RATHI CLASSES

आजीवनम् ज्ञानवर्धनम्

New mantra for Success

CPT-3

EDC, Analog Circuits and Communication Systems

(Electronics and Related Branch & Electrical Engineering Branch)

Duration ~ 1:00 Hour **Maximum Marks ~ 50**

Read the following instructions carefully

1. This question paper contains 30 objective types questions carrying 50 marks. Q.1 to Q.10 (10 Questions) carry **ONE MARK** and Q.11 to Q.30 (20 Questions) and will carry **TWO MARKS** each.
2. Attempt all the questions.
3. Questions must be answered on **Objective Response Sheet (ORS)** by marking (A, B, C, D) using **Blue or Black ball pen** against the question number on the left hand side of **(ORS).** Each question has only one correct answer.
4. For **1 mark** multiple-choice questions, **1/3 marks** will be deducted for a wrong answer. Likewise, for **2 marks** multiple-choice questions, **2/3 marks** will be deducted for a wrong answer.

   There is NO negative marking for numerical answer type questions.
5. Write your registration number, your name and name of the examination centre at the specified locations on the right half of the **ORS**.
6. Calculator is allowed in the examinatinon hall.
7. Charts, graph sheets or tables are NOT allowed in the examination hall.
8. Rough work can be done on the question paper itself. Additionally blank pages are given at the end of the question paper for rough work.
9. This question paper contains 16 printed pages including 4 pages for Rough Work. Please check all pages and report, if there is any discrepancy.

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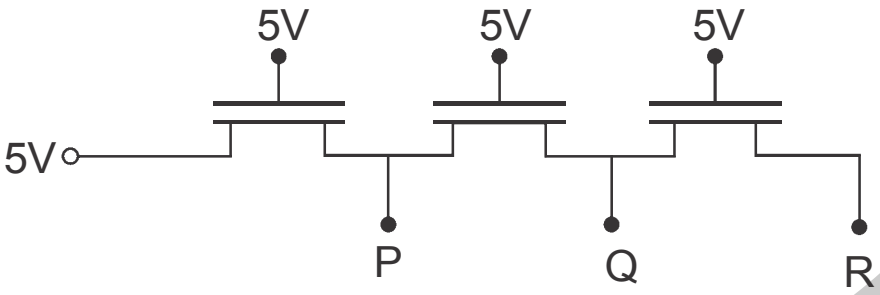
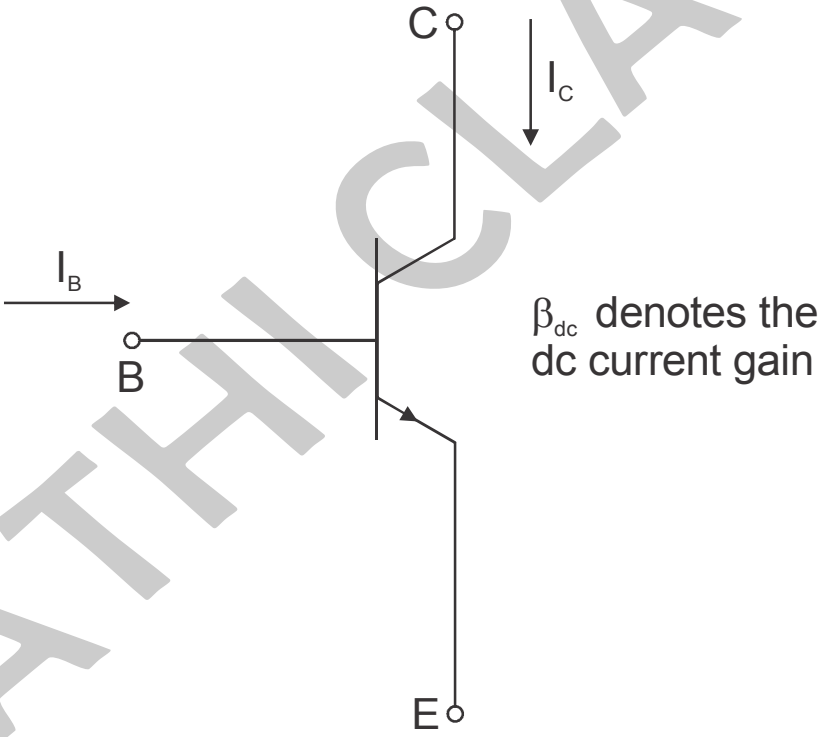
Q.1 In the following circuit employing pass transistor logic, all NMOS transistors are identical with a threshold voltage of 1 V. Ignoring the body-effect, the output voltages at P, Q and R are



(a) 4 V, 3 V, 2 V (b) 5 V, 5 V, 5 V

(c) 4 V, 4 V, 4 V (d) 5 V, 4 V, 3 V

Q.2 If the transistor in the figure is in saturation, then



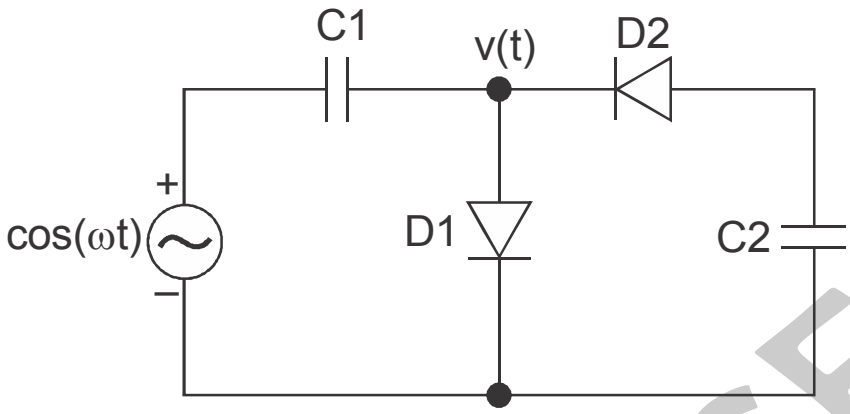
(a) I_C is always equal to $\beta_{dc} I_B$

(b) I_C is always equal to $-\beta_{dc} I_B$

(c) I_C is greater than or equal to $\beta_{dc} I_B$

(d) I_C is less than or equal to $\beta_{dc} I_B$

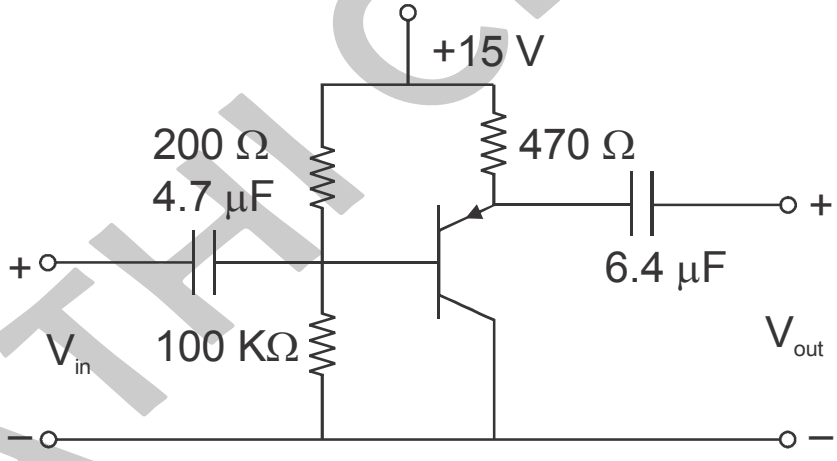
Q.3 The diodes and capacitors in the circuit shown are ideal. The voltage v(t) across the diode D1 is



(a) $\cos(\omega t)-1$ (b) $\sin(\omega t)$

(c) $1-\cos(\omega t)$ (d) Zero

Q.4 For the Amplifier circuit of figure. The transistor has a β of 800. The mid band voltage gain V_0/V_i of the circuit will be



(a) 0 (b) < 1

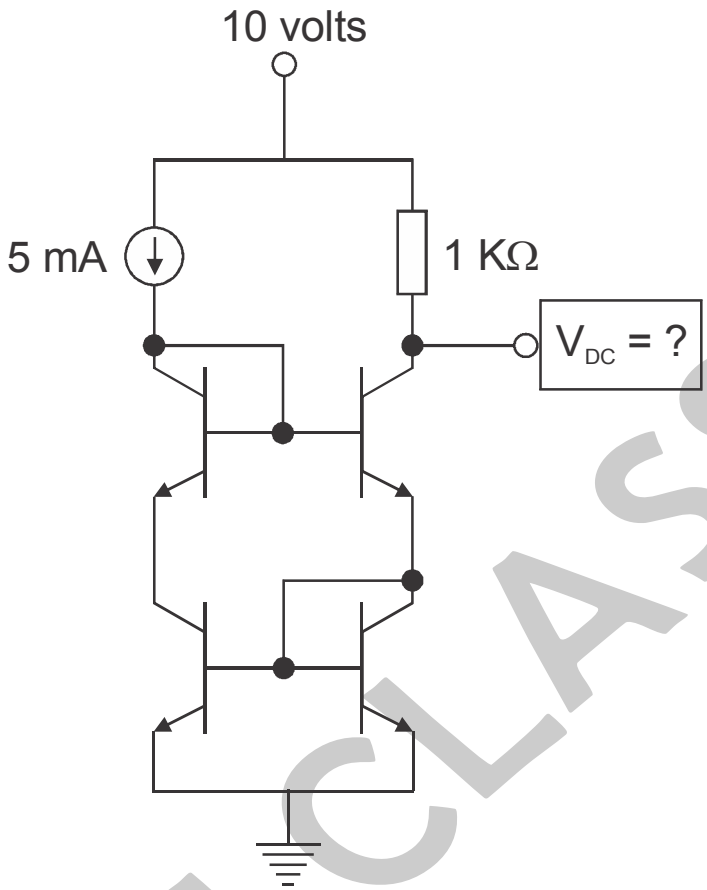
(c) ≈ 1 (d) 800

Q.5 In order to reduce the harmonic distortion in an Amplifier its dynamic range has to be.

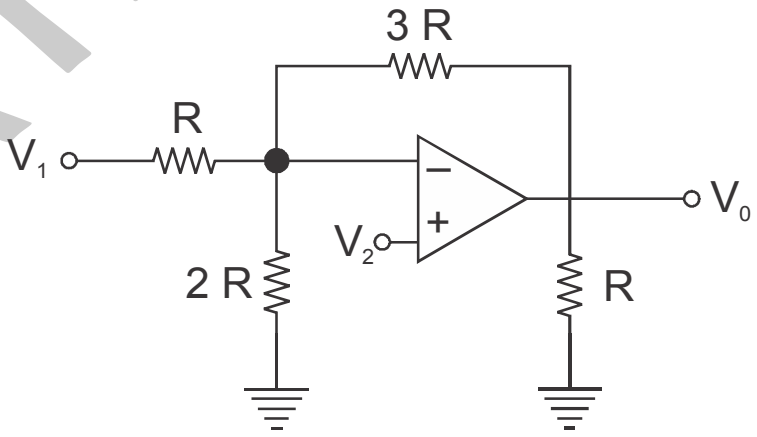
(a) Compressed (b) Uncompressed

(c) Either a or b (d) None

Q.6 In the figure all transistors are identical and have a high value of beta. The voltage V_{DC} is equal to _____.



Q.7 Assuming that the Op-amp in the circuit shown is ideal, V_0 is given by



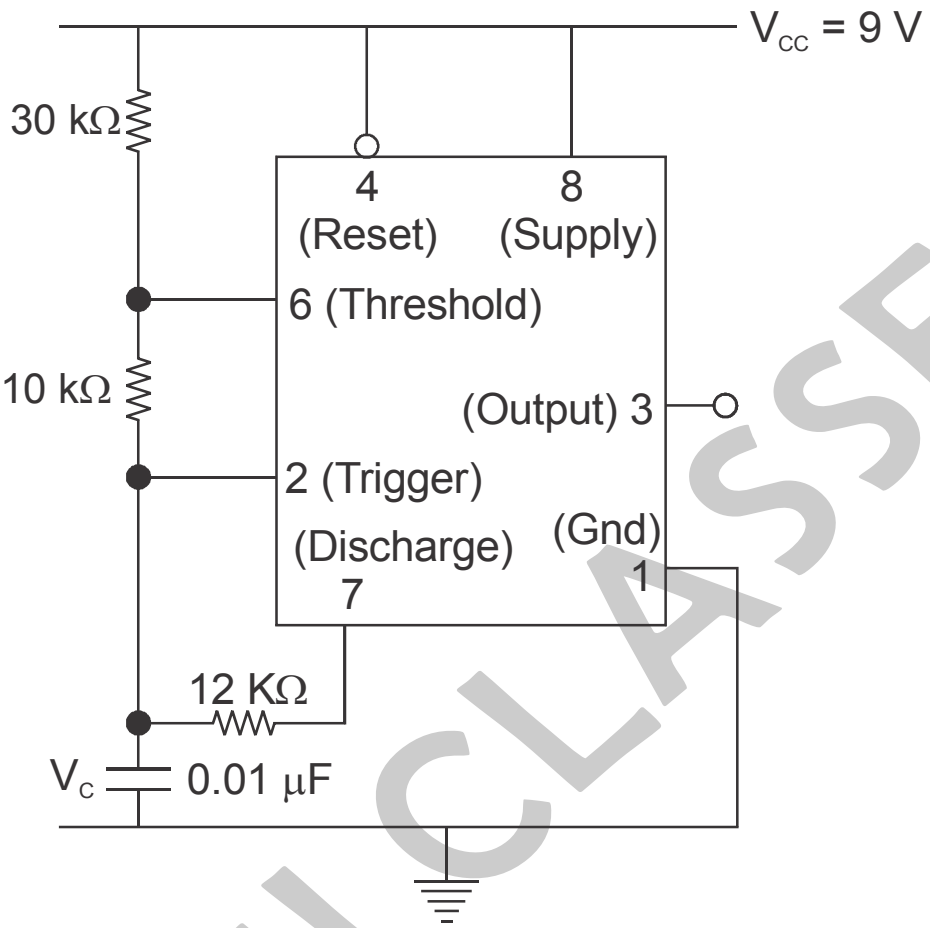
(a) $\frac{5}{2}V_1 - 3\,V_2$

(b) $2\,V_1 - \frac{5}{2}V_2$

(c) $-\frac{3}{2}V_1 + \frac{7}{2}V_2$

(d) $-3\,V_1 + \frac{11}{2}V_2$

Q.8 An astable multi-vibrator circuit using IC 555 timer is shown below. Assume that the circuit is oscillating steadily.



The voltage V_C across the capacitor varies between

(a) 3 V to 5 V (b) 3 V to 6 V

(c) 3.6 V to 6 V (d) 3.6 to 5 V

Q.9 A bipolar junction transistor is operating in the active region with a collector current of 1 mA. Assuming that the β of the transistor is 100 and the thermal voltage (V_T) is 25 mV, the transconductance (g_m) and the the input resistance (r_π) of the transistor in the common emitter configuration, are

(a) g_m = 25mA/V and $r_\pi = 15.625\ k\Omega$

(b) g_m = 40mA/V and $r_\pi = 4.0\ k\Omega$

(c) g_m = 25mA/V and $r_\pi = 2.5\ k\Omega$

(d) g_m = 40mA/V and $r_\pi = 2.5\ k\Omega$

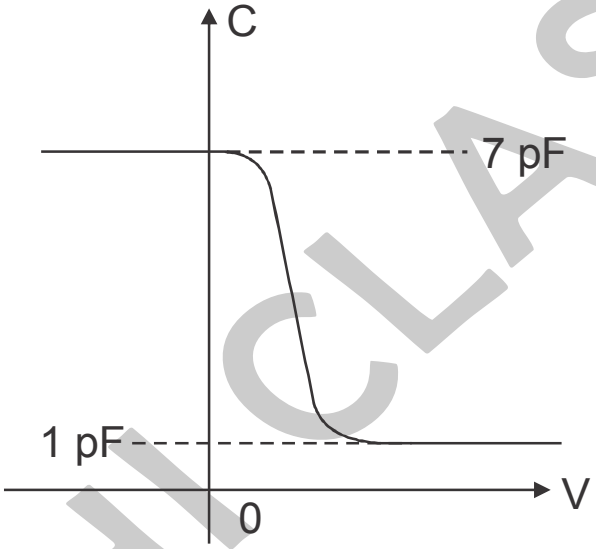
Q.10 Which of the following modulation technique is different from others

(a) BPSK (b) MSK

(c) QPSK (d) DPSK

Common Data Question 11, 12 and 13:

The figure shows the high-frequency capacitance voltage (C-V) characteristics of a Metal/SiO_2/silicon (MOS) capacitor having an area of 1×10^{-4} cm^2. Assume that the permittivities $(\varepsilon_0\varepsilon_r)$ of silicon and SiO_2 are 1×10^{-12} F/cm and 3.5×10^{-13} F/cm respectively.



Q.11 The gate oxide thickness in the MOS capacitor is

(a) 50 nm (b) 143 nm

(c) 350 nm (d) 1 μm

Q.12 The maximum depletion layer width in silicon is

(a) 0.143 μm (b) 0.857 μm

(c) 1 μm (d) 1.143 μm

Q.13 Consider the following statements about the C-V characteristics plot

S_1 : The MOS capacitor has as n-type substrate.

S_2 : If positive charges are introduced in the oxide, the C-V plot will shift to the left.

Then which of the following is true?

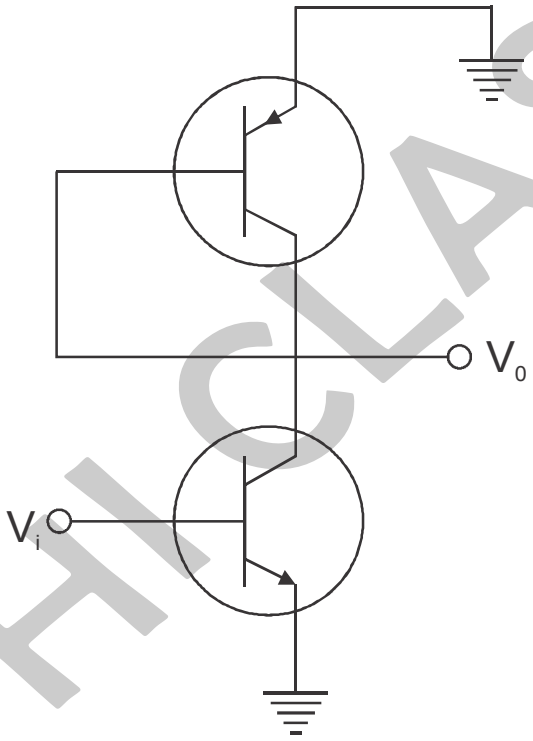
(a) Both S_1 and S_2 are true

(b) S_1 is true and S_2 is false

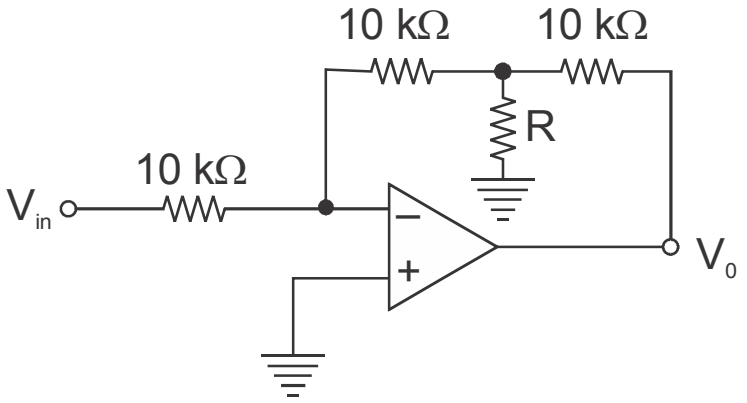
(c) S_1 is false and S_2 is true

(d) Both S_1 and S_2 are false

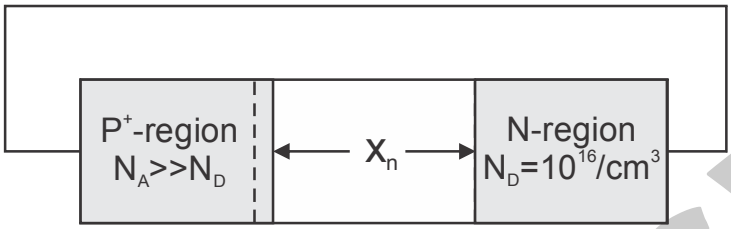
Q.14 In the AC equivalent circuit shown, the two BJTs are biased in active region and have identical parameters with $\beta >> 1$. The open circuit small signal voltage gain is approximately _____.



Q.15 In the circuit shown, assume that the Op-amp is ideal. If the gain (V_0/V_{in}) is – 12, the value of R $(\text{in k}\Omega)$ is ____.



Q.16 Consider an abrupt PN junction (at T = 300 K) shown in the figure. The depletion region width x_n on the N-side of the junction is 0.2 μm and the permittivity of silicon $(\in_{si})$ is 1.044 × 10^{-12} F/cm. At the junction, the approximate value of the peak electric field (in kV/cm) is _____.

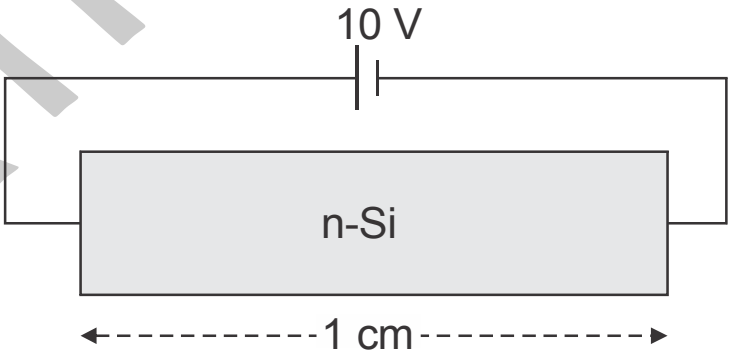


Q.17 The DC current gain (β) of a BJT is 50. Assuming that the emitter injection efficiency is 0.995, the base transport factor is

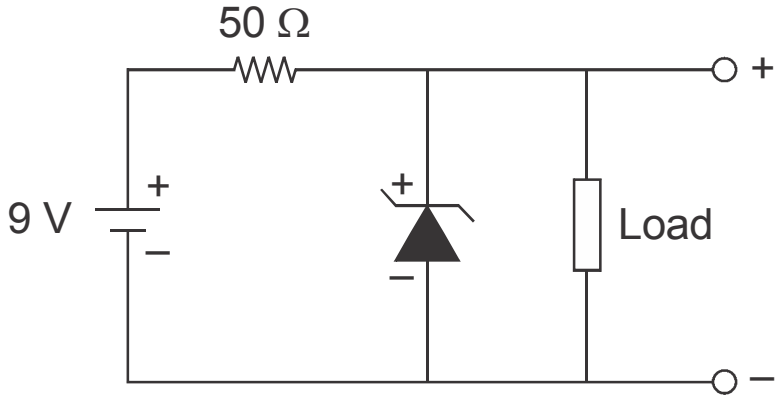
(a) 0.980 (b) 0.985

(c) 0.990 (d) 0.995

Q.18 A dc voltage of 10 V is applied across an n-type silicon bar having a rectangular cross-section and length of 1 cm as shown in figure. The donor doping concentration N_D and the mobility of electron μ_n are 10^{16} cm^{-3} and 1000 cm^2 V^{-1} s^{-1}, respectively. The average time $(\text{in } \mu s)$ taken by the electrons to move from one end of the bar to other end is _____.



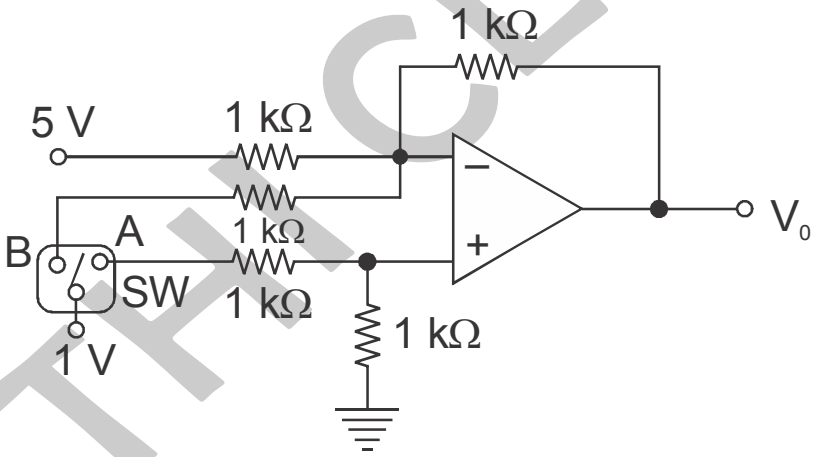
Q.19 A Zener diode in the circuit shown in below figure has a knee current of mA, and a maximum allowed power dissipation of 300 mW. What are the minimum and maximum load currents that can be drawn safely from the circuit, keeping the output voltage V_0 constant at 6 V?



(a) 0 mA, 180 mA (b) 5 mA, 110 mA

(c) 10 mA, 55 mA (d) 60 mA, 180 mA

Q.20 In the circuit shown, $V_0 = V_{0A}$ for switch SW in position A and $V_0 = V_{0B}$ for SW in position B. Assume that the Op-amp is ideal. The value of $\frac{V_{0B}}{V_{0A}}$ is _____.



Q.21 When a silicon diode having a doping concentration of $N_A = 9 \times 10^{16}$ cm^{-3} on p-side and $N_D = 1 \times 10^{16}$ cm^{-3} on n-side is reverse biased, the total depletion width is found to by 3 μm. Given that the permittivity of silicon is 1.04×10^{-12} F/cm, the depletion width on the p-side and the maximum electric field in the depletion region, respectively, are

(a) 2.7 μm and 2.3×10^5 V/cm

(b) 0.3 μm and 4.15×10^5 V/cm

(c) 0.3 μm and 0.42×10^5 V/cm

(d) 2.1 μm and 0.42×10^5 V/cm

Q.22 The function $f_{x,y}(x,y) = \begin{cases} be^{-(x+y)} & 0 < x < a \text{ and } 0 < y < \infty \\ 0 & \text{else where} \end{cases}$

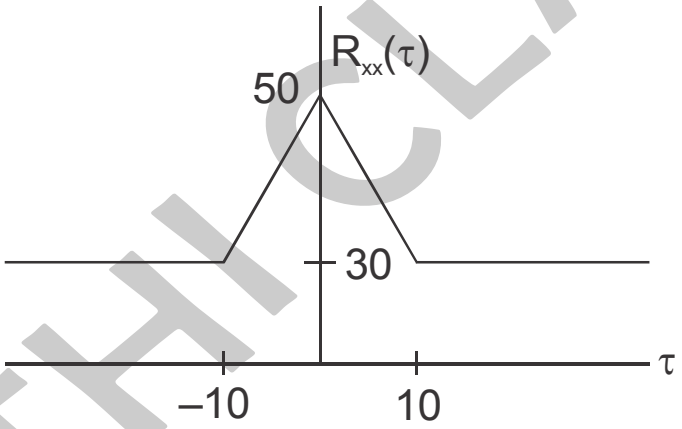
is a valid joint density function if b is

(a) $\frac{a^2}{1-e^{-a}}$ (b) $\frac{a}{1-e^{-a}}$

(c) $\frac{1}{1-e^{-a}}$ (d) None of these

Common Data Question for Q. 23 and Q.24

The auto correlation function of a stationary ergodic random process is shown below



Q.23 The mean value $E[x(t)]$ is

(a) 50 (b) $\sqrt{50}$

(c) 20 (d) $\sqrt{30}$

Q.24 The $E[x^2(t)]$ and variance σ_x^2 respectively

(a) 50, 20 (b) $\sqrt{10}$, 50

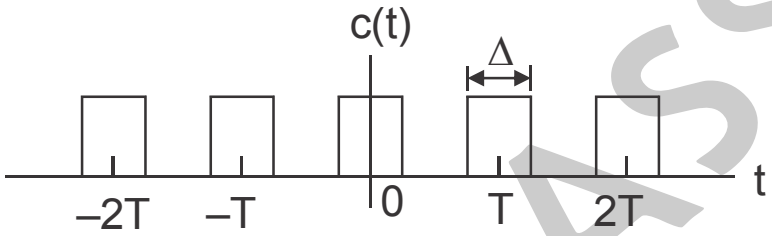
(c) $\sqrt{50}$, 70 (d) 50, 30

Q.25 A source has an alphabet set $\{m_0, m_1, m_2, m_3\}$ with corresponding probabilities {0.1, 0.2, 0.3, 0.4} the minimum required average code word length to represent this source for error free reconstruction is

(a) 0.3468 (b) 1.8464

(c) 2.9636 (d) 3.6936

Q.26 Consider a set of 10 signals $x_i(t)$, i = 1, 2, 3 ..... 10. Each signal is band limited to 1kHz. All 10 signals are to be time-division multiplexed after that each is multiplied by a carrier c(t) shown in figure. If the period T of c(t) is choosen to have the maximum allowable value. The largest value of Δ would be



(a) 5×10^{-3} sec (b) 5×10^{-4} sec

(c) 5×10^{-5} sec (d) 5×10^{-6} sec

Q.27 The minimum step-size required for a Delta-modulation, operating at 32 K samples/sec to track the signal (here u(t) is the unit step function)

$x(t) = 125t\,[u(t) - u(t-1)] + (250 - 125t)[u(t-1) - u(t-2)]$

the slope overload is avoided, would be

(a) 2^{-10} (b) 2^{-8}

(c) 2^{-6} (d) 3^{-4}

Q.28 Using the Huffman algorithm the average-code word length for the code with probabilities {0.1, 0.2, 0.3, 0.4} is _____.

Q.29 It is given that $c(t) = 5\cos 2\pi \times 10^6 t$, $m(t) = 6\cos 4\pi \times 10^3 t$. If c(t) and m(t) are used to generate FM such that maximum frequency deviation is 4 times to AM bandwidth find the coefficient of the term $\cos 2\pi\left(1014 \times 10^3 t\right)$, interms of the resulting FM expression.

(a) $5J_7(8)$ (b) $5J_8(7)$

(c) $5J_7(6)$ (d) $5J_6(8)$

Q.30 Match the followings

List-I

A. Coherent PSK

B. FSK (coherent, with 1-bit decoding)

C. DPSK

List-II

1. $Q\left(\sqrt{\frac{Eb}{N_0}}\right)$

2. $\frac{1}{2}\exp\left(-\frac{Eb}{N_0}\right)$

3. $Q\left(\sqrt{\frac{2Eb}{N_0}}\right)$

(a) A-1, B-2, C-3 (b) A-1, B-2, C-3

(c) A-3, B-1, C-2 (d) None

(End of the question paper)

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