I.E.S-(Conv.)-2000

ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time Allowed: Three Hours *Maximum Marks : 200*

Candidates should attempt any FIVE questions.

Some useful data:

Electron charge : -1.6×10^{-19} Coulomb

Free space permeability $4 \pi \times 10^{-7}$ H/m

Free space permittivity $1/36 \pi \times 10^{9}$ F/m

Velocity of light in free space 3×10^{8} m/s

Boltzmann constant 1.38×10^{-23} J/K

Planck's constant : 6.626×10^{-34} J-s

1. (a) Discuss "Hall Effect" in materials.

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(b) Explain how this phenomenon can be used to determine whether a semiconductor is 'n' type or 'p' type.

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(c) Define Hall Coefficient R_H. Obtain an expression for R_H in terms of Hall Voltage V_H.

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2. (a) What are Optoisolators ? Where do they find application ? Discuss their propagation delay, operating voltage range and power dissipation.

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(b) With a sketch of characteristics, explain the features of a power MOSFET.

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(c) The reverse recovery time t_{rr} of a diode is 3 μs. In a conducting mode to reverse blocking mode operation, it needs a diode current rate of fall of 30 Amps/ μs.

Determine (i) storage charge, Q_{RR} and (ii) peak reverse current, I_{RR}.

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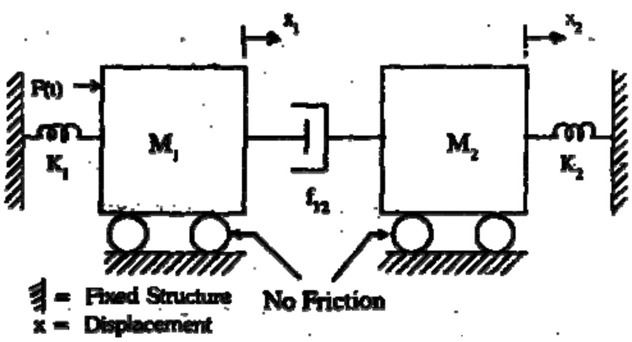

For the mechanical system of figure shown above:

(i) Obtain the differential equations of the mechanical system.

16

(ii) Sketch the mechanical equivalent representation.

8

(iii) Draw the electrical analogous circuit based on force current analogy.

16

4. (a) Explain the terms : "reflection coefficient" and "standing wave ratio."

16

(b) Define intrinsic impedance (characteristic impedance) of a non-conducting medium. Obtain its value for free space.

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(c) The electric field intensity associated with a plane wave travelling in a perfect dielectric medium is given by

$E_x (z, t) = 10 \cos (2\pi \times 10^7 t - 0.1 \pi z)$ V/m.

Calculate (i) the velocity of propagation (ii) intrinsic impedance.

14

5. (a) Define the z-transform.

5

(b) Discuss the methods of obtaining inverse z-transform of the form r(kT).

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(c) Given the z-transformed function:

$$R(z) = \frac{\left(1 - e^{-\alpha T}\right)}{(z-1)\left(z - e^{-\alpha T}\right)}$$

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Determine the inverse.

15

6. (a) State Tellegen's Theorem. Enumerate the implication of this theorem.

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(b) What are the methods of realization of reactance functions? Give brief explanation with circuit configurations.

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7. (a) Mention the applications of circular waveguides. Why are they generally avoided?

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(b) Calculate the ratio of the area of a circular waveguide to that of a rectangular one if each is to have the same cut-off wavelength for its dominant mode.

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(c) Discuss the operating principle of a simultaneous three bit A/D converter.

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ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Candidates should attempt question no. 1 which is compulsory and FOUR more questions taking TWO each from Section A and Section B.

Some useful constants are given below:

$e = 1.6 \times 10^{-19}$ Coul

$m = 9.1 \times 10^{-31}$ kg

$h = 6.625 \times 10^{-34}$ J-s

$c = 3 \times 10^{8}$ m/s

G = Universal constant of gravitation, 6.668×10^{-11} $m^3/kg\text{-}s^2$

M = mass of the earth, 5.997×10^{24} kg

r = radius o the earth, 6,378 km

1. (a) For the common emitter amplifier shown in Fig. 1, draw the simplified high frequency equivalent circuit and derive an approximate expression for the voltage gain and 3 dB frequency.

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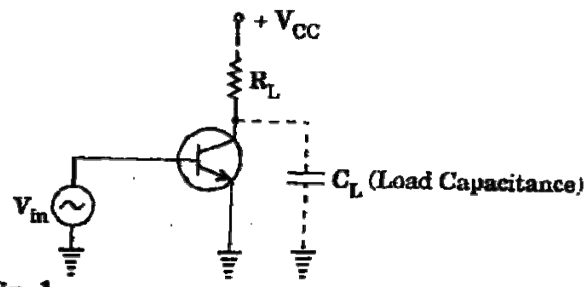

Fig. 1

(b) Calculate the output voltage V_0 of the circuit shown in Fig. 2. The input voltages are $V_1 = 2.5$ V and $V_2 = 1$ V.

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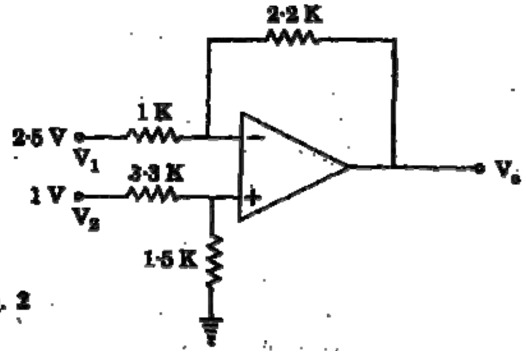

Fig. 2

(c) Verify the following equations by using Boolean algebra:

(i) $AB + AC + B\overline{C} = AC + B\overline{C}$

4

(ii) $\overline{AB+BC+CA} = \overline{A}\overline{B} + \overline{B}\overline{C} + \overline{C}\overline{A}$

4

(d) Using logic gates and diode ROM design an encoder to satisfy the following truth table:

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INPUTS			OUTPUTS				
W_2	W_1	W_0	Y_4	Y_3	Y_2	Y_1	Y_0
0	0	1	1	0	1	0	1
0	1	0	1	0	0	1	1
1	0	0	0	1	1	1	0
1	1	0	1	1	0	1	0

(e) (i) Write the transfer function of a PID controller and state the effect of integral control on the performance of the system.

4

(ii) A closed loop system has $G(s) = \frac{1}{s^2+2}$ and H(s) = 1/s. Draw the Nyquist path for analysing the stability of the system.

4

(f) (i) Calculate the beamwidth between first nulls of a 2.5 m paraboloid reflector used at 6 GHz.

4

(ii) Calculate its gain in decibels.

4

(g) Verify that the product of maximum unambiguous radial velocity V and maximum unambiguous range R is independent for radar's PRF and is equal to Kλ and K is a constant.

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(h) A parametric amplifier operating in upper sideband up-converter mode is pumped by a 20GHz pump frequency. If the signal frequency is 2 GHz,

(i) Determine the power gain in dB.

4

(ii) If the parametric amplifier was operated as a non- degenerate lower sideband up-converter, what would have been the power gain in that case ?

4

(i) Draw the architecture of Intel 8086 and mention the special functions associated with its registers.

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(j) (i) Write a program in 8085 assembly language to store the contents of its flag register in the memory location 2000 H.

4

(ii) Explain what happens in an 8085 processor based system when the microprocessor receives HOLD signal.

SECTION A

2. (a) (i) In the level shifter circuit shown in Fig. 3, calculate the value of R for V_0 to become zero. Assume $V_D = V_{BE} = 0.7$ V and h_{FE} is very large.

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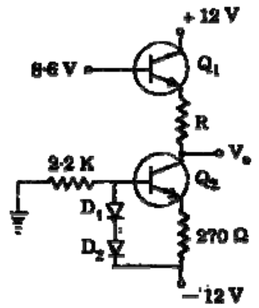

Fig. 3

(ii) Calculate V_0 in the circuit shown in Fig. 4. Assume h_{FE} to be large and neglect the base current. $V_{BE} = 0.7$ V.

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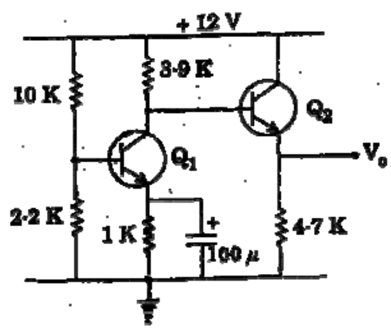

Fig. 4

(b) Derive an expression for the stability factor of the circuit shown in Fig. 5.

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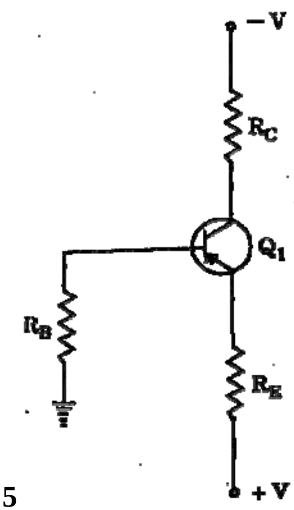

Fig. 5

3. (a) An amplifier with open loop voltage gain $A_0 = 1000 \pm 100$ is available. It is required to have an amplifier whose voltage gain varies by no more than $\pm$ 0.1 percent.

(i) Find the value of the feedback factor required.

4

(ii) Find the gain with feedback.

4

(b) In the circuit shown in Fig. 6 calculate the value of the output current I_o for V_{in} = 5 V. If $I_{CE\ SAT}$ of Q_2 is 0.3 V. Calculate the maximum value of R_L that can be used in the circuit.

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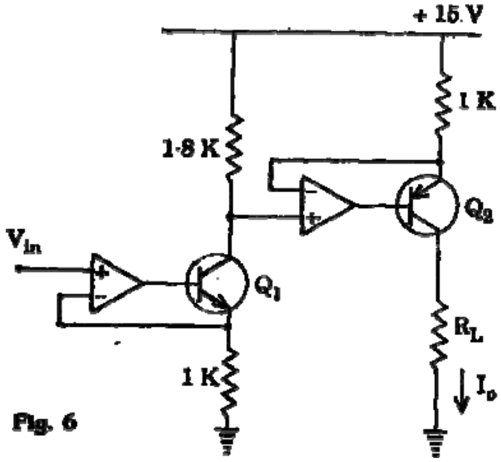

Fig. 6

(c) Draw the internal block diagram of an IC PLL NE 565 or equivalent. Explain how you will realize a frequency multiplier to multiply an input frequency by a factor of 12 by using this PLL.

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4. (a) Design a combinational circuit to convert the binary input ABCD to Gray code.

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(b) Draw the circuit of an 8 bit D/A converter. Use 741 operational amplifier. If the value of the weighted resistor corresponding to MSB is 1 K, note down the values of all the other resistors. The reference voltage is 2.5 volt. The output voltage of the converter corresponding to full scale input is 5.0 volt. What value of feedback resistor should be used in the operational amplifier ? What should be the tolerance of the resistor corresponding to MSB if the error in the converter output is to remain less than 1% of full scale value ?

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5. (a) A mercury thermometer was kept in ice (0^o C) for an indefinite period. It was removed and immediately put in boiling water (100° C). It showed 75^0 C after 2.5 seconds. Evaluate the transfer function of the thermometer.

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(b) A second order control system with proportional derivative controller is shown in Fig. 7. Derive expressions for its (i) steady state error to velocity input (ii) natural frequency of oscillation (iii) damping ratio in terms of the system parameters.

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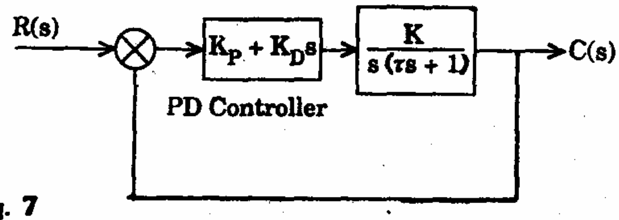

Fig. 7

(c) By analytical method calculate the gain margin in dB the unity feedback control system with transfer function.

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$$G(s)=\frac{10}{s(s+1)(s+2)}$$

SECTION B

6. (a) A high frequency radio link has to be established between two points at a distance of 2500 km on the earth's surface. Considering ionospheric height to be 200 km and its critical frequency 5 MHz, calculate the maximum usable frequency for the given path.

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(b) A measuring system is used to calibrate the setting on a CW signal generator. Two adjacent null are found on the coaxial slotted line. The scale readings are 12.4 cm and 25.7 cm.

(i) What is the wavelength and frequency of the signal generator at this setting?

(ii) What cutoff frequency should be selected for the low pass filter ?

(iii) What must the local oscillator frequency be if the IF amplifier frequency is 60 MHz?

(iv) What attenuator should be selected to reduce the reflected power by 12 dB?

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7. (a) An air filled hollow rectangular conducting waveguide has cross - section of 8 × 10 cm. How many TE mode will this waveguide transmit at frequencies below 4 GHz? How are these modes designated and what are the cut-off frequencies?

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(b) A four cavity Klystron has the following parameters:

Beam voltage V_0 = 14.5 KV

Beam current = 1.4 A

Operating frequency f = 10 GHz

DC electron charge density $\rho_0 = 10^{-6}$ C/m^3

RF charge density $\rho = 10^{-8}$ C/m^3

Velocity perturbations V = 10^5 m/sec

Compute:

(i) DC electron velocity

(ii) DC phase constant

(iii) The plasma frequency

(iv) The dc beam current density

(v) The instantaneous beam current density

8. (a) Calculate the antenna beam angle required by a satellite antenna to provide full global coverage from a geostationary orbit.

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(b) Calculate the figure of merit of an earth station in dB given the effective noise temperature for the antenna as 27 K, receiver noise temperature as 75 K and isotropic power gain of the antenna as 45 dB.

5

(c) The mean optical power launched into an 8 km length of fibre is 120 μW. The mean optical power at the fibre output is 3 μW. Determine

(i) The overall signal attenuation in dB through the fibre assuming there are no connectors or splices.

(ii) The signal attenuation per kilometer for the fibre.

(iii) The overall signal attenuation for a 10 km optical link using the same fibre with splices at 1 km intervals each giving an attenuation of 1 dB.

(iv) The numerical input/output power ratio as calculated in (iii).

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9. (a) Explain SIM and RIM instructions of 8085.

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(b) An 8085 based system has 4 KB RAM. The address and chip enable pins of the RAM are connected as shown in Fig. 8. Calculate the memory map of the RAM in HEX form.

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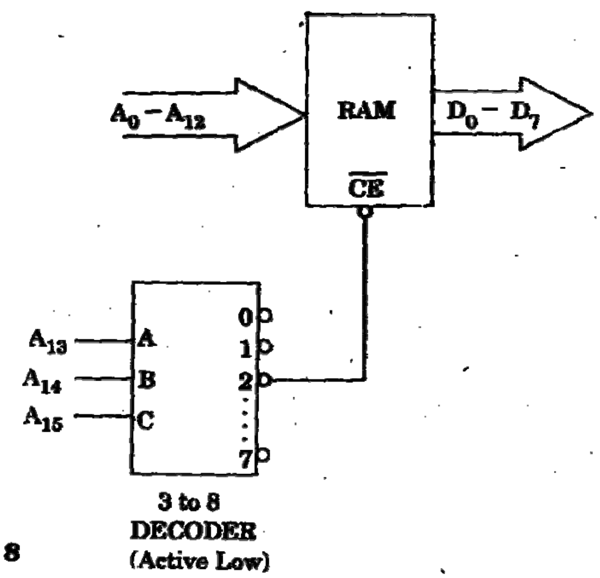

Fig. 8

(c) A BCD number is stored in memory location 2040 H in packed form. Write a program using 8085 assembly language to unpack it and store in memory location 2041 H and 2042 H. Least significant digit should be stored first.

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(d) Explain the term 'near CALL' and 'far CALL' with reference to Intel 8086.

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