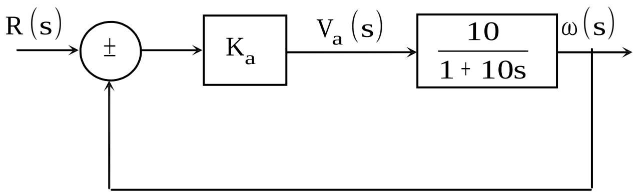
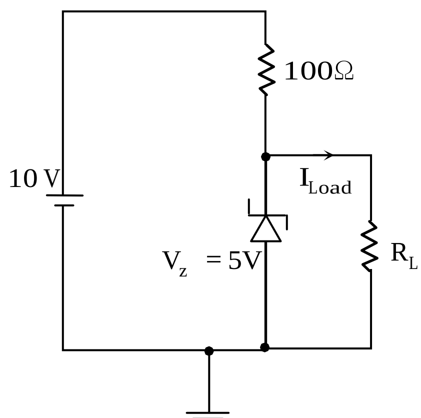
29. The open-loop transfer function of a dc motor is given as $\frac{\omega(s)}{V_a(s)} = \frac{10}{1+10s}$, when connected in feedback as shown below, the approximate value of K_a that will reduce the time constant of the closed loop system by one hundred times as compared to that of the open-loop system is



(A) 1 (B) 5 (C) 10 (D) 100

Answer: (C)

30. In the circuit shown below, the knee current of the ideal Zener diode is 10mA. To maintain 5V across R_L, the minimum value of R_L in Ω and the minimum power rating of the Zener diode in mW, respectively, are



(A) 125 and 125 (B) 125 and 250
(C) 250 and 125 (D) 250 and 250

Answer: (B)

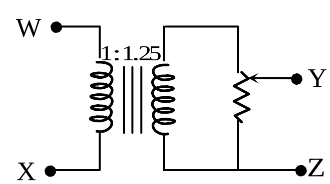
31. The following arrangement consists of an ideal transformer and an attenuator which attenuates by a factor of 0.8 An ac voltage $V_{wx1} = 100V$ is applied across WX to get an open circuit voltage V_{YZ1} across YZ. Next, an ac voltage $V_{YZ2} = 100V$ is applied across YZ to get an open circuit voltage V_{WX2} across WX. Then, V_{YZ1}/V_{WX1}, V_{WX2}/V_{YZ2} are respectively.

(A) 125 / 100 and 80 / 100

(B) 100 / 100 and 80 / 100

(C) 100 / 100 and 100 / 100

(D) 80 / 100 and 80 / 100



Answer: (C)

32. Two magnetically uncoupled inductive coils have Q factors q_1 and q_2 at the chosen operating frequency. Their respective resistances are R_1 and R_2. When connected in series, their effective Q factor at the same operating frequency is

(A) $q_1 + q_2$ (B) $(1/q_1) + (1/q_2)$

(C) $(q_1R_1 + q_2R_2)/(R_1 + R_2)$ (D) $(q_1R_2 + q_2R_1)/(R_1 + R_2)$

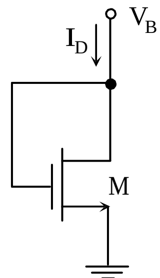
Answer: (C)

33. The impulse response of a continuous time system is given by $h(t) = \delta(t-1) + \delta(t-3)$. The value of the step response at $t = 2$ is

(A) 0 (B) 1 (C) 2 (D) 3

Answer: (B)

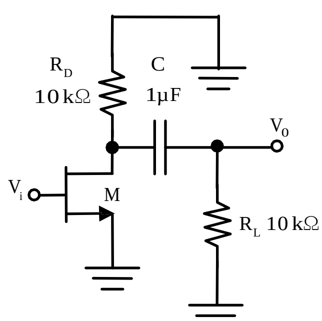
34. The small-signal resistance $(i.e., dV_B / dI_D)$ in $k\Omega$ offered by the n-channel MOSFET M shown in the figure below, at a bias point of $V_B = 2\,V$ is (device data for M: device transconductance parameter $k_N = \mu_n C'_{ox}(W/L) = 40\mu A/V^2$, threshold voltage $V_{TN} = 1\,V$, and neglect body effect and channel length modulation effects)



(A) 12.5 (B) 25 (C) 50 (D) 100

Answer: (B)

35. The ac schematic of an NMOS common-source stage is shown in the figure below, where part of the biasing circuits has been omitted for simplicity. For the n-channel MOSFET M, the transconductance $g_m = 1\,mA/V$, and body effect and channel length modulation effect are to be neglected. The lower cutoff frequency in Hz of the circuit is approximately at



(A) 8 (B) 32 (C) 50 (D) 200

Answer: (C)

|EC-GATE-2013 PAPER|

36. A system is described by the differential equation $\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 6y(t) = x(t)$.

Let x(t) be a rectangular pulse given by

$$x(t) = \begin{cases} 1 & 0 < t < 2 \\ 0 & \text{otherwise} \end{cases}$$

Assuming that y(0)=0 and $\frac{dy}{dt} = 0$ at $t = 0$, the Laplace transform of y(t) is

(A) $\frac{e^{-2s}}{s(s+2)(s+3)}$

(B) $\frac{1-e^{-2s}}{s(s+2)(s+3)}$

(C) $\frac{e^{-2s}}{(s+2)(s+3)}$

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

Answer: (B)

37. A system described by a linear, constant coefficient, ordinary, first order differential equation has an exact solution given by y(t) for t>0, when the forcing function is x(t) and the initial condition is y(0). If one wishes to modify the system so that the solution becomes -2y(t) for t>0, we need to

(A) change the initial condition to –y(0) and the forcing function to 2x(t)

(B) change the initial condition to $2y(0)$ and the forcing function to $-x(t)$

(C) change the initial condition to $j\sqrt{2}y(0)$ and the forcing function to $j\sqrt{2}x(t)$

(D) change the initial condition to -2y(0) and the forcing function to $-2x(t)$

Answer: (D)

38. Consider two identically distributed zero-mean random variables U and V. Let the cumulative distribution functions of U and 2V be F(x) and G(x) respectively. Then, for all values of x

(A) $F(x) - G(x) \le 0$

(B) $F(x) - G(x) \ge 0$

(C) $(F(x) - G(x)).x \le 0$

(D) $(F(x) - G(x)).x \ge 0$

Answer: (D)

39. The DFT of vector $\begin{bmatrix} a & b & c & d \end{bmatrix}$ is the vector $\begin{bmatrix} \alpha & \beta & \gamma & \delta \end{bmatrix}$. Consider the product

$$\begin{bmatrix} p & q & r & s \end{bmatrix} = \begin{bmatrix} a & b & c & d \end{bmatrix} \begin{bmatrix} a & b & c & d \\ d & a & b & c \\ c & d & a & b \\ b & c & d & a \end{bmatrix}$$

The DFT of the vector $\begin{bmatrix} p & q & r & s \end{bmatrix}$ is a scaled version of

(A) $\begin{bmatrix} \alpha^2 & \beta^2 & \gamma^2 & \delta^2 \end{bmatrix}$

(B) $\begin{bmatrix} \sqrt{\alpha} & \sqrt{\beta} & \sqrt{\gamma} & \sqrt{\delta} \end{bmatrix}$

(C) $\begin{bmatrix} \alpha+\beta & \beta+\delta & \delta+\gamma & \gamma+\alpha \end{bmatrix}$

(D) $\begin{bmatrix} \alpha & \beta & \gamma & \delta \end{bmatrix}$

Answer: (A)

9

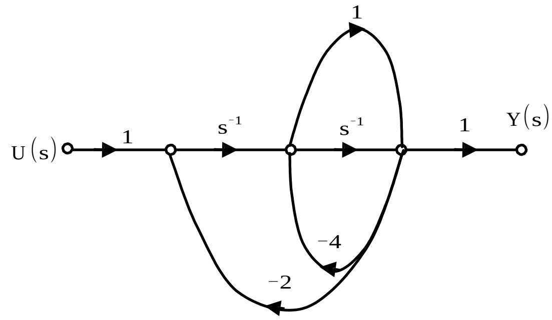
40. The signal flow graph for a system is given below. The transfer function $\frac{Y(s)}{U(s)}$ for this system is

(A) $\frac{s+1}{5s^2+6s+2}$

(B) $\frac{s+1}{s^2+6s+2}$

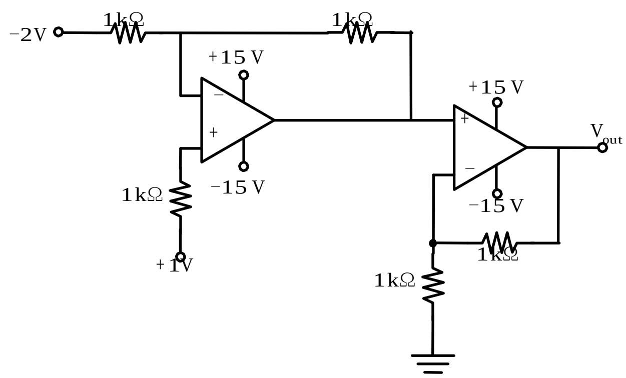
(C) $\frac{s+1}{s^2+4s+2}$

(D) $\frac{1}{5s^2+6s+2}$



Answer: (A)

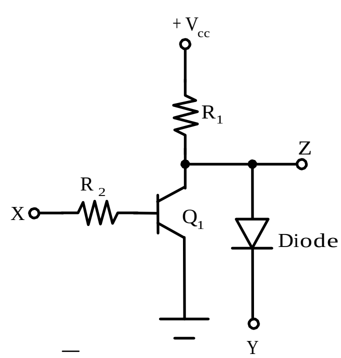
41. In the circuit shown below the op-amps are ideal. The V_{out} in Volts is



(A) 4 (B) 6 (C) 8 (D) 10

Answer: (C)

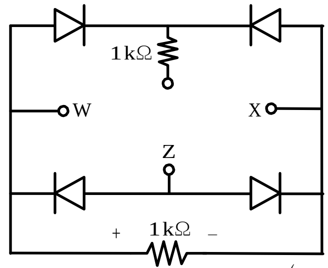
42. In the circuit shown below, Q_1 has negligible collector-to-emitter saturation voltage and the diode drops negligible voltage across it under forward bias. If V_{cc} is $+5V$, X and Y are digital signals with 0 V as logic 0 and V_{CC} as logic 1, then the Boolean expression for Z is



(A) XY (B) $\overline{X}Y$ (C) $X\overline{Y}$ (D) $\overline{XY}$

Answer: (B)10

43. A voltage $1000\sin\omega t$ Volts is applied across YZ. Assuming ideal diodes, the voltage measured across WX in Volts, is



(A) $\sin\omega t$

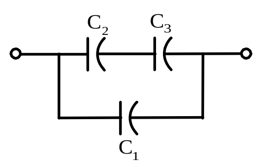
(B) $\left(\sin\omega t + |\sin\omega t|\right)/2$

(C) $\left(\sin\omega t - |\sin\omega t|\right)/2$

(D) 0 for all t

Answer: (D)

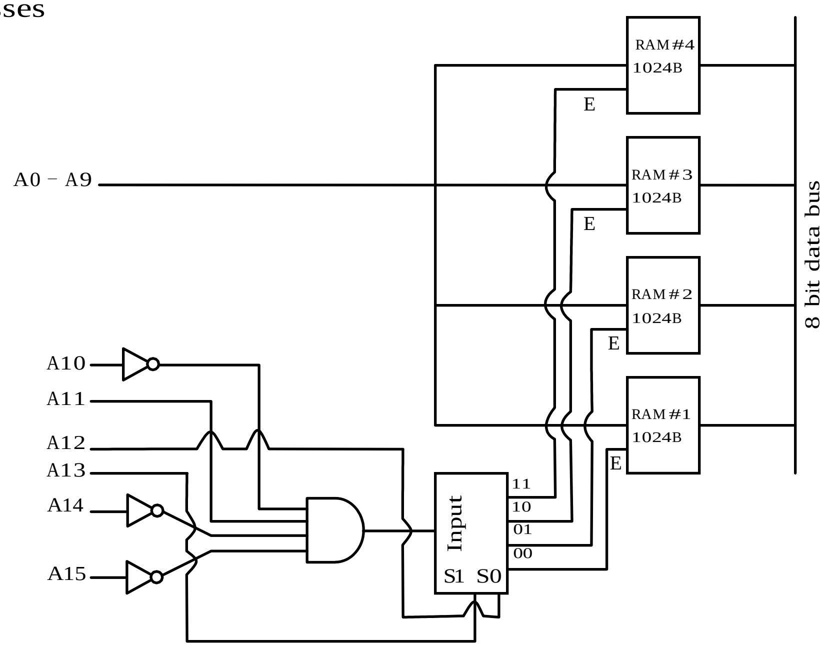
44. Three capacitors C_1, C_2 and C_3 whose values are $10\mu F$, $5\mu F$, and $2\mu F$ respectively, have breakdown voltages of 10V, 5V, and 2V respectively. For the interconnection shown below, the maximum safe voltage in Volts that can be applied across the combination, and the corresponding total charge in μC stored in the effective capacitance across the terminals are respectively.



(A) 2.8 and 36 (B) 7 and 119 (C) 2.8 and 32 (D) 7 and 80

Answer: (C)

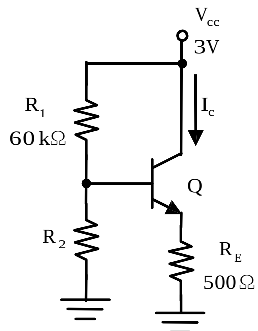
45. There are four chips each of 1024 bytes connected to a 16 bit address bus as shown in the figure below. RAMs 1,2,3 and 4 respectively are mapped to addresses



(A) 0C00H – 0FFFH, 1C00H – 1FFFH, 2C00H – 2FFFH, 3C00H – 3FFFH
(B) 1800H – 1FFFH, 2800H – 2FFFH, 3800H – 3FFFH, 4800H – 4FFFH (C)
0500H – 08FFH, 1500H – 18FFH, 3500H – 38FFH, 5500H – 58FFH (D)
0800H – 0BFFH, 1800H – 1BFFH, 2800H – 2BFFH, 3800H – 3BFFH

Answer: (D)

46. In the circuit shown below, the silicon npn transistor Q has a very high value of β. The required value of R_2 in kΩ to produce $I_C = 1\,mA$ is



(A) 20 (B) 30 (C) 40 (D) 50

Answer: (C)

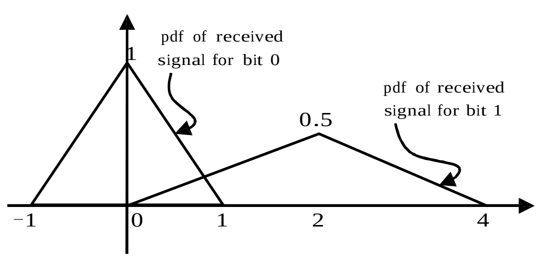
47. Let U and V be two independent and identically distributed random variables such that $P(U = +1) = P(U = -1) = \frac{1}{2}$. The entropy H(U + V) in bits is

(A) 3/4 (B) 1 (C) 3/2 (D) $\log_2 3$

Answer: (C)

Common Data Questions: 48 & 49

Bits 1 and 0 are transmitted with equal probability. At the receiver, the pdf of the respective received signals for both bits are as shown below.



48. If the detection threshold is 1, the BER will be

(A) $\frac{1}{2}$ (B) $\frac{1}{4}$ (C) $\frac{1}{8}$ (D) $\frac{1}{16}$

Answer: (D)