

GATE 2005
EC : Electronics and Communication Engineering

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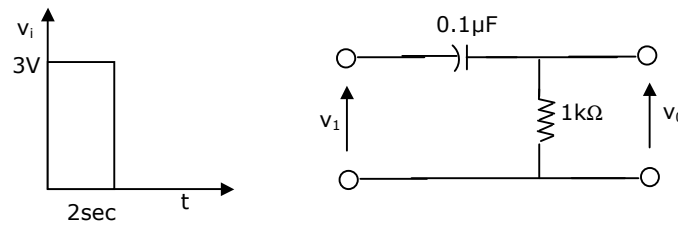
Duration: 3 Hours

Maximum Marks:150

Read the following instructions carefully:

1. This question paper contains all objective questions. Q.1 to Q.30 carry **One** mark each and Q.31 to Q.80 carry **Two** marks each. Q.81 to Q.85 each contains part "a" and "b". In these questions, parts "a" as well as "b" carry **Two** marks each.
2. Answer all the questions.
3. Questions must be answered on special machine gradable **Objective Response Sheet (ORS)** by darkening the appropriate bubble (marked A, B, C, D) against the question number on the left hand side of the **ORS**, using **HB** pencil. **Each question has only one correct answer.** In case you wish to change an answer, erase the old answer completely using a good soft eraser.
4. There will be **NEGATIVE** marking. In Q.1 to Q.30, **0.25** mark will be deducted for each wrong answer and in Q.31 to Q.80, **0.5** mark will be deducted for each wrong answer. In Q.81 to Q.85, for the part "a", **0.5** marks will be deducted for a wrong answer. Marks for correct answers to part "b" of Q.81 to Q.85 will be given only if the answer to the corresponding part "a" is correct. However there is no negative marking for part "b" of Q.81 to Q.85. More than one answer bubbled against a question will be deemed as an incorrect response.
5. Write your registration number, name and name of the Centre at the specified locations on the right half of the **ORS**.
6. Using HB pencil, darken the appropriate bubble under each digit of your registration number and the letters corresponding to your paper code.
7. Calculator is allowed in the examination hall.
8. Charts, graph sheets or tables are not allowed.
9. Use the blank pages given at the end of the question paper for rough work.
10. Please check all pages and report, if there is any discrepancy.

43. A square pulse of 3 volts amplitude is applied to C-R circuit shown in figure. The capacitor is initially uncharged. The output voltage v_0 at time $t=2$ sec is



- (a) 3 V (b) -3V (c) 4 V (d) -4V
44. A silicon sample A is doped with 10^{18} atoms/cm³ of Boron. Another sample B of identical dimensions is doped with 10^{18} atoms/cm³ of Phosphorus. The ratio of electron to hole mobility is 3. The ratio of conductivity of the sample A to B is

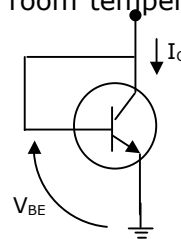
- (a) 3 (b) $\frac{1}{3}$ (c) $\frac{2}{3}$ (d) $\frac{3}{2}$

45. A Silicon PN junction diode under reverse bias has depletion region of width 10 μm . The relative permittivity of Silicon, $\epsilon_r = 11.7$ and the permittivity of free space $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$. The depletion capacitance of the diode per square meter is

- (a) 100 μF (b) 10 μF (c) 1 μF (d) 20 μF

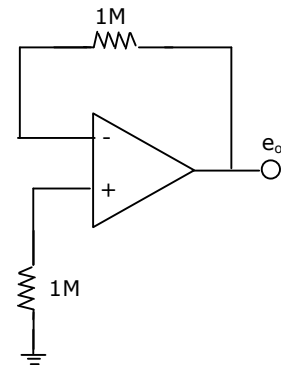
46. For an npn transistor connected as shown in figure, $V_{BE} = 0.7$ Volts. Given that reverse saturation current of the junction at room temperature 300°K is 10^{-13} A, the emitter current is

- (a) 30 mA
(b) 39 mA
(c) 49 mA
(d) 20 mA

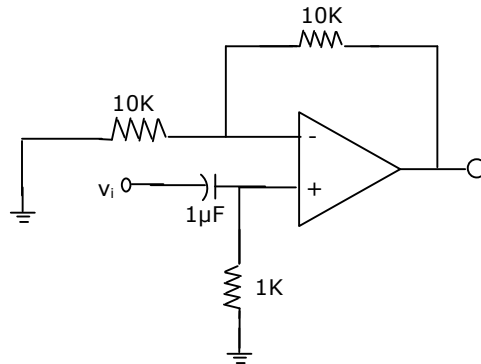


47. The voltage e_o indicated in figure has been measured by an ideal voltmeter. Which of the following can be calculated?

- (a) Bias current of the inverting input only.
(b) Bias current of the inverting and non-inverting inputs only.
(c) Input offset current only.
(d) Both the bias currents and the input offset current.



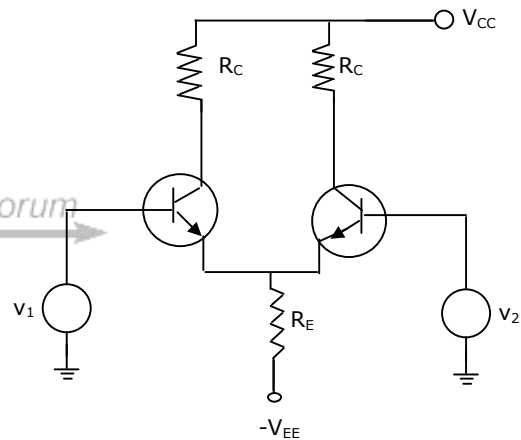
48. The Op-amp circuit shown in figure is a filter. The type of filter and its cut-off frequency are respectively.



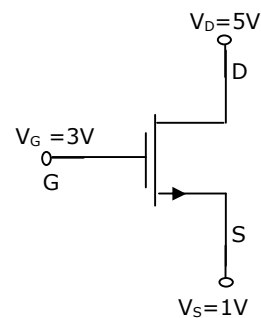
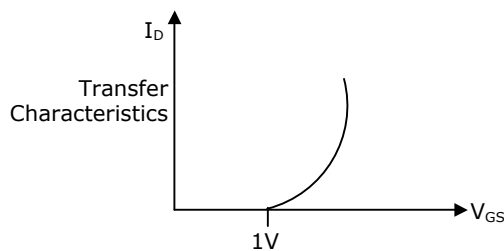
- (a) high pass, 1000 rad/sec. (b) low pass, 1000 rad/sec.
 (c) high pass, 10000 rad/sec. (d) low pass, 10000 rad/sec.

49. In an ideal differential amplifier shown in figure, a large value of R_E

- (a) increases both the differential and common-mode gains.
 (b) increases the common-mode gain only.
 (c) decreases the differential-mode gain only.
 (d) decreases the common-mode gain only.

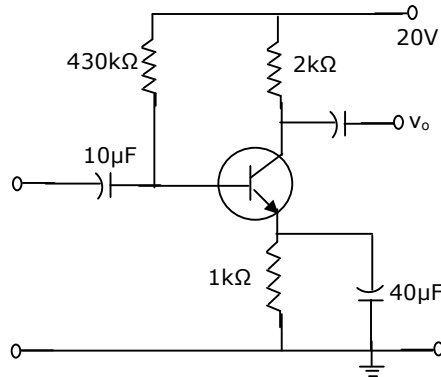


50. For an n-channel MOSFET and its transfer curve shown in figure, the threshold voltage is

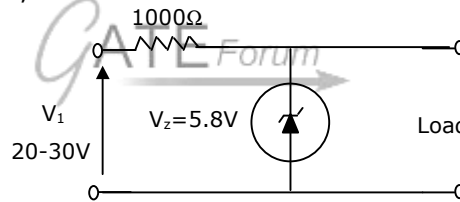


- (a) 1 V and the device is in active region.
 (b) -1 V and the device is in saturation region.
 (c) 1 V and the device is in saturation region.
 (d) -1 V and the device is in active region.

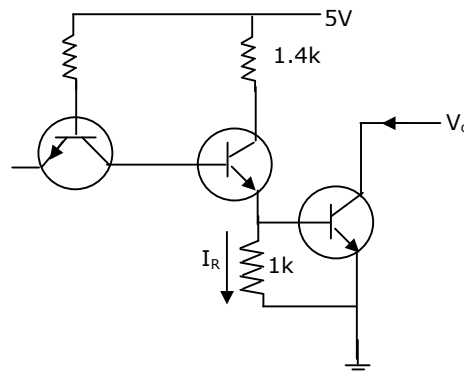
51. The circuit using a BJT with $\beta=50$ and $V_{BE} = 0.7$ V is shown in figure. The base current I_B and collector voltage V_C are respectively



- (a) $43 \mu\text{A}$ and 11.4 Volts
 (b) $40 \mu\text{A}$ and 16 Volts
 (c) $45 \mu\text{A}$ and 11 Volts
 (d) $50 \mu\text{A}$ and 10 Volts
52. The Zener diode in the regulator circuit shown in figure has a Zener voltage of 5.8 Volts and a Zener knee current of 0.5 mA. The maximum load current drawn from this circuit ensuring proper functioning over the input voltage range between 20 and 30 Volts, is

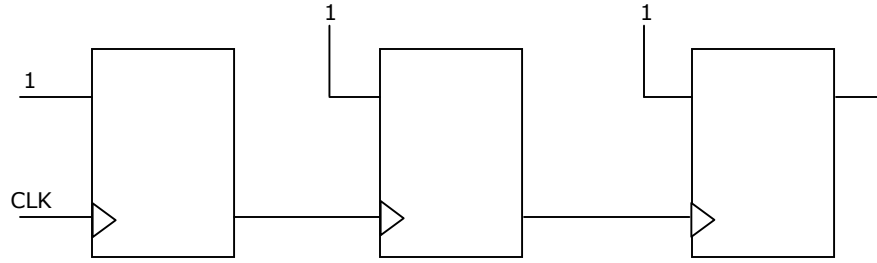


- (a) 23.7 mA
 (b) 14.2 mA
 (c) 13.7 mA
 (d) 24.2 mA
53. The transistors used in a portion of the TTL gate shown in figure have $\beta=100$. the base-emitter voltage of is 0.7V for a transistor in active region and 0.75V for a transistor in saturation. If the sink current $I=1\text{mA}$ and the output is at logic 0, then the current I_R will be equal to



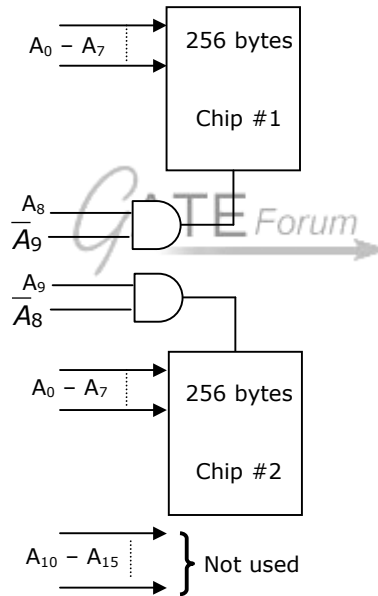
- (a) 0.65 mA
 (b) 0.70 mA
 (c) 0.75 mA
 (d) 1.00 mA

57. Figure shows a ripple counter using positive edge triggered flip-flops. If the present state of counter is $Q_2Q_1Q_0 = 011$, then its next state ($Q_2Q_1Q_0$) will be



- (a) 010 (b) 100 (c) 111 (d) 101

58. What memory address range is NOT represented by chip #1 and chip #2 in figure? A_0 to A_{15} in this figure are the address lines and CS means Chip Select.



- (a) 0100 - 02FF (b) 1500 - 16FF (c) F900 - FAFF (d) F800 - F9FF

59. The output $y(t)$ of a linear time invariant system is related to its input $x(t)$ by the following equation: $y(t) = 0.5x(t - t_d + T) + x(t - t_d) + 0.5x(t - t_d - T)$. The filter transfer function $H(\omega)$ of such a system is given by

- (a) $(1 + \cos \omega T) e^{-j\omega t_d}$ (b) $(1 + 0.5 \cos \omega T) e^{-j\omega t_d}$
(c) $(1 + \cos \omega T) e^{j\omega t_d}$ (d) $(1 - 0.5 \cos \omega T) e^{-j\omega t_d}$

60. Match the following and choose the correct combination:

Group 1**Group 2**

- | | |
|------------------------------------|-------------------------------------------------------|
| E. continuous and aperiodic signal | 1. Fourier representation is continuous and aperiodic |
| F. continuous and periodic signal | 2. Fourier representation is discrete and aperiodic |
| G. discrete and aperiodic signal | 3. Fourier representation is continuous and periodic |
| H. discrete and periodic signal | 4. Fourier representation is discrete and periodic |

(a) E - 3 F - 2 G - 4 H - 1

(b) E - 1 F - 3 G - 2 H - 4

(c) E - 1 F - 2 G - 3 H - 4

(d) E - 2 F - 1 G - 4 H - 3

61. A signal $x(n) = \sin(\omega_0 n + \phi)$ is the input to a linear time-invariant system having a frequency response $H(e^{j\omega})$. If the output of the system is $Ax(n - n_0)$, then the most general form of $\angle H(e^{j\omega})$ will be

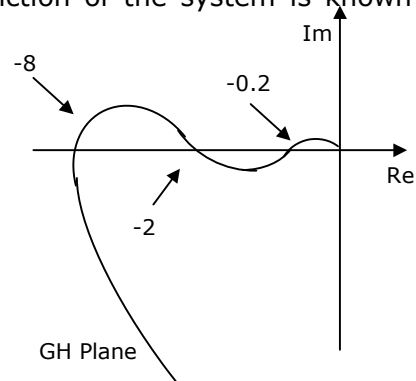
- (a) $-n_0\omega_0 + \beta$ for any arbitrary real β .
 (b) $-n_0\omega_0 + 2\pi k$ for any arbitrary integer k .
 (c) $n_0\omega_0 + 2\pi k$ for any arbitrary integer k .
 (d) $-n_0\omega_0 + \phi$.

62. For a signal $x(t)$ the Fourier transform is $X(f)$. Then the inverse Fourier transform of $X(3f + 2)$ is given by

(a) $\frac{1}{2}x\left(\frac{1}{2}\right)e^{j3\pi t}$ (b) $\frac{1}{3}x\left(\frac{1}{3}\right)e^{-\frac{j4\pi t}{3}}$ (c) $3x(3t)e^{-j4\pi t}$ (d) $x(3t + 2)$

63. The polar diagram of a conditionally stable system for open loop gain $K=1$ is shown in figure. The open loop transfer function of the system is known to be stable. The closed loop system is stable for

- (a) $K < 5$ and $\frac{1}{2} < K < \frac{1}{8}$
 (b) $K < \frac{1}{8}$ and $\frac{1}{2} < K < 5$
 (c) $K < \frac{1}{8}$ and $5 < K$
 (d) $K > \frac{1}{8}$ and $K < 5$



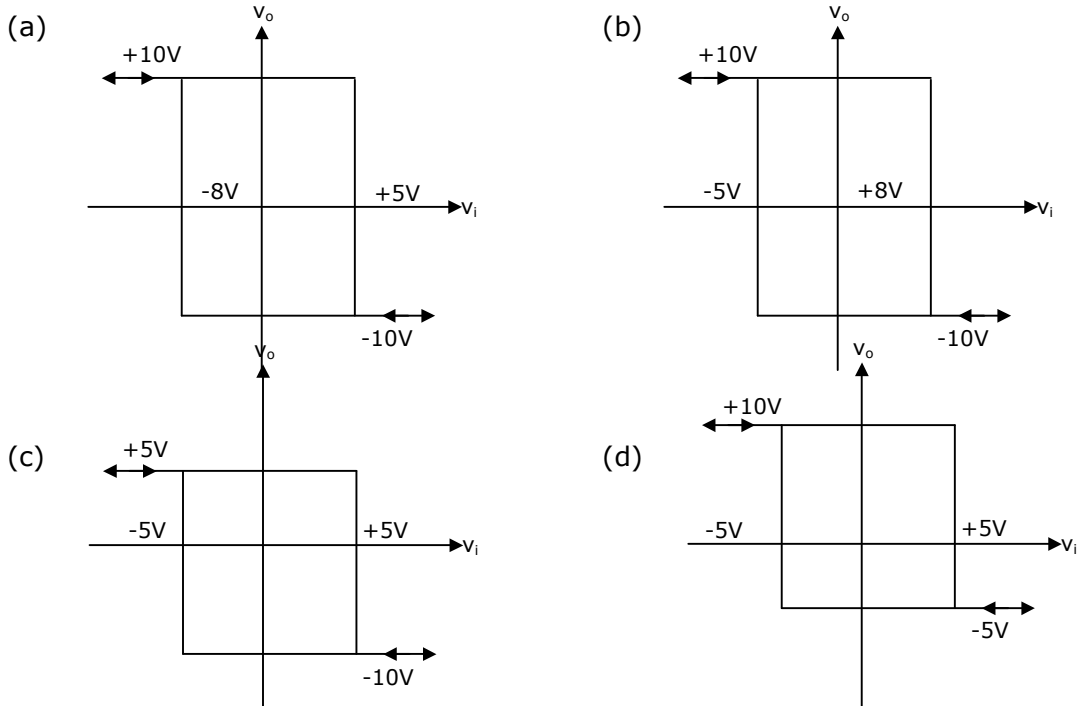
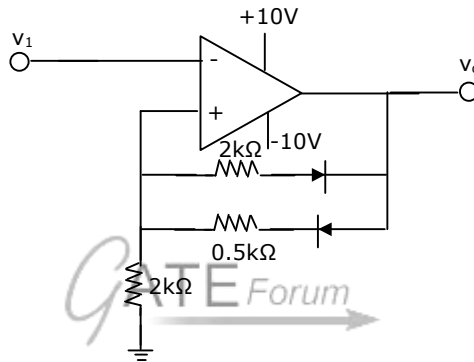
64. In the derivation of expression for peak percent overshoot,

$$M_p = \exp\left(\frac{-\pi\xi}{\sqrt{1-\xi^2}}\right) \times 100\%$$

which one of the following conditions is NOT required?

- (a) System is linear and time invariant.
- (b) The system transfer function has a pair of complex conjugate poles and no zeroes.
- (c) There is no transportation delay in the system.
- (d) The system has zero initial conditions.

65. Given the ideal operational amplifier circuit shown in figure indicate the correct transfer characteristics assuming ideal diodes with zero cut-in voltage.



66. A ramp input applied to an unity feedback system results in 5% steady state error. The type number and zero frequency gain of the system are respectively.

(a) 1 and 20 (b) 0 and 20 (c) 0 and $\frac{1}{20}$ (d) 1 and $\frac{1}{20}$

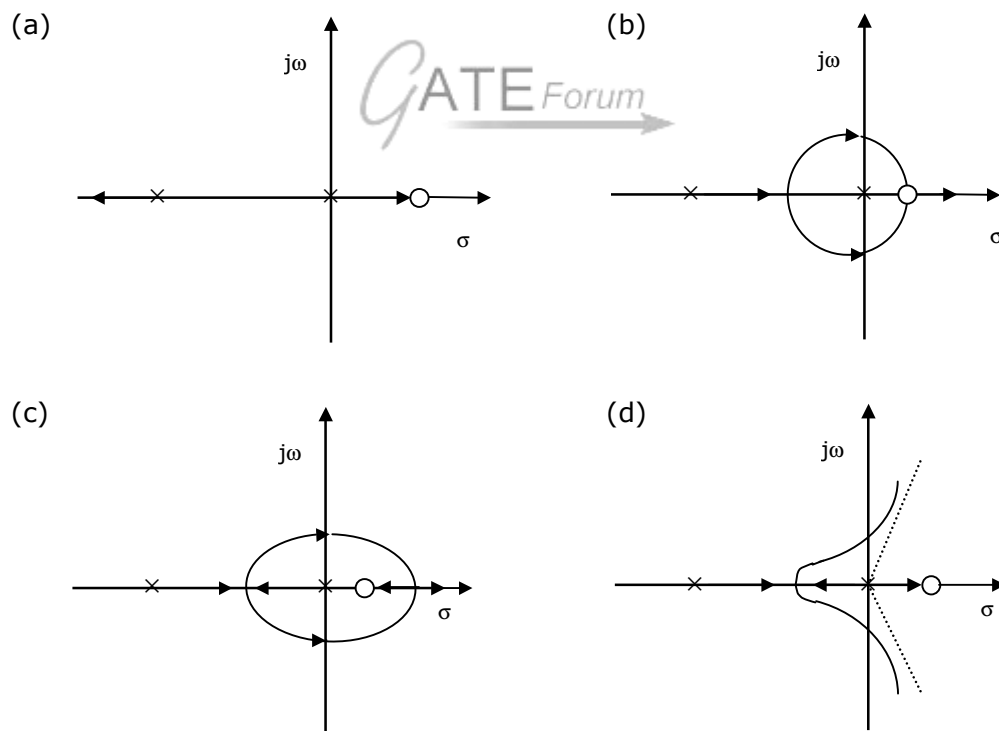
67. A double integrator plant, $G(s) = \frac{K}{s^2}$, $H(s) = 1$ is to be compensated to achieve the damping ratio $\xi = 0.5$, and an undamped natural frequency, $\omega_n = 5$ rad/s. Which one of the following compensator $G_c(s)$ will be suitable?

(a) $\frac{s+3}{s+9.9}$ (b) $\frac{s+9.9}{s+3}$ (c) $\frac{s-6}{s+8.33}$ (d) $\frac{s+6}{s}$

68. An unity feedback system is given as

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

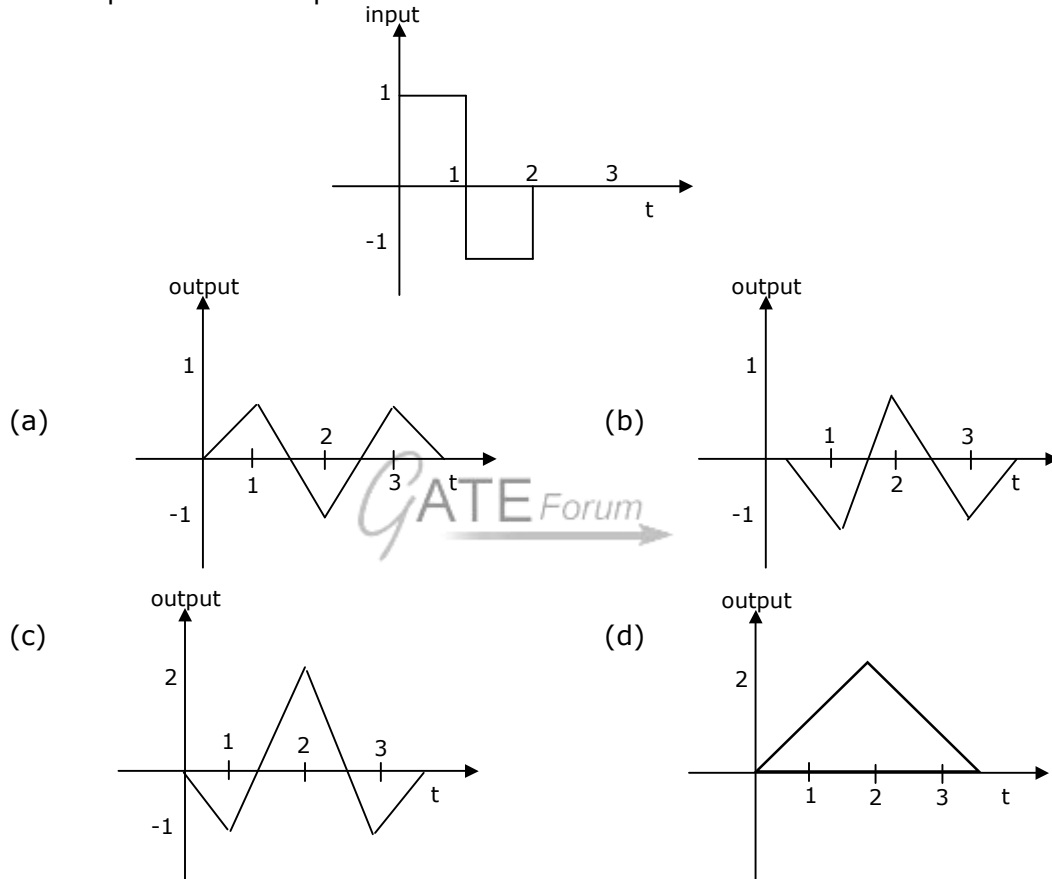
Indicate the correct root locus diagram.



69. A MOS capacitor made using p type substrate is in the accumulation mode. The dominant charge in the channel is due to the presence of

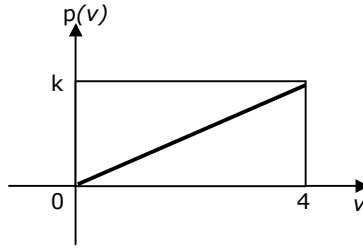
(a) holes (b) electrons
(c) positively charged ions (d) negatively charged ions

70. A device with input $x(t)$ and output $y(t)$ is characterized by: $y(t) = x^2(t)$. An FM signal with frequency deviation of 90 kHz and modulating signal bandwidth of 5 kHz is applied to this device. The bandwidth of the output signal is
 (a) 370 kHz (b) 190 kHz (c) 380 kHz (d) 95 kHz
71. A signal as shown in figure is applied to a matched filter. Which of the following does represent the output of this matched filter?

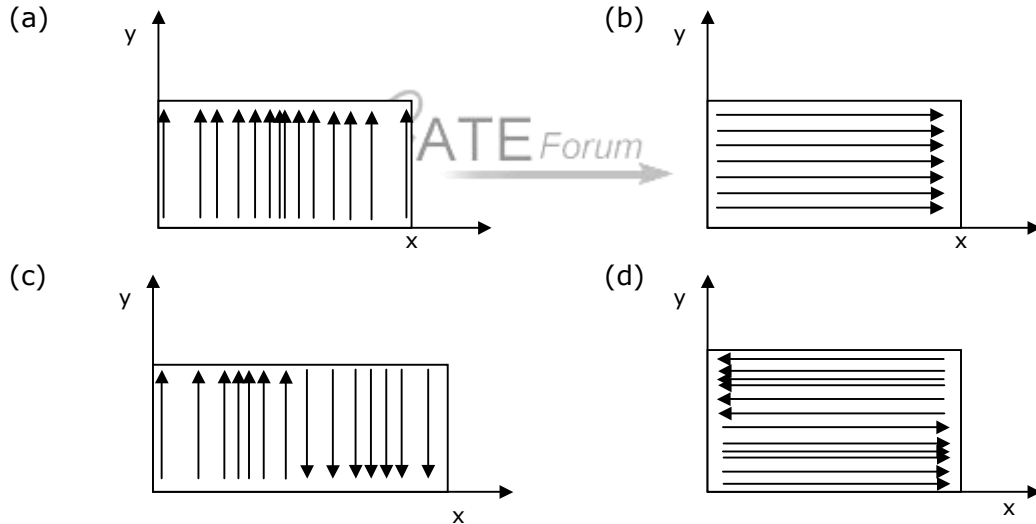


72. Noise with uniform power spectral density of N_0W / Hz is passed through a filter $H(\omega) = 2 \exp(-j\omega t_d)$ followed by an ideal low pass filter of bandwidth B Hz. The output noise power in Watts is
 (a) $2N_0B$ (b) $4N_0B$ (c) $8N_0B$ (d) $16N_0B$
73. A carrier is phase modulated (PM) with frequency deviation of 10 kHz by a single tone frequency of 1 kHz. If the single tone frequency is increased to 2 kHz, assuming that phase deviation remains unchanged, the bandwidth of the PM signal is
 (a) 21 kHz (b) 22 kHz (c) 42 kHz (d) 44 kHz

74. An output of a communication channel is a random variable v with the probability density function as shown in figure. The mean square value of v is

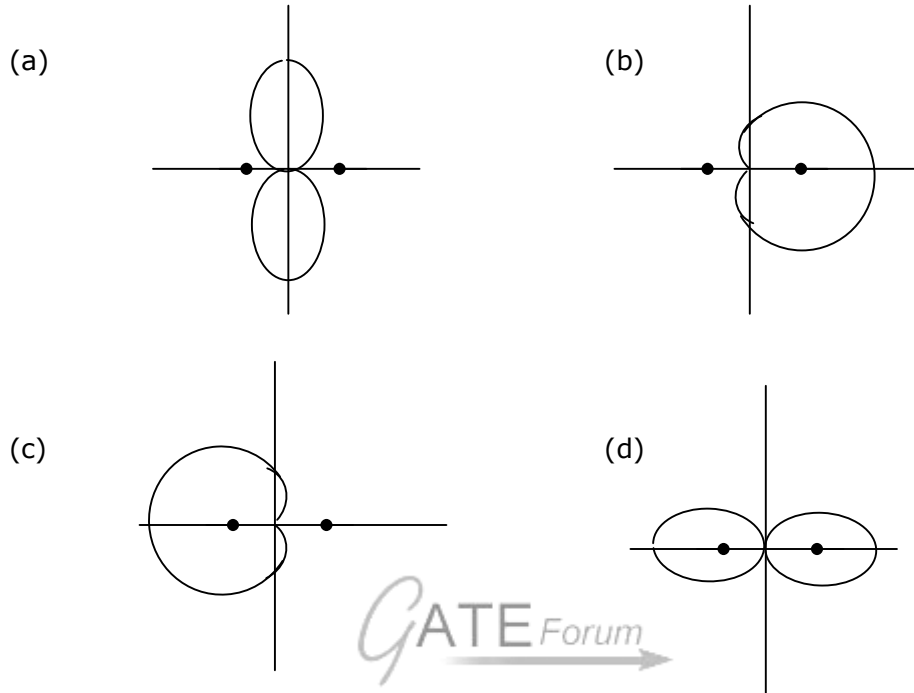


- (a) 4 (b) 6 (c) 8 (d) 9
75. Which one of the following does represent the electric field lines for the TE_{02} mode in the cross-section of a hollow rectangular metallic waveguide?



76. Characteristic impedance of a transmission line is 50Ω . Input impedance of the open circuited line is $Z_{oc} = 100 + j150 \Omega$. When the transmission line is short-circuited the value of the input impedance will be
- (a) 50Ω (b) $100 + j150 \Omega$
(c) $7.69 + j11.54 \Omega$ (d) $7.69 - j11.54 \Omega$

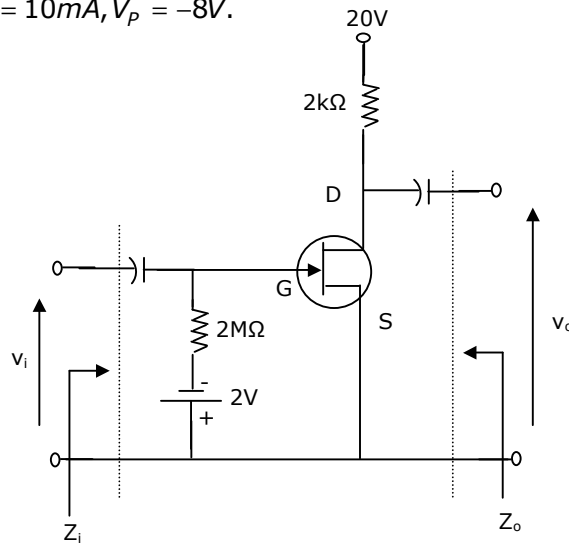
77. Two identical and parallel dipole antennas are kept apart by a distance of $\frac{\lambda}{4}$ in the H-plane. They are fed with equal currents but the right most antenna has a phase shift of $+90^\circ$. The radiation pattern is given as



Common Data Questions:

Common Data for questions 78, 79, 80:

Given $r_d = 20k\Omega, I_{DSS} = 10mA, V_p = -8V$.



78. Z_i and Z_o of the circuit are respectively
- (a) $2\text{ M}\Omega$ and $2\text{ k}\Omega$ (b) $2\text{ M}\Omega$ and $\frac{20}{11}\text{ k}\Omega$
(c) Infinity and $2\text{ k}\Omega$ (d) Infinity and $\frac{20}{11}\text{ k}\Omega$
79. I_D and I_{DS} under DC conditions are respectively
- (a) 5.625 mA and 8.75 V (b) 7.500 mA and 5.00 V
(c) 4.500 mA and 11.00 V (d) 6.250 mA and 7.50 V
80. Transconductance in milli-Siemens (mS) and voltage gain of the amplifier are respectively
- (a) 1.875 mS and 3.41 (b) 1.875 mS and -3.41
(c) 3.3 mS and -6 (d) 3.3 mS and 6

Linked Answer Questions: Q.81a to Q.85b carry two marks each.

Statement for Linked Answer Questions 81a & 81b:

Consider an 8085-microprocessor system.

81. (A) The following program starts at location 0100H.

```
LXI SP, 00FF
LXI H, 0701
MVI A, 20H
SUB M
```

The content of accumulator when the program counter reaches 0109H is

- (a) 20H (b) 02H (c) 00H (d) FFH

- (B) If in addition following code exists from 0109H onwards.

```
ORI 40H
ADD M
```

What will be the result in the accumulator after the last instruction is executed?

- (a) 40H (b) 20H (c) 60H (d) 42H

Statement for Linked Answer Questions 82a & 82b:

The open loop transfer function of a unity feedback is given by $G(s) = \frac{3e^{-2s}}{s(s+2)}$.

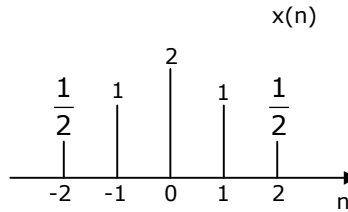
82. (A) The gain and phase crossover frequencies in rad/sec are, respectively
- (a) 0.632 and 1.26 (b) 0.632 and 0.485
(c) 0.485 and 0.632 (d) 1.26 and 0.632

(B) The reflection coefficient is given by

- (a) -0.6 (b) -1 (c) 0.6 (d) 0

Statement for Linked Answer Questions 85a & 85b:

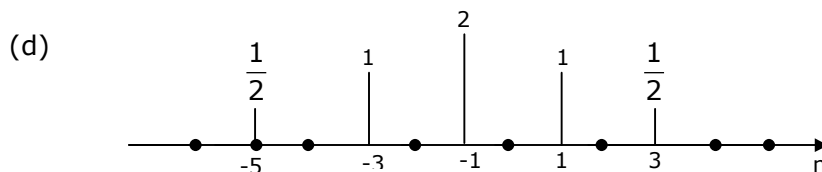
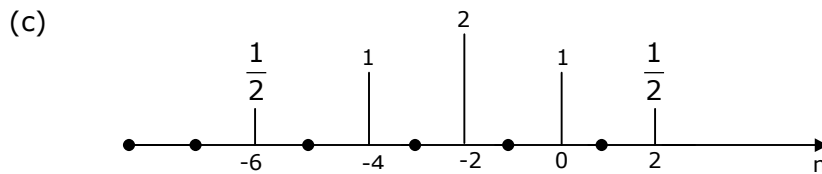
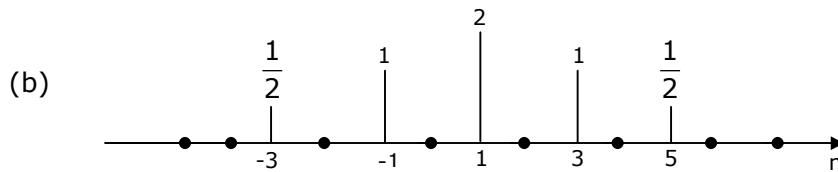
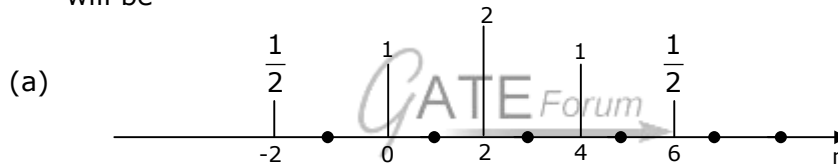
A sequence $x(n)$ has non-zero values as shown in figure.



85. (A) The sequence

$$y(n) = \begin{cases} x\left(\frac{n}{2} - 1\right) & \text{for } n \text{ even} \\ 0 & \text{for } n \text{ odd} \end{cases}$$

will be



(B) The Fourier transform of $y(2n)$ will be

- (a) $e^{-j2\omega} [\cos 4\omega + 2 \cos 2\omega + 2]$ (b) $[\cos 2\omega + 2 \cos \omega + 2]$
(c) $e^{-j\omega} [\cos 2\omega + 2 \cos \omega + 2]$ (d) $e^{j2\omega} [\cos 2\omega + 2 \cos \omega + 2]$