Sl. No. 0063543   **A–HUF–P–VEB**

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

Paper—II

(Conventional)

Time Allowed : Three Hours	Maximum Marks : 200

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions.

There are SEVEN questions in the paper.

Candidates are required to attempt FIVE questions in all. Question No. 1 is compulsory.

Out of the remaining SIX questions, attempt any FOUR questions.

The number of marks carried by a question/part is indicated against it.

Unless otherwise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary and indicate the same clearly.

Neat sketches are to be drawn to illustrate answers, wherever required.

All parts and sub-parts of a question are to be attempted together in the answer book.

Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly.

Answers must be written in ENGLISH only.

Any page or portion of the page left blank in the answer book must be clearly struck off.

1. (a) In the circuit shown below, find the ratio I_o/I_{REF} :
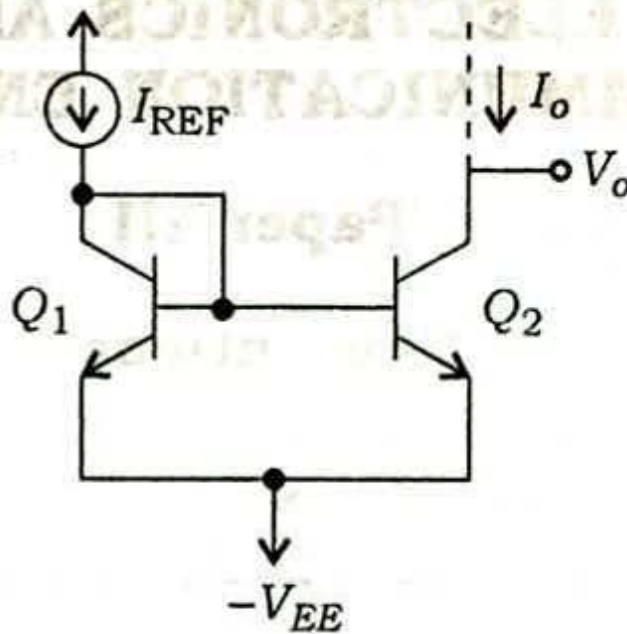
Assume that $\beta = 50$ and Q_1 and Q_2 are matched.   5

(b) Obtain the NAND logic diagram of a full adder from the Boolean function

$$C = xy + xz + yz$$
$$S = C'(x + y + z) + xyz$$

where $C' = NOT(C)$. Assume that two-input and three-input NAND gates are available.   5

(c) Compute the error constants and steady-state errors for unit-step, unit-ramp and unit-parabolic inputs for a system with

$$G(s) = \frac{K(s+3\cdot15)}{s(s+1\cdot5)(s+0\cdot5)}$$

and $H(s) = 1$.   5

(d) A WSS random process $X(t)$ is applied to the input of an LTI system with impulse response

$$h(t) = 3e^{-2t} u(t)$$

Find the mean value of the output $Y(t)$ of the system, if $E[X(t)] = 2$. Here $E[\cdot]$ denotes the expectation operator. 5

(e) The transfer function $H(\omega)$ of a communication channel is given by

$$H(\omega) = \begin{cases} (1 + k\cos T\omega)e^{-j\omega t_d}, & |\omega| < 2\pi B \\ 0 & , & |\omega| > 2\pi B \end{cases}$$

A pulse $g(t)$ band-limited to B Hz is applied at the input of this channel. Find the output $y(t)$. Consider this to be an LTI system. 5

(f) A ruby laser contains a crystal length 4 cm with a refractive index of 1·78. The peak emission wavelength from the device is 0·55 μm. Determine the number of longitudinal modes and their frequency separation. 5

(g) A parabolic-reflector antenna is designed for operation at 3 GHz. Its largest aperture dimension is 2 m. Find the minimum distance between primary and secondary antenna for measurement of radiation pattern. 5

(h) A satellite at a distance of 40000 km from a point on the earth's surface radiates a power of 10 W from an antenna with a gain of 17 dB in the direction of the observer. Find the power received by an antenna at the receiving point with an effective area of 10 m^2. 5

2. *(a)* Find the transfer characteristic for the circuit given below : 10
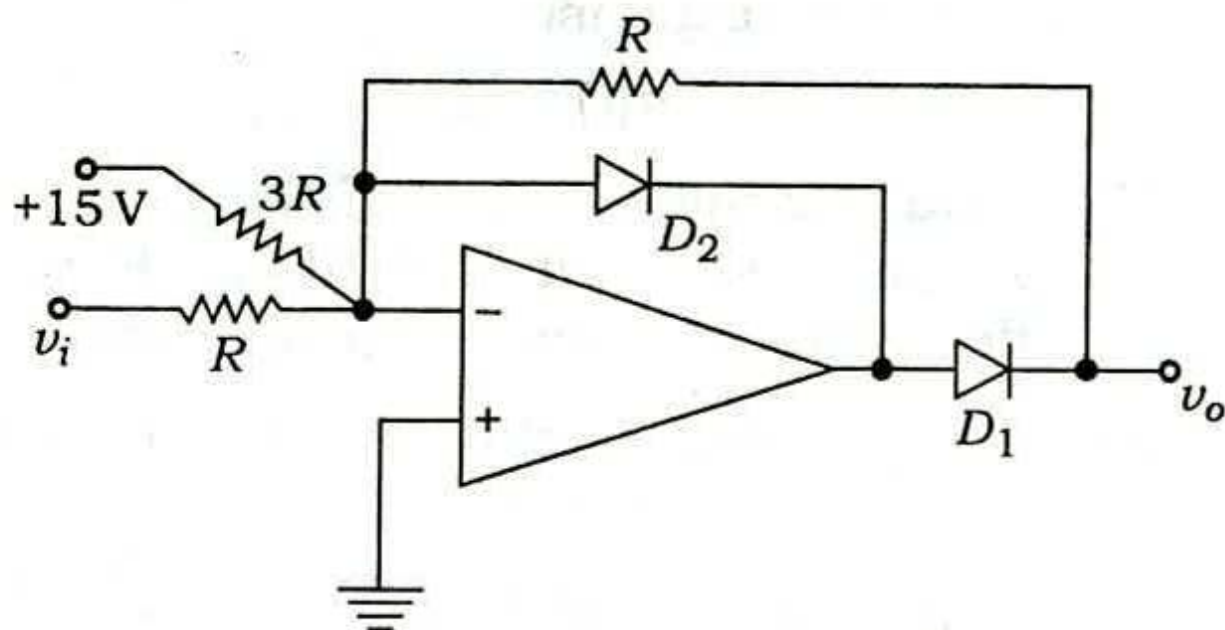

(b) Consider the tuned amplifier circuit shown below :
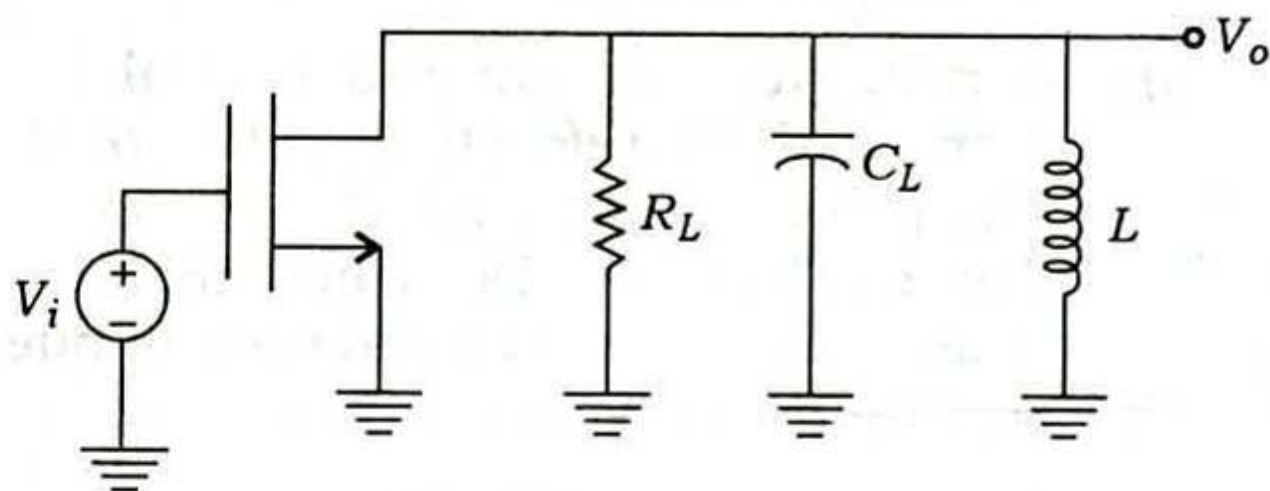
It is desired to have a center frequency $f_0 = 1$ MHz, 3-dB bandwidth $= 10$ kHz and center frequency gain $= -10$ V/V. The MOSFET used has at the bias point $g_m = 5$ mA/V and $r_0 = 10$ kΩ. The output capacitance is negligible. Determine the values of R_L, C_L and L. If the inductor L has $Q_0 = 150$, then find the value to which R_L should be changed so as to keep the overall Q unchanged. 15

(c) Determine the voltage gain of the transistor amplifier shown below :
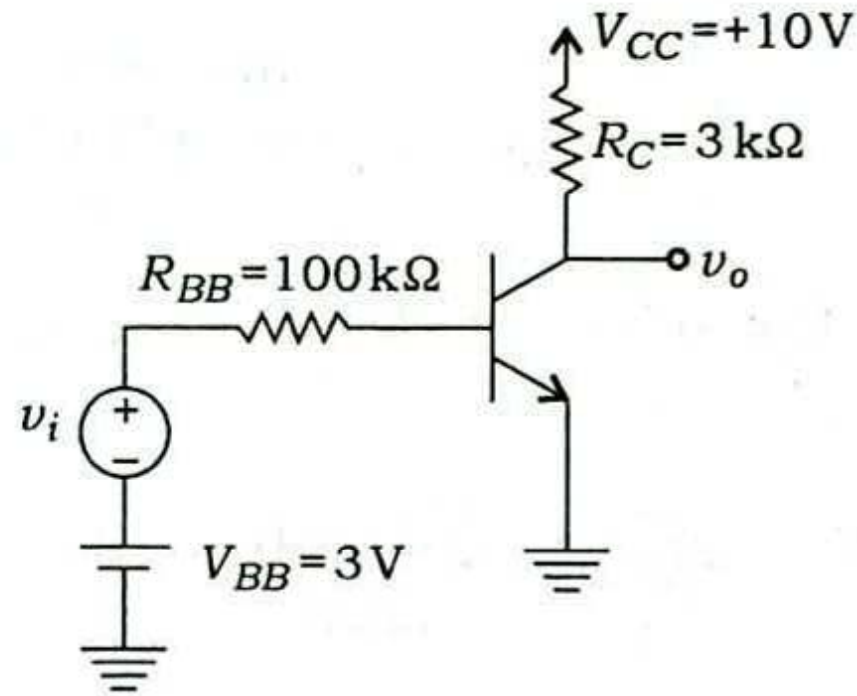
Assume $\beta = 100$ and $V_{BE} = 0 \cdot 7$ V. 15

3. (a) What size of ROM would it take to implement—

(i) a BCD adder/subtractor with a control input to select between the addition and subtraction;

(ii) a binary multiplier that multiplies two 4-bit numbers;

(iii) dual 4-line to 1-line multiplexers with common selection inputs?

Justify your answers. 10

(b) Design a binary counter having the following repeated binary sequence using *J-K* flip-flops :

0, 1, 2, 4, 5, 6

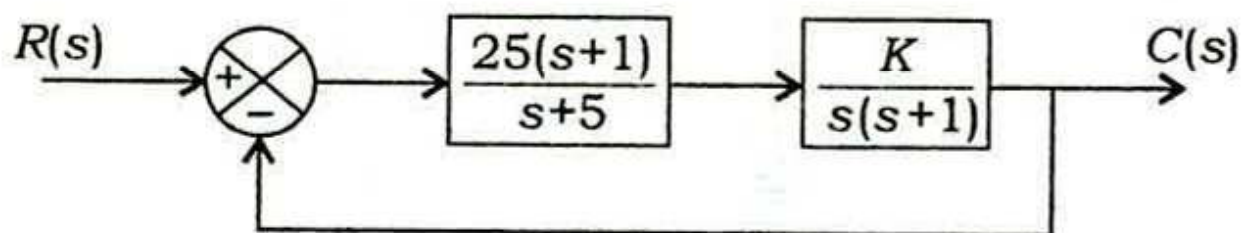Is the counter self-starting? Justify. 15

(c) Express the function

$$F = A \odot B \odot C \odot D$$

as the sum of minterms, where $\odot$ denotes equivalence operation. 15

4. (a) Consider the feedback control system shown below :

The normal value of process parameter K is 1. Evaluate the sensitivity of transfer function $T(s) = C(s)/R(s)$ to variations in parameter K. What is the magnitude of sensitivity at $\omega = 5$? 10

(b) A unity feedback control system has open-loop transfer function of

$$G(s) = \frac{K(s+1)(s+2)}{(s+0 \cdot 1)(s-1)}$$

Draw its root locus. Find the value of gain K for which the closed-loop system is critically damped. 20

(c) An open-loop system has transfer function

$$G(s)H(s) = \frac{s+2}{(s+1)(s-1)}$$

Find its stability when the feedback path is closed using Nyquist stability criterion. 10

5. (a) A channel has the following channel matrix :

$$[P(Y|X)] = \begin{bmatrix} 1-p & p & 0 \\ 0 & p & 1-p \end{bmatrix}$$

   (i) Draw the channel diagram.

   (ii) If the source symbols/bits have equally likely probabilities, then compute the probabilities associated with the channel outputs for $p = 0.2$. 10

   (b) Find the output of the matched filter and determine the maximum value of $(S/N)_o$, if the input $s(t)$ is a rectangular pulse of amplitude A and duration T. 10

   (c) A graded index fiber has a core with a parabolic refractive index profile which has a diameter of 50 μm. The fiber has a numerical aperture of 0·2. Estimate the total number of guided modes propagating in the fiber when it is operating at a wavelength of 1 μm. Also estimate the maximum core diameter which allows single-mode operation at the same wavelength assuming same value of numerical aperture. 20

6. (a) Consider a length of Teflon-filled copper K-band rectangular waveguide having dimensions $a = 1.07$ cm and $b = 0.43$ cm. Find the cut-off frequencies of the first five propagating modes. If the operating frequency is 15 GHz, then find the attenuation due to dielectric loss. Given that $\varepsilon_r = 2.08$ and $\tan\delta = 0.0004$ for Teflon. 20

(b) A two-port network is known to have the following scattering matrix :

$$[S] = \begin{bmatrix} 0.15\angle 0° & 0.85\angle -45° \\ 0.85\angle 45° & 0.2\angle 0° \end{bmatrix}$$

Determine if the network is reciprocal and lossless. If port 2 is terminated with a matched load, then what is the return loss seen at port 1? 10

(c) An n-type GaAs Gunn diode has the following parameters :

Electron drift velocity : $v_d = 2.5 \times 10^5$ m/s

Negative electron mobility : $|\mu_n| = 0.015$ m^2/V-s

Relative dielectric constant : $\varepsilon_r = 13.1$

Determine the criterion for classifying the modes of operation. 10

7. (a) Explain the concept of segmented memory as applicable to 8086 micro-processor. Calculate the beginning and ending addresses for the data segment assuming that register DS = E000H. 15

(b) Compare the range of representable numbers for 16-bit floating-point word with 7-bit exponent and 9-bit mantissa as (i) fraction and (ii) integer. 10

(c) Consider the system of equations

$$ax + by = c, \quad dx + ey = f$$

Write a C program that reads the values of a, b, c, d, e and f, and outputs the values of x and y, if they exist, otherwise print the appropriate message. 15

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