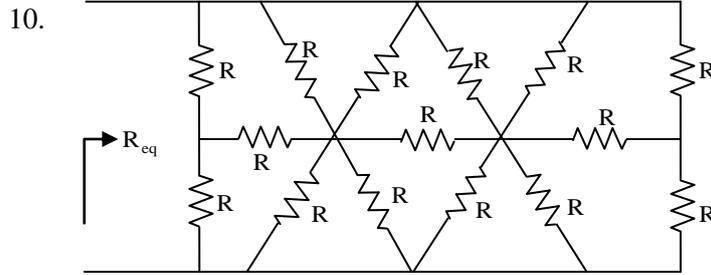
$$Z_{Th} = 2 \parallel 12j$$

$$R_L = |Z_{th}| = 0.485 \Omega$$

Maximum power transfer to R_L is

$$P_{max} = \frac{V_{Th(max)}^2}{8R_L} = \frac{4}{8 \times 0.485} = \frac{4}{3.88} = 1.03 \text{ W}$$

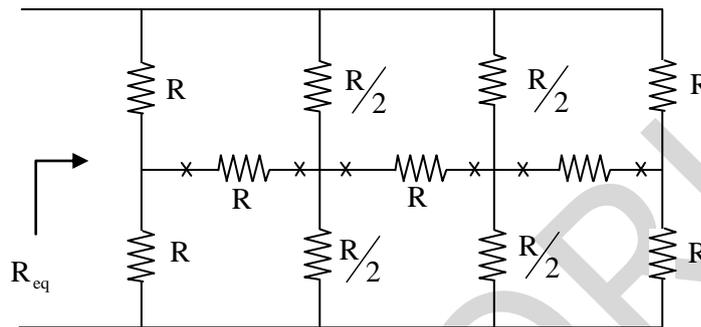
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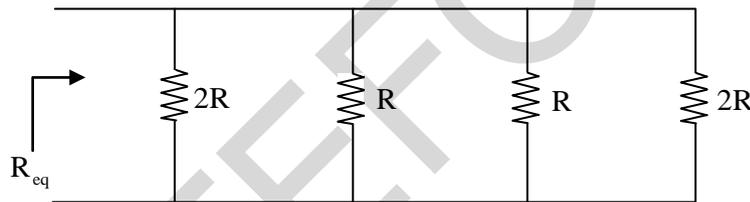
The value of R is 300Ω . R_{eq} is _____ Ω .

Key: 100

Exp.



By bridge condition



$$R_{eq} = \frac{R}{3} = 100\Omega$$

11. If matrix $\begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ is eigen vector of the matrix $\begin{bmatrix} 4 & 1 & 2 \\ P & 2 & 1 \\ 14 & -4 & 10 \end{bmatrix}$, then value of P is _____.

12. Find the value of K so that point $(-1 + j2)$ lies on root locus of unity feedback system

whose open loop transfer function is given by $GH = \frac{K(s+4)}{(s+8)(s^2-9)}$

Key: 25.5

Exp: By magnitude condition

$$|G(s)H(s)|_{s=-1+j2} = 1$$

$$\text{So, } \frac{k|2j+3|}{|7+2j||2+2j||-4+2j|} = 1$$

$$K = \frac{\sqrt{20}\sqrt{8}\sqrt{53}}{\sqrt{13}}$$

$$= 25.5$$

So K value is = 25.5

13. If vector P is given by $x^3y \hat{a}_x - x^2y^2 \hat{a}_y - x^2yz \hat{a}_z$ then P is

- (A) solenoidal and irrotational
- (B) not solenoidal but irrotational
- (C) solenoidal but not irrotational
- (D) neither solenoidal non irrotational

Key: (C)

Exp: $P = x^3y \hat{a}_x - x^2y^2 \hat{a}_y - x^2yz \hat{a}_z$
 $\nabla \cdot P = 3x^2y - 2x^2y - x^2y = 0$

It is solenoidal.

$$\nabla \times P = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x^3y & -x^2y^2 & -x^2yz \end{vmatrix}$$

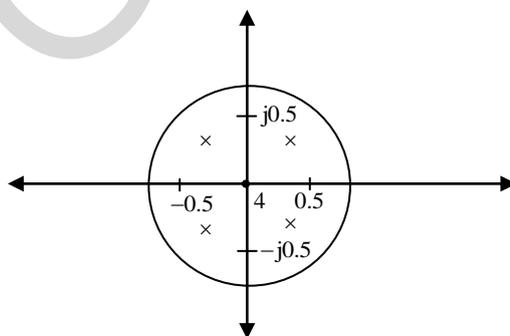
$$= \hat{a}_x(-x^2y) - \hat{a}_y(-2xyz) + \hat{a}_z(-2xy^2 - x^3) \neq 0$$

So P is solenoidal but not irrotational.

14. Negative differential resistance is observed in PN junction diode if

- (A) Both P and N side are heavily doped.
- (B) Only P side heavily doped.
- (C) Only N side heavily doped
- (D) A intrinsic silicon is inserted between the junction of P and N.

15.



Zeros of multiplicity 4.

Figure above shows pole zero location in z-plane of a system. The impulse response of the system is $h[n]$. If $h[0] = 1$, then

- (A) $h[n]$ is real for all 'n'
- (B) $h[n]$ is imaginary for all 'n'
- (C) $h[n]$ is real for even 'n'
- (D) $h[n]$ is imaginary for odd 'n'.

16. 3-input majority gate represents as $M(a, b, c) = ab + bc + ca$.

The function $f(\overline{M(a, b, c)}, M(a, b, \bar{c}), c)$ is realized by

- (A) 3-input XOR gate
- (B) 3-input XNOR gate
- (C) 3-input OR gate
- (D) 3-input AND gate

Key: (A)

Exp: $M(a, b, c) = ab + bc + ca$

$$\overline{M(a, b, c)} = \bar{a}\bar{b} + \bar{b}\bar{c} + \bar{c}\bar{a}$$

$$M(a, b, \bar{c}) = ab + b\bar{c} + \bar{c}a$$

From $f(\overline{M(a, b, c)}, M(a, b, \bar{c}), c)$

$$= \overline{M(a, b, c)}M(a, b, \bar{c}) + M(a, b, \bar{c}).c + \overline{M(a, b, c)}c$$

$$f(\overline{M(a, b, c)}, M(a, b, \bar{c}), c) = \bar{a}\bar{b}\bar{c} + a\bar{b}\bar{c} + a\bar{b}c + \bar{a}\bar{b}c$$

$$= \Sigma m(1, 3, 5, 7)$$

It can be realized by three input Ex-OR gate

17. The open loop transfer function is $G(s) = \frac{k}{s(s+1)(s+3)}$ for unity negative feedback system.

The value of gain $k (>0)$, at which root locus crosses the imaginary axis is _____.

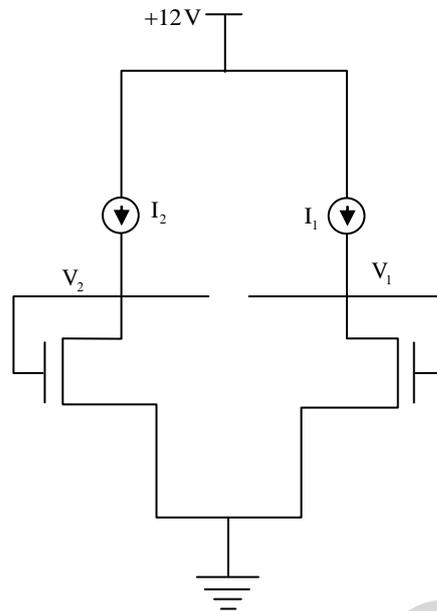
Key: 12

Exp: $C.E.s + 1 + \frac{k}{s(s+1)(s+3)} = 0$

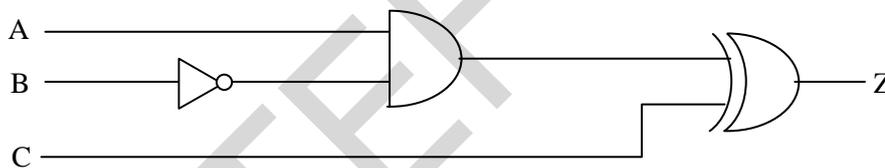
$$s^3 + 4s^2 + 3s + k = 0$$

For poles to cross 'j ω ' axis in root locus, k should be 12.

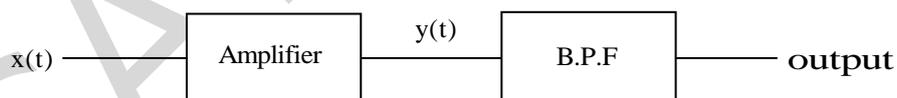
18. For figure shown below, the values of currents are $I_2 = 8\text{mA}$, $I_1 = 4\text{mA}$, V_T (thermal voltage) at 27°K is 26mV . What is the value of $V_1 - V_2$ at 50°C ? _____



19. Propagation delay of each gate is 10nsec in below circuit. Initially (at $t < 0$): $A=0$, $B=1$, $C=0$. Suppose at $t=0$ inputs flip as: $A=1$, $B=0$, $C=1$, then for how much duration output z will remain high? _____ nsec



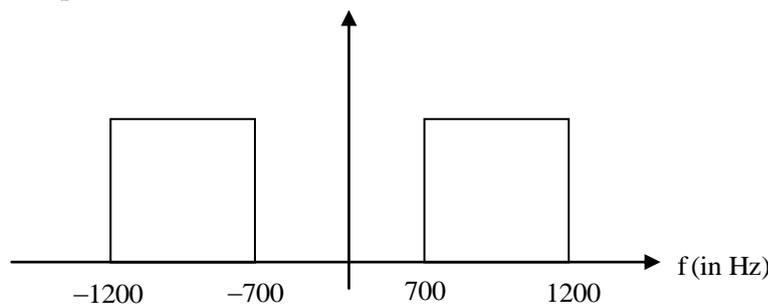
20. For the given system



$$x(t) = m(t)\cos(2000\pi t)$$

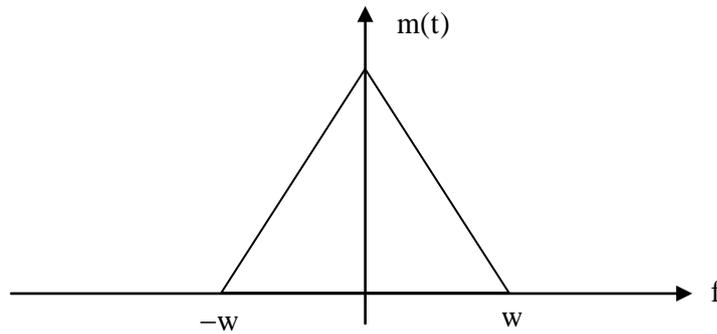
$$y(t) = x^2(t) + 10x(t)$$

Bandpass characteristic are shown below



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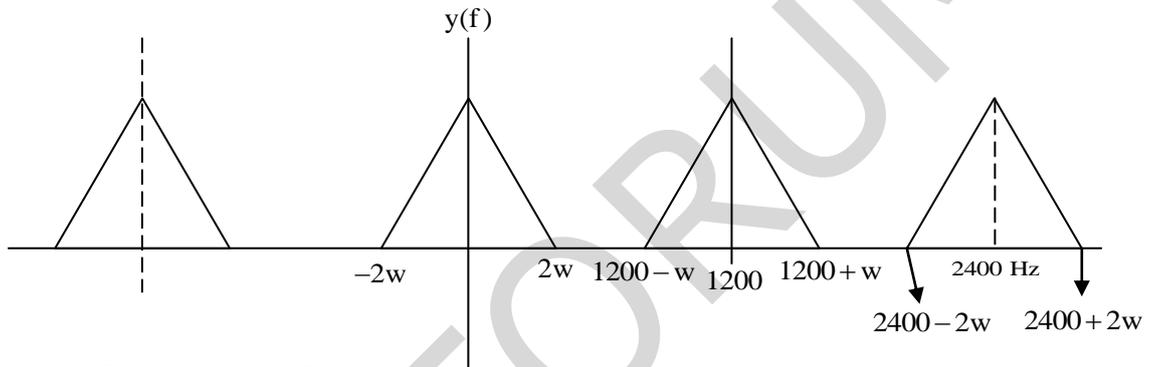
Message signal $m(t)$ spectrum is as below



When output is $10x(t)$, the value of w is strictly less than _____.

Key: 350

Exp:



When output is $10x(t)$

$$\text{It must be } 1200 - w > 2w \quad \dots (1)$$

$$2400 - 2w > 1700 \quad \dots (2)$$

From (1) & (2)

$$w < 400 \quad \dots (3)$$

$$w < 350 \quad \dots (4)$$

So from (3) & (4)

$$w < 350$$

So answer is 350.

21. A 4 bit D/A converter. The analog value corresponding to digital signals of values 0000 and 0001 are 0V & 0.0615V respectively. The analog value (in Vots) corresponding to digital signal 1111 is _____.

Key: 0.9375

Exp: $\Delta =$ Step size is 0.0615

$$V_0 = \Delta \times (\text{digital input})$$

$$= 0.0615 \times 15$$

$$= 0.9375(-1,1)$$

22. $f(x) = 1 - x^2 + x^3$ is defined in closed interval $[-1, 1]$. The value of x , in the open interval for which the mean value theorem is satisfied is,
 (A) $-\frac{1}{2}$ (b) $-\frac{1}{3}$ (C) $\frac{1}{3}$ (D) $\frac{1}{2}$

Key: (B)

Exp: By Cauchy's mean value theorem

$$f'(x) = \frac{f(1) - f(-1)}{1 - (-1)} = \frac{2}{2} = 1$$

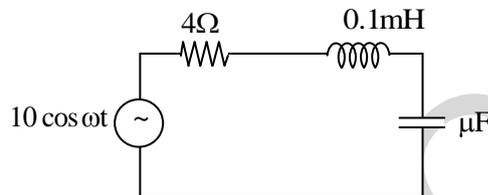
$$-2x + 3x^2 = 1$$

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

$$\text{So, } x = 1, -\frac{1}{3}$$

So, (B) is correct.

23. In circuit shown below at resonance, the amplitude of the sinusoidal voltage (in Vots) across the capacitor is _____.



Key: (25)

Exp: $V_c = QV \angle -90^\circ$

$$Q = \frac{\omega_0 L}{R} = \frac{1}{R} \sqrt{\frac{L}{C}} = \frac{10}{4} = 2.5$$

$$V_c = 25 \angle -90^\circ$$

$$|V_c| = 25V$$

24. Negative feedback in a closed loop control system does not
 (A) reduce overall gain
 (B) reduce bandwidth
 (C) Improve disturbance rejection
 (D) reduce sensitivity to parameter variation

Key: (B)

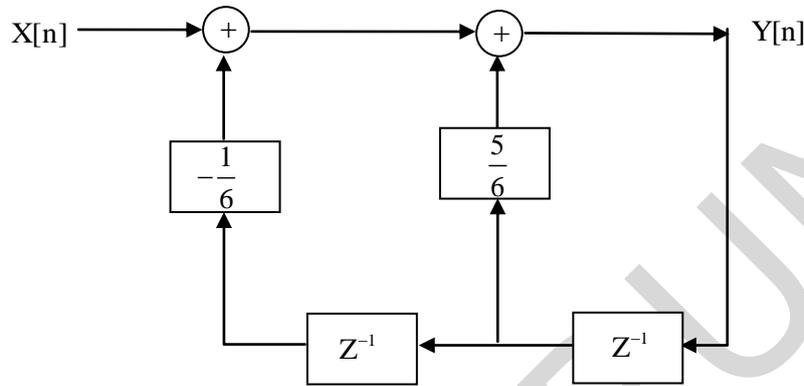
Exp: Negative feedback in a closed loop

- (i) Increases bandwidth
- (ii) Reduces gain
- (iii) Improve disturbance rejection

25. The damping ratio of a series RLC circuit can be expressed as

- (A) $\frac{R^2 C}{2L}$ (B) $\frac{2L}{R^2 C}$ (C) $\frac{R}{C} \sqrt{\frac{C}{L}}$ (D) $\frac{2}{R} \sqrt{\frac{L}{C}}$

26. For the discrete system shown, the poles of the system are located at



- (A) 2,3 (B) $\frac{1}{2}, 3$ (C) $\frac{1}{2}, \frac{1}{3}$ (D) $2, \frac{1}{3}$

Key: (C)

Exp: ' ξ ' = $\frac{1}{2Q}$ (In series RLC circuit)

$$= \frac{1}{2 \frac{1}{R} \sqrt{\frac{L}{C}}} = \frac{R}{2} \sqrt{\frac{C}{L}}$$

$$\frac{Y(z)}{X(z)} = H(z) = \frac{1}{1 - \frac{5}{6}z^{-1} + \frac{z^{-2}}{6}} = \frac{z^2}{z^2 - \frac{5}{6}z + \frac{1}{6}}$$

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

So, poles are $z = \frac{1}{2}, z = \frac{1}{3}$.

27. The built in potential of an abrupt p-n junction is 0.75V. If its junction capacitance (C_j) at a reverse bias (V_R) of 1.25 V is 5 pF, then the value of C_j (in pf) when $V_R=7.25V$ is _____.

Key: (2.5)

Exp: $C_j \propto \frac{1}{\sqrt{V_{bi} + V_R}}$

$$\frac{C_{2j}}{C_{1j}} = \sqrt{\frac{V_{bi} + V_{R_1}}{V_{bi} + V_{R_2}}}$$
$$C_{2j} = C_{1j} \sqrt{\frac{2}{8}} = \frac{C_{1j}}{2} = 2.5 \text{ pF}$$

So, answer is 2.5

28. The max area (in sq units) of a rectangle whose vertices lie on the ellipse $x^2 + 4y^2 = 1$ is _____.
29. A 16kb (=16,384 bit) memory array is designed as a square with as aspect ratio of one (no. of rows= no. of columns). The minimum no. of address lines needed for the row decoder is _____.