



# GATE 2020

**Electronics &  
Communication  
Engineering**

**Questions**

## GENERAL APTITUDE

- The untimely loss of life is a cause of serious global concern as thousands of people get killed ..... accidents every year while many other die ..... diseases like cardiovascular  
A. from, from  
B. from, of  
C. in, of  
D. during, from
- He was not only accused of theft ..... of conspiracy.  
A. but even  
B. rather than  
C. rather  
D. but also
- Select the word that fits the analogy:  
Explicit: Implicit:: Express: .....  
A. Impress  
B. Compress  
C. Suppress  
D. Repress
- The Canadian constitution requires that equal importance be given to English and French. Last year, Air Canada lost a lawsuit, and had to pay a six-figure fine to a French-speaking couple after they filed complaints about formal in-flight announcements in English lasting 15 seconds, as opposed to informal 5 second messages in French, The French-speaking couple were upset at  
A. the English announcements being clearer than the French ones.  
B. the in-flight announcements being made in English.  
C. the English announcements being longer than the French ones.  
D. equal importance being given to English and French.
- A super additive function  $n f (.)$  satisfies the following property  
$$f(x_1 + x_2) \geq f(x_1) + f(x_2)$$
  
Which of the following functions is a super additive function for  $x > 1$ ?  
A.  $e^x$   
B.  $e^{-x}$   
C.  $1/x$   
D.  $\sqrt{x}$
- The global financial crisis in 2008 is considered to be the most serious world-wide financial crisis, which started with the sub-prime lending crisis in USA in 2007. The subprime lending crisis led to the banking crisis in 2008 with the collapse of Lehman Brothers in 2008. The sub-prime lending refers to the provision of loans to those borrowers who may have difficulties in repaying loans, and it arises because of excess liquidity following the East Asian crisis.  
Which one of the following sequences shows the correct precedence as per the given passage?

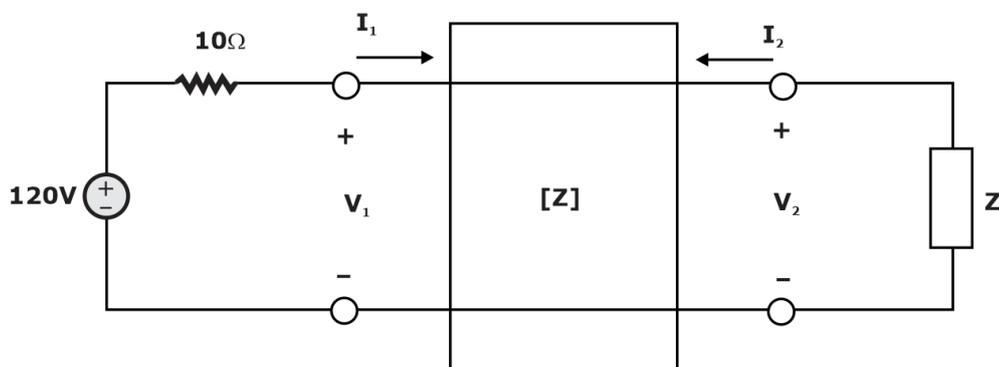
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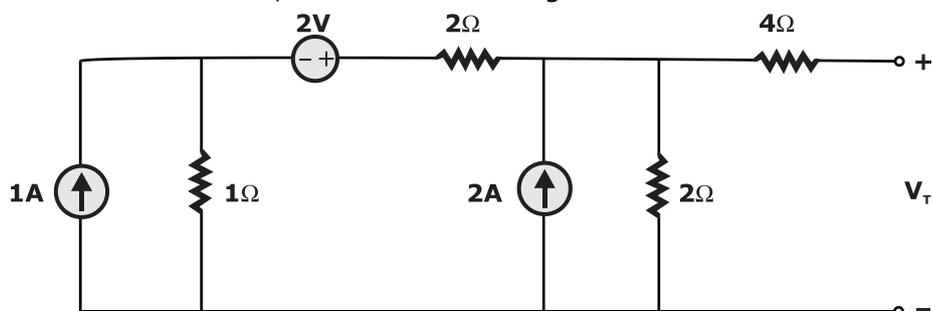


**TECHNICAL**

1. A transmission line of length  $3\lambda/4$  and having a characteristic impedance of  $50 \Omega$  is terminated with a load of  $400 \Omega$ . The impedance (rounded off to two decimal places) seen at the input end of the transmission line is .....  $\Omega$ .
2. In the given circuit, the two-port network has the impedance matrix  $[Z] = \begin{bmatrix} 40 & 60 \\ 60 & 120 \end{bmatrix}$ . The value of  $Z_L$  for which maximum power is transferred to the load is .....  $\Omega$ .



3. Consider the recombination process via bulk traps in a forward biased pn homojunction diode. The maximum recombination rate is  $U_{max}$ . If the electron and the hole capture cross-sections are equal, which one of the following is FALSE?
  - A.  $U_{max}$  depends exponentially on the applied bias.
  - B.  $U_{max}$  occurs at the edges of the depletion region in the device.
  - C. With all other parameters unchanged,  $U_{max}$  increases if the thermal velocity of the carriers increases.
  - D. With all other parameters unchanged,  $U_{max}$  decreases if the intrinsic carrier density is reduced.
4. In the circuit shown below, the Thevenin voltage  $V_{TH}$  is



- A. 2.8 V
- B. 3.6 V
- C. 4.5 V
- D. 2.4 V

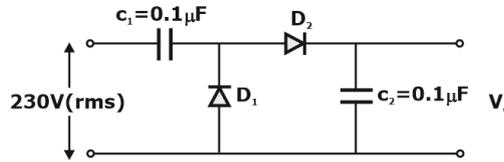


10. The loop transfer function of a negative feedback system is

$$G(s)H(s) = \frac{K(s+11)}{s(s+2)(s+8)}$$

The value of K, for which the system is marginally stable, is .....

11. In the circuit shown below all component ideal, input voltage is sinusoidal. Magnitude of steady state output  $V_o$  is \_\_\_\_\_ V.



12. The output  $y[n]$  of a discrete-time system for an input  $x[n]$  is

$$y[n] = \max_{-\infty \leq k \leq n} |x[k]|$$

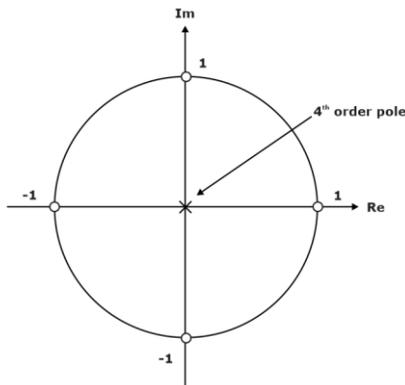
The unit impulse response of the system is

Option

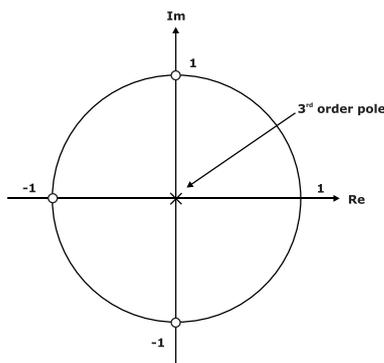
1. 0 for all n
  2. unit impulse signal  $\delta [n]$
  3. unit step signal  $u[n]$
  4. 1 for all n
13. Which one of the following pole-zero plots corresponds to the function of an LTI system characterized by the input-output difference equation given below?

$$y[n] = \sum_{k=0}^3 (-1)^k x[n-k]$$

A.



B.



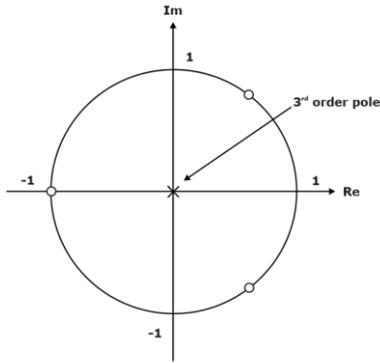
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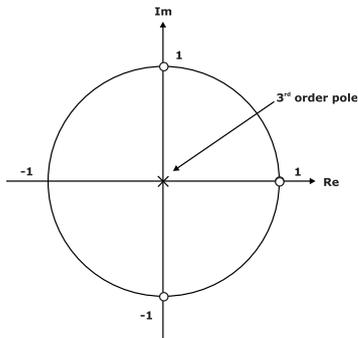
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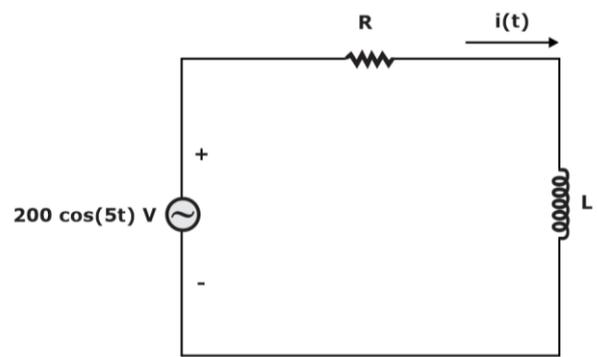
C.



D.



14. If  $v_1, v_2, \dots, v_6$  are six vectors in  $R^4$ , which one of the following statements is FALSE?
- A. If  $\{v_1, v_3, v_5, v_6\}$  spans  $R^4$ , then it forms a basis for  $R^4$
  - B. It is not necessary that these vectors span  $R^4$ .
  - C. Any four of these vectors form a basis for  $R^4$ .
  - D. These vectors are not linearly independent.
15. The general solution of  $\frac{d^2y}{dx^2} - 6\frac{dy}{dx} + 9y = 0$  is
- A.  $y = C_1e^{3x}$
  - B.  $y = (C_1 + C_2x)e^{-3x}$
  - C.  $C_1e^{3x} + C_2e^{-3x}$
  - D.  $y = (C_1 + C_2x)e^{3x}$
16. The current in the RL-circuit shown below is  $i(t) = 10\cos(5t - \pi/4)$  A  
The value of the inductor (rounded off to two decimal places) is ..... H.



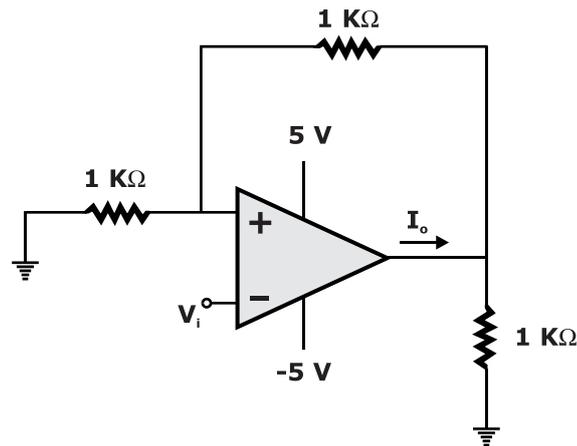
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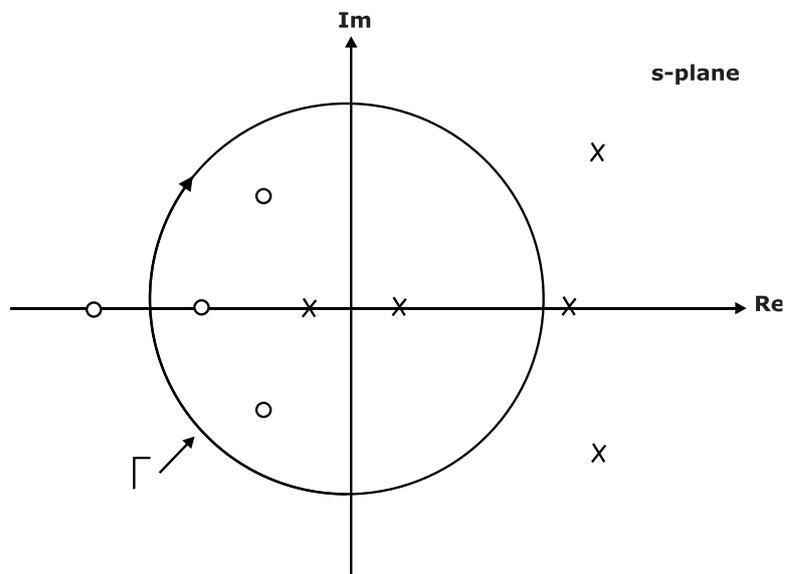
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17. In the circuit shown below, all the components are ideal. If  $V_i$  is +2V, the current  $I_o$  sourced by the op-amp is ..... mA.



18. A 10-bit D/A converter is calibrated over full range from 0 to 10 V. If input to D/A converter is 13A (in hexadecimal number). Then output voltage is \_\_\_\_\_ V.
19. In 8085 microprocessor, number of address lines required to access 16K byte memory bank?
20. The pole-zero map of a rational function  $G(s)$  is shown below. When the closed contour  $\Gamma$  is mapped into the  $G(s)$ -plane, then the mapping encircles.



- A. the origin of the  $G(s)$  -plane once in the counter-clockwise direction.
- B. the point  $-1 + j0$  of the  $G(s)$ -plane once in the counter-clockwise direction.
- C. the origin of the  $G(s)$  -plane once in the clockwise direction.
- D. the point  $-1 + j0$  of the  $G(s)$ -plane once in the clockwise direction.
21. A binary random variable  $X$  takes the value +2 or -2. The probability  $P(X = +2) = a$ . The value of  $a$  (rounded off to one decimal place), for which the entropy of  $X$  is maximum, is

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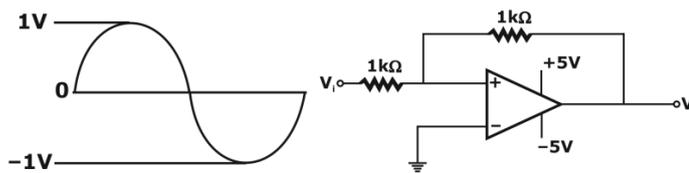
22. The impedances  $Z = jX$ , for all  $X$  in the range  $(-\infty, \infty)$ , map to the Smith chart as
- a circle of radius 0.5 with centre at (0.5, 0).
  - a circle of radius 1 with centre at (0, 0).
  - a point at the centre of the chart.
  - a line passing through the centre of the chart.

23. The partial derivative of the function

$$F(x, y, z) = e^{1-x \cos y} + xze^{-1/(1+y^2)}$$

With respect to  $x$  at the point (1, 0, e) is

- 1
  - $\frac{1}{e}$
  - 0
  - 1
24. The components in the circuit shown below are ideal.



If the Op-amp is in positive feedback and the input voltage  $V_i$  is a sine wave of amplitude 1V,  $V_0 = ?$

- a constant of either + 5V or - 5V
  - A square wave of 5V amplitude
  - A non-inverted sine wave of 2V amplitude
  - An inverted sine wave of 1V amplitude
25. For a vector field  $\vec{A}$ , Which one of the following is false
- $\nabla \times \vec{A}$  in another vector field
  - $\nabla \times (\nabla \times \vec{A}) = \nabla(\nabla \cdot \vec{A}) - \nabla^2 \vec{A}$
  - $\vec{A}$  is irrotational if  $\nabla^2 \times \vec{A} = 0$
  - $\vec{A}$  is sinusoidal if  $\vec{A}$  is sinusoidal if  $\nabla \cdot \vec{A} = 0$
26. In a digital communication system, a symbol  $S$  randomly chosen from the set  $\{s_1, s_2, s_3, s_4\}$  is transmitted. It is given that  $s_1 = -3, s_2 = -1, s_3 = +1$  and  $s_4 = +2$ . The received symbol is  $Y = S + W$ .  $W$  is a zero-mean unit-variance Gaussian random variable and is independent of  $S$ .  $P_i$  is the conditional probability of symbol error for the maximum likelihood (ML) decoding when the transmitted symbol  $S = s_i$ . The index  $i$  for which the conditional symbol error probability  $P_i$  is the highest is .....
27. The characteristic equation of a system is
- $$s^3 + 3s^2 + (K + 2)s + 3K = 0$$
- In the root locus plot for the given system, as  $K$  varies from 0 to  $\infty$ , the break-away or break-in point(s) lie within
- $(-\infty, -3)$
  - $(-2, -1)$
  - $(-3, -2)$
  - $(-1, 0)$

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Sol. Magnitude will become constant for all pass system

$$H(z) = \frac{Z - a}{Z + b}$$

$$b = \frac{1}{\alpha^*}$$

$$\alpha = \frac{1}{0.5}$$

$$\alpha = 2$$

31. A finite duration discrete time signal  $x(n)$  is obtained by sampling the continuous time signal,

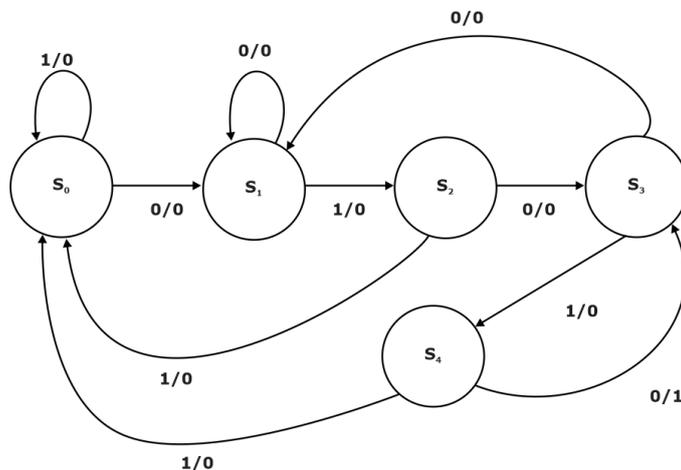
$$x(t) = \cos(200\pi t) \text{ at sampling instants, } t = \frac{n}{400}, n = 0, \dots, 7. \text{ The 8-point DFT and } x[n]$$

is defined as

$$X[k] = \sum_{n=0}^7 x[n] e^{-j\pi kn/4} \quad ; k = 0, 1, \dots, 7$$

Which is true?

- A. Only  $X[4]$  is non zero.
  - B. All  $X[K]$  are non-zero
  - C. Only  $X[3]$  and  $X[5]$  are non-zero
  - D. Only  $X[2]$  and  $X[6]$  are non-zero.
32. The state diagram of a sequence detector is shown below. State  $S_0$  is the initial state of the sequence detector. If the output is 1, then



- A. the sequence 01010 is detected.
- B. the sequence 01011 is detected.
- C. the sequence 01110 is detected.
- D. the sequence 01001 is detected.

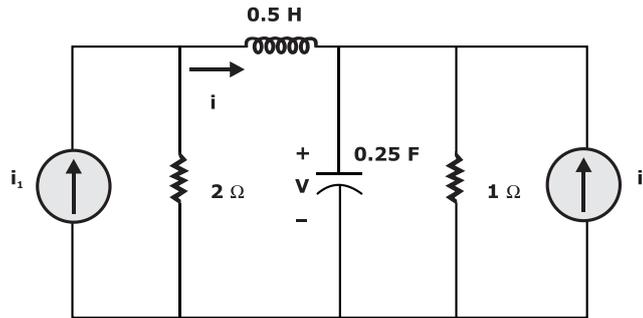
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33. For the given circuit, which one of the following is the correct state question?



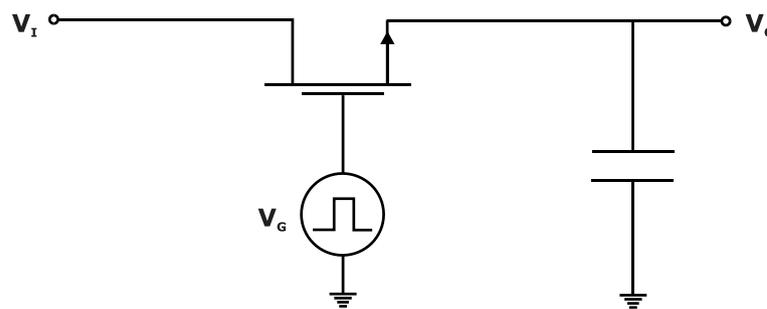
- A.  $\frac{d}{dt} \begin{bmatrix} v \\ i \end{bmatrix} = \begin{bmatrix} -4 & 4 \\ -2 & -4 \end{bmatrix} \begin{bmatrix} v \\ i \end{bmatrix} + \begin{bmatrix} 0 & 4 \\ 4 & 0 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$
- B.  $\frac{d}{dt} \begin{bmatrix} v \\ i \end{bmatrix} = \begin{bmatrix} -4 & -4 \\ -2 & -4 \end{bmatrix} \begin{bmatrix} v \\ i \end{bmatrix} + \begin{bmatrix} 4 & 0 \\ 0 & 4 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$
- C.  $\frac{d}{dt} \begin{bmatrix} v \\ i \end{bmatrix} = \begin{bmatrix} 4 & -4 \\ -2 & -4 \end{bmatrix} \begin{bmatrix} v \\ i \end{bmatrix} + \begin{bmatrix} 0 & 4 \\ 4 & 4 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$
- D.  $\frac{d}{dt} \begin{bmatrix} v \\ i \end{bmatrix} = \begin{bmatrix} -4 & -4 \\ -2 & 4 \end{bmatrix} \begin{bmatrix} v \\ i \end{bmatrix} + \begin{bmatrix} 4 & 4 \\ 4 & 0 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$

34. Consider the following system of linear equation

$$x_1 + 2x_2 = b_1; \quad 2x_1 + 4x_2 = b_2; \quad 3x_1 + 7x_2 = b_3; \quad 3x_1 + 9x_2 = b_4$$

Which one of the following conditions ensures that a solution exists for the above system?

- A.  $b_2 = 2b_1$  and  $3b_1 - 6b_3 + b_4 = 0$
  - B.  $b_3 = 2b_1$  and  $3b_1 - 6b_3 + b_4 = 0$
  - C.  $b_2 = 2b_1$  and  $6b_1 - 3b_3 + b_4 = 0$
  - D.  $b_3 = 2b_1$  and  $6b_1 - 3b_3 + b_4 = 0$
35. An enhancement MOSFET of threshold voltage 3 V is being used in the sample and hold circuit given below. Assume that the substrate of MOS device is connected to -10 V. If the input voltage  $V_1$  lies between  $\pm 10$  V, the minimum and the maximum values of  $V_G$  required of proper sampling and holding respectively, are



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39. The magnetic field of a uniform plane wave in vacuum is given by

$$\vec{H}(x, y, z, t) = (\hat{a}_x + 2\hat{a}_y + b\hat{a}_z) \cos(\omega t + 3x - y - z)$$

The value of b is .....

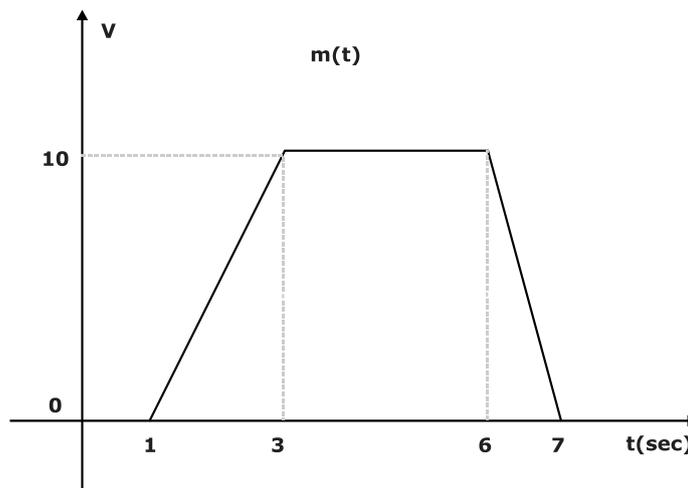
40.  $S_{PM}(t)$  and  $S_{FM}(t)$  as defined below, are the phase modulated and frequency modulated waveforms, respectively, corresponding to the message signal  $m(t)$  shown in the figure.

$$S_{PM}(t) = \cos(1000\pi t + K_p m(t))$$

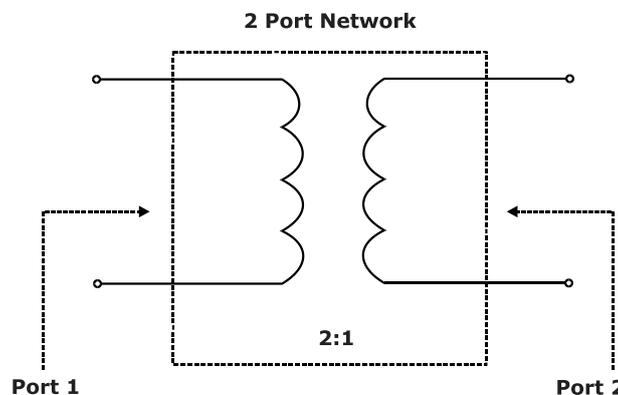
$$\text{and } S_{FM}(t) = \cos(1000\pi t + K_f \int_{-\infty}^t m(\tau) d\tau)$$

Where  $K_p$  is the phase deviation constant in radians/volt and  $K_f$  is the frequency deviation constant in radians/second/volt. If the highest instantaneous frequencies of  $S_{PM}(t)$  and

$S_{FM}(t)$  are same, then the value of the ratio  $\frac{K_p}{K_f}$  is ..... seconds.



41. For a 2-port network consisting an ideal lossless transformer, the parameter  $S_{21}$ , (rounded off to two decimal places) for a reference impedance of  $10\Omega$ , is .....



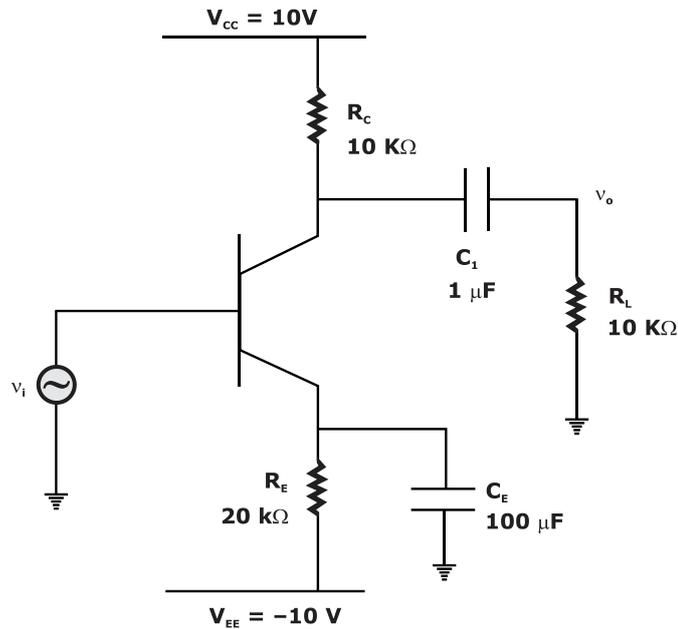
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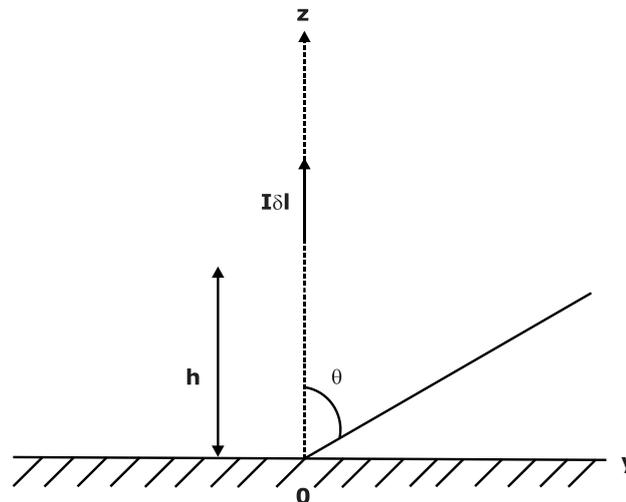
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- A. -89.42
- B. -178.85
- C. -128.21
- D. -256.42

46. For an infinitesimally small dipole in free space, the electric field  $E_\theta$  in the far field proportional to  $(e^{-jkr}/r) \sin\theta$ , where  $k = 2\pi/\lambda$ . A vertical infinitesimally small electric dipole ( $\delta l \ll \lambda$ ) is placed at a distance  $h$  ( $h > 0$ ) above an infinite ideal conducting plane, as shown in the figure. The minimum value of  $h$ , for which one of the maxima in the far field radiation pattern occurs at  $\theta = 60^\circ$ , is



- A.  $0.75\lambda$
- B.  $\lambda$
- C.  $0.25\lambda$
- D.  $0.5\lambda$

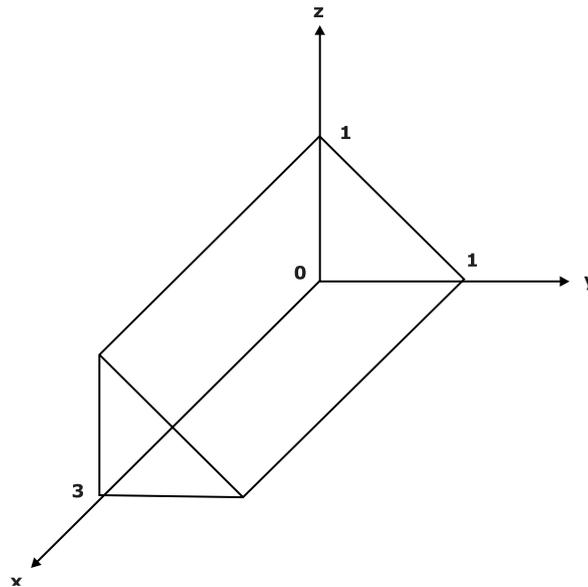
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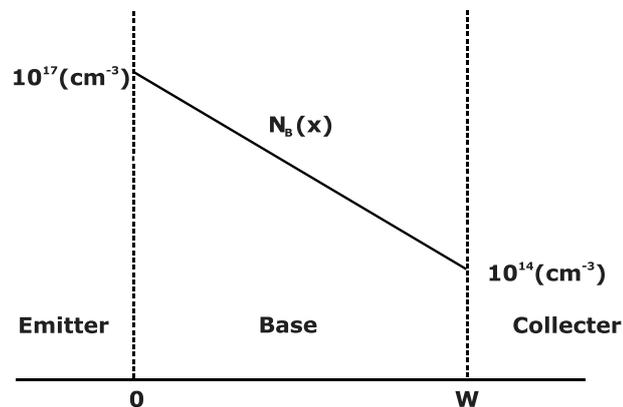
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47. For the solid S shown below, the value of  $\iiint_S xdx dy dz$  (rounded off to two decimal places ) is .....



48. A system with transfer function  $G(s) = \frac{1}{(s+1)(s+a)}$ ,  $a > 0$  is subjected to an input  $5 \cos 3t$ . The steady state output of the system is  $\frac{1}{\sqrt{10}} \cos(3t - 1.892)$ . The value of  $a$  is .....
49. The base of an npn BJT T1 has a linear doping profile  $N_B(x)$  as shown below, The base of another npn BJT T2 has a uniform doping  $N_B$  of  $10^{17} \text{ cm}^{-3}$ . All other parameters are identical for both the devices. Assuming that the hole density profile is the same as that of doping, the common-emitter current gain of T2 is



- A. approximately 2.0 times that of T1
- B. approximately 0.7 times that of T1
- C. approximately 0.3 times that of T1
- D. approximately 2.5 times that of T1

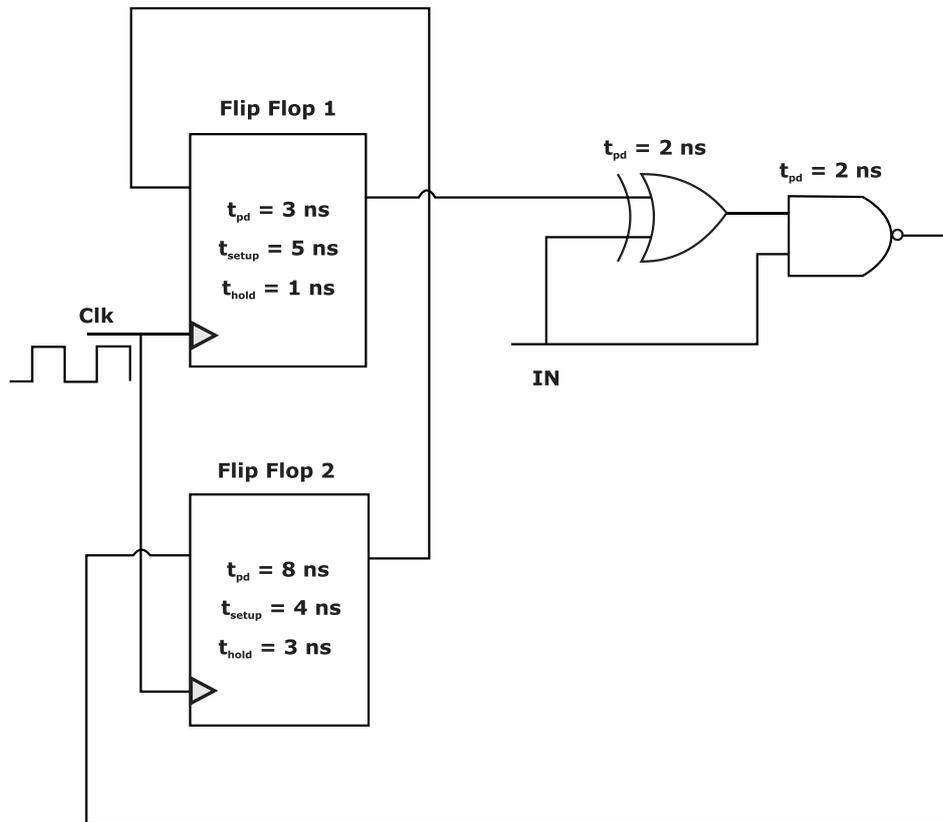
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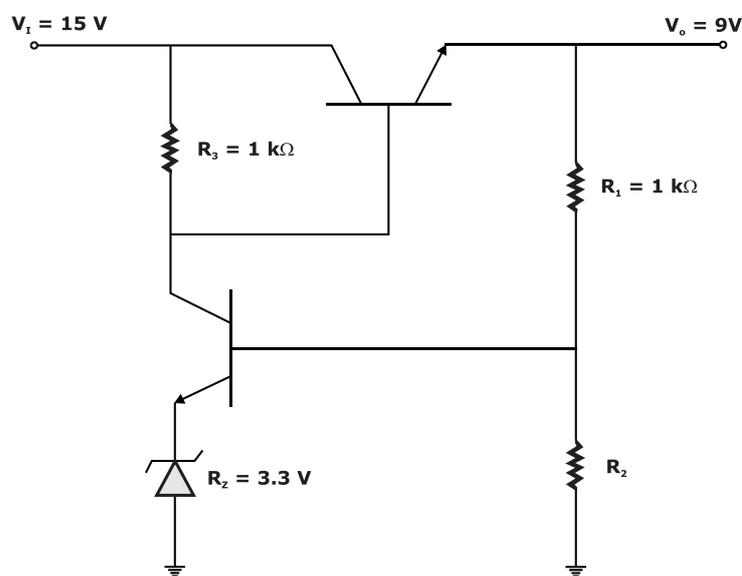
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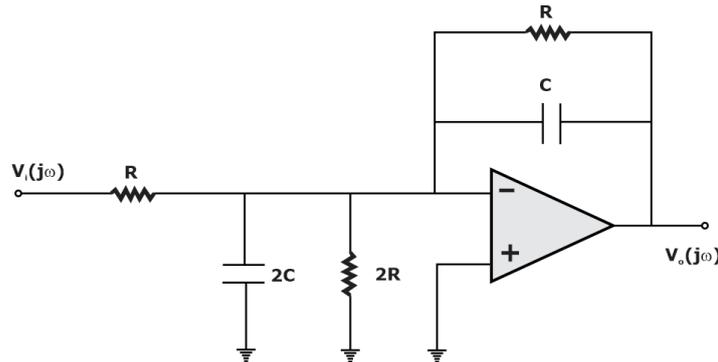
50. For the components in the sequential circuit shown below,  $t_{pd}$  is the propagation delay,  $t_{setup}$  is the setup time, and  $t_{hold}$  is the hold time. The maximum clock frequency (rounded off to the nearest integer), at which the given circuit can operate reliably, is .... MHz.



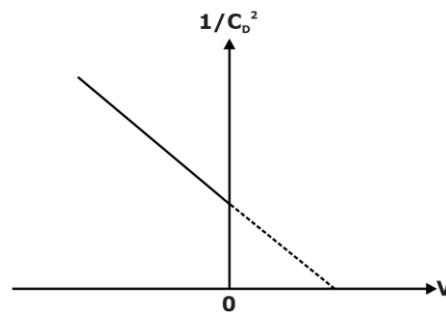
51. In the voltage regulator shown below,  $V_1$  is the unregulated at 15 V. Assume  $V_{BE} = 0.7\text{ V}$  and the base current is negligible for both the BJTs. If the regulated output  $V_o$  is 9 V, the value of  $R_2$  is .....  $\Omega$ .



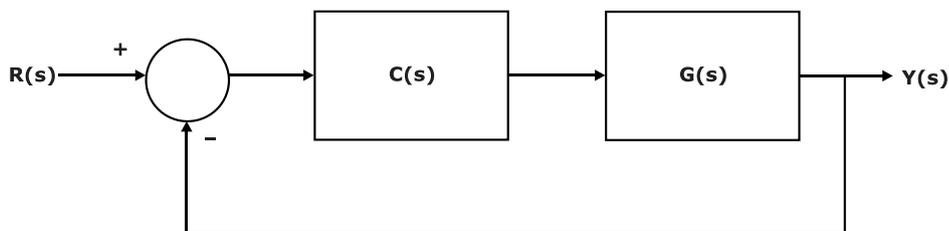
52. The components in the circuit given below are ideal. If  $R = 2 \text{ k}\Omega$  and  $C = 1 \text{ }\mu\text{F}$ , the -3 dB cut-off frequency of the circuit in Hz is



- A. 14.92  
 B. 79.58  
 C. 34.46  
 D. 59.68
53. A one-sided abrupt pn junction diode has a depletion capacitance  $C_D$  of 50 PF at reverse bias of 0.2 V. The plot of  $1/C_D^2$  versus the applied voltage  $V$  for this diode is a straight line as shown in the below. The slope of the plot is .....  $\times 10^{20} \text{ F}^{-2}\text{V}^{-1}$ .



- A. -0.47  
 B. -5.7  
 C. -1.2  
 D. -3.8
54.  $X$  is random variable with uniform probability density function in the interval  $[-2, 10]$ . For  $Y = 2X - 6$ , the conditional probability  $P(Y \leq 7 \mid X \geq 5)$  (rounded off to three decimal places) is .....
55. Consider the following closed loop control system



Where  $G(s) = \frac{1}{s(s+1)}$  and  $C(s) = K \frac{s+1}{s+3}$ . If the steady state error for a unit ramp is 0.1, then the value of  $K$  is .....

\*\*\*\*

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EE



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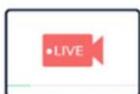
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