ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - I

Time Allowed: 3 hours *Maximum Marks : 200*

Candidates should attempt any FIVE questions.

Assume suitable data, if found necessary, and indicate them clearly.

Values of the following constants may be used wherever necessary:

Electronics charge = -1.6×10^{-19} Coulomb.

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

Free space permittivity = $(1/36\ \pi) \times 10^{-9}$ Farad/m.

Velocity of light in free space = 3×10^{8} m/sec.

Boltzmann constant = 1.38×10^{-23} Joule/K.

Planck's constant = 6.626×10^{-34} Joule.sec.

1. (a) Draw sketches illustrating a (100) plane, a (110) plane, and a (111) plane in a cubic unit cell. How many equivalent (100) planes are there in a cubic crystal ? A material has a face-centred cubic structure with an ionic radius of 1.06 Å. Calculate the inter planar separation for (111) planes.

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(b) Explain the phenomenon of superconductivity. Briefly explain its salient features, mechanism and applications.

The periphery of a copper disk 50 cm in radius and 10 mm in thickness is maintained at a potential of 50 V. A thin rod 1 cm in radius is soldered to the disk at its centre (at right angles to the plane of the disk) and maintained at a potential of 49 V. If the resistivity of copper is 1.7×10^{-8} Ωm, calculate the current through the disk.

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(c) With the help of band diagrams, properly labelled, discuss briefly an idealized metal to p-type semiconductor contact, both for a rectifying and an ohmic contact. Why do some semi-conducting specimens form a rectifying contact regardless of the metal used?

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2. (a) Explain Hall effect.

An n-type germanium sample is 2 mm wide and 0.2 mm thick. A current of 10 mA is passed through the sample (x-direction) and a field of 0.1 weber/m^2 is directed perpendicular to the current flow(z-direction). The developed Hall voltage is –1.0 mV. Calculate the Hall constant and the number of electrons/m^3.

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(b) By drawing suitable diagrams, explain the constructional details and working of a silicon controlled rectifier (SCR).

An a.c. voltage v=240 sin 314 t is applied to an SCR. If the SCR has a forward breakdown voltage of 180 V, find the time during which the SCR remains off.

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(c) What is an integrated circuit (IC) ? Discuss the relative advantages and disadvantages of ICs over discrete assembly. How will you make a monolithic IC ?

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3. (a) Using Laplace transforms, find the current, $i_1(t)$ that enters the network, given below, when the switch is closed at t=0 with zero initial current in the inductor Numerical values of the circuit elements are as shown.

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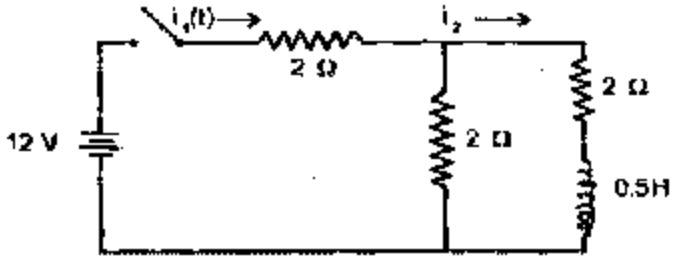

(b) The switch S is kept open until steady state is reached by the network shown below. At t = 0, S is closed

What is the voltage across inductor, v_L at t=0 ? Also find i(t).

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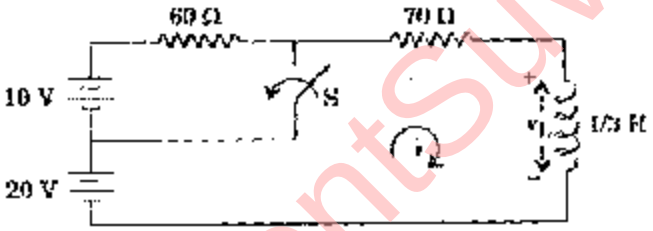

(c) Three small spheres each carrying a charge q are placed on the circumference of a circle of radius r to form an equilateral triangle. Find the electric field and the potential at the centre of the circle

4. (a) Synthesize the following impedance function in Foster-I and Causer-I forms:

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$$Z(s)=\frac{(s^2+4)(s^2+25)}{s(s^2+9)}$$

(b) In the circuit shown below, with the capacitor initially uncharged, the switch S is opened for a long time and is then closed at $t = t_0$. Calculate the output voltage V_0 at $t = t_0$, at 25 m.sec and at $t = \infty$. Also sketch the corresponding transient

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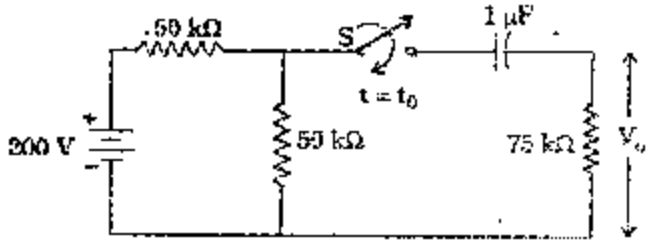

(c) State and prove Thevenin's theorem. Determine Thevenin's equivalent circuit which may be used to represent the network shown below at terminals CD.

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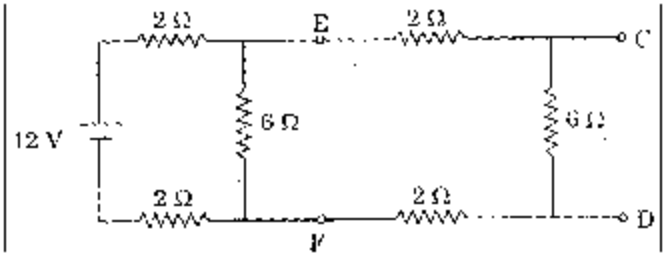

5. (a) Two identical parallel plate capacitors are connected to a battery, as shown below, with a switch S closed. The switch is now opened and the free space between the plates of the capacitors is filled with a dielectric of dielectric coefficient, K = 2. Find the ratio of the total electrostatic energy stored in both capacitors before and after the introduction of the dielectric.

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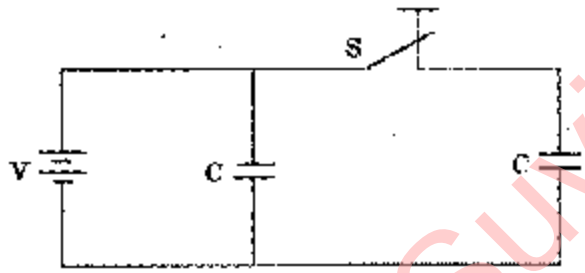

(b) A lossless transmission line With air dielectric is 12 m long. What is the line length in wavelengths and what is the value of phase constant, β at 15 MHz ?

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(c) By making use of necessary equations, establish that the energy stored in a plate electromagnetic wave is equally divided between the electric and magnetic fields.

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6. (a) What do you mean by 'time-base' in a cathode ray oscilloscope (CRO) ? Explain the operation of a circuit suitable for the generation of time-base voltage.

The deflection sensitivity of a CRO is 0.02 mm/V. If an unknown voltage is applied to the horizontal plates, the spot shifts 4.0 mm horizontally. Find the value of the unknown voltage.

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(b) Define a transducer. Give three examples of transducers involving different principles of action. A strain gauge has a gain factor of 4. If this strain gauge is attached to a metal bar that stretches from 25 cm to 25.2 cm, calculate the percentage change in its resistance. If the unstrained value of resistance is 120 Ω, what would be its value after strain is applied?

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(c) You are given a 0 – 1 m A meter with an internal resistance of 5 Ω. How would you extend its range to 10 mA?

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7. (a) A silicon abrupt p-n junction at 300 K has acceptor density, $N_a = 10^{18}$ cm^{-3} and donor density, $N_d = 10^{15}$ cm^{-3} . If the intrinsic concentration, $N_i = 1.5 \times 10^{10}$ cm^{-3}, calculate the built-in voltage, V_i. Derive the relations used.

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(b) Explain the distinguishing features of astable, monostable and bistable multivibrator and give the operational details of any one of them.

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(c) A dipole antenna having a length of 10 cm and carrying a current of 2 A at an angular frequency of 10^{10} radians per second, radiates into free space. Calculate the electric field intensity at a distance of 20 km from the antenna where the conduction field is negligible.

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ELECTRONICS AND TELECOMMUNICATION ENGINEERING

PAPER - II

Time Allowed: 3 hours *Maximum Marks : 200*

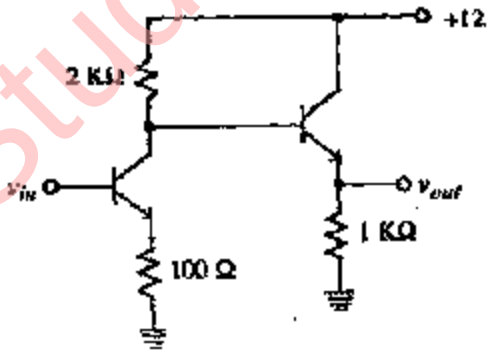
Candidates should attempt Question No. I which is compulsory and FOUR more questions taking TWO each from Section 'A' arid Section 'B'.

Assume suitable data, if required.

Some useful constants are given below:

Electron charge	: $e = 1.6 \times 10^{-19}$ Coulomb
Electron mass	: $M = 9.1 \times 10^{-31}$ kg
Planck's constant	: $h = 6.625 \times 10^{-34}$ J-s
Velocity of light	: $C = 3 \times 10^{8}$ m/s
Universal constant of gravitation	: $G = 6.668 \times 10^{-11}$ $m^3/kg\text{-}s^2$
Mass of earth	: $M = 5.997 \times 10^{24}$ kg
Radius of earth	: R = 6,378 km
Permeability of vaccum	: $\mu_0 = 4\pi \times 10^{-7}$ H/m
Permittivity of vaccum	: $\varepsilon_0 = 10^{-9}/36\pi$ F/m.

1. (a) Consider silicon npn transistors for the following circuit.



If v_{in} is +1 V, what is the value of v_{out}? If v_{in} is changed to +3 V, what is the value of v_{out} ? What is the output voltage compliance (maximum voltage range that the output can swing when the input is varied) of the circuit ?

3+2+3

(b) What is the class-D operation of power amplifier ? Draw the circuit diagram of transistorized class-D amplifier and explain its working.

2+3+3

(c) Determine the don't care combinations in the following Boolean expression : $BE + \overline{B}D\overline{E}$, which is a simplified version of expression

$\overline{A}BE + BCDE + B\overline{C}\overline{D}E + \overline{A}\overline{B}D\overline{E} + \overline{B}\overline{C}D\overline{E}$

8

(d) Design a logic circuit that has inputs A, B and C whose output 'Y' will be HIGH only when a majority of the inputs is HIGH.

8

(e) The following experimental results were obtained from an open-loop frequency test for an automatic control system:

ω rad/sec	4	5	6	8	10
Gain	0.66	0.48	0.36	0.23	0.15
Phase angle	–134	–143	–152	–167	–180

Plot the locus of the loop transfer function and measure the gain and phase margin.

2+3+3

(f) Explain how frequency modulation may be obtained from a phase modulator. Diagrammatically compare the amplitude modulation, frequency modulation and phase modulation in respect of change in amplitude, frequency and phase when the carrier is modulated with a step function.

8

(g) (i) Distinguish between optical horizon and radio horizon.

4

(ii) In a radio link, the repeater spacing is 40 km. Assuming identical antenna heights for the repeater stations, compute the elevation of the antenna from the ground plane.

4

(h) Guided wavelength of a rectangular waveguide (1 D 2.286 cm x 1.016 cm) is 4.42 cm. When the waveguide is short-circuited, find the distance between two consecutive voltage minimum positions of standing wave pattern so formed. Obtain the operating frequency of the microwave source.

8

(i) A reflex klystron is to be amplitude modulated only. Describe, with neat diagrams and justification, the method of such modulation.

8

(j) What are the functions of the following pins of 8085 microprocessor?

(i) READY (ii) ALE (iii) HOLD (iv) TRAP.

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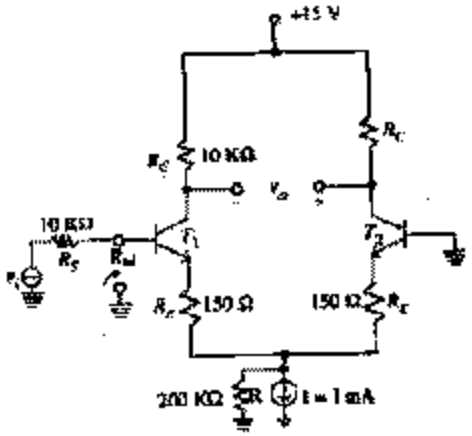
SECTION A

2. (a) Consider the following circuit:



The transistors have $\beta = 100$. Determine input differential resistance R_{id}, overall voltage gain v_0/v_i and the worst case common mode rejection ratio if the two collector resistances are accurate to within ±1%.

5+5+5

(b) Draw the circuit diagram of a Colpitt's oscillator using transistor. Derive an expression for its frequency of oscillations. Deduce the starting condition for this oscillator.

5+5+5

3. (a) Design a logic circuit for detecting equality of two 2-bit binary numbers.

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(b) With a neat block diagram, explain the operation of 8-bit successive approximation ADC. What is the maximum conversion time for this type of ADC ?

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(c) Design a 4-bit binary UP / DOWN ripple counter with a control for UP/DOWN counting.

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4. (a) A three term controller is described by the equation

$$\theta_c(t) = 20\left[e(t) + \frac{1}{T_r}\int_0^t e(t)\,dt + T_d - \frac{de(t)}{dt}\right]$$

where $e(t)$ = system error

$\theta_c(t)$ = controller output

T_r = reset time

T_d = derivative time

This is used to control a process with transfer function

$$G(s) = \frac{40}{10s^2 + 80 + 800}$$

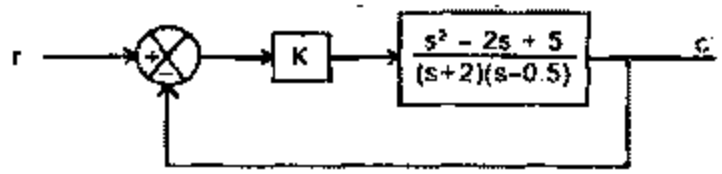
unity feedback is used.

(i) If integral action is not employed, find the derivative time required to make the closed-loop damping ratio unity.

(ii) If this value of derivative time is maintained, determine the minimum value of reset time that can be used without instability arising.

8 + 7

(b) Consider the following control system

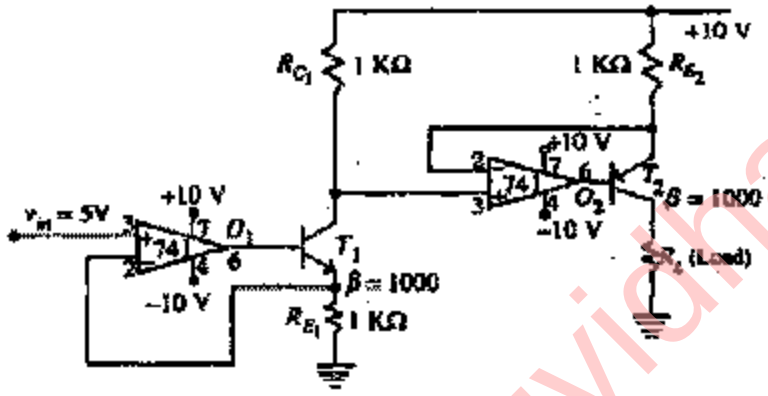


(i) Sketch the root locus diagram for $0 < K < \infty$.

(ii) Determine the value o K that gives the system characteristic equation a damping ratio of 0.5.

10+5

5. (a) Consider the following circuit assume ideal opamps O_1 and O_2.



If the load resistance is 500 Ω what is the load voltage? If the load resistance is reduced to zero what is the load current?

5 + 5

(b) Using an 8038 IC waveform generator, design a pulse generator to produce a positive pulse with pulse width of 100 micro seconds and a pulse repetition of 1 KHz. The output amplitude is to be approximately 10 V.

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(c) A phase lead compensator has a transfer function

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

Determine the maximum value of the phase lead and the frequency at which it occurs. Sketch the Bode diagram for this network.

3+3+4

SECTION B

6. (a) State and .explain what is meant by G/T ratio of a satellite ground station indicating its significance in satellite communication. How these components of the ratio are generated in the systems ? State the methods of improving the ratio.

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(b) Give the details of Gain/Loss budget of the up-link and down-link of the satellite system, indicating all the system parameters controlling the budget.

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(c) In a satellite earth station, the high power TWA delivers an output signal of 600 W at 12 GHz. The feeder line connected to the parabolic dish antenna consumes a power of 2.0 dB. The gain of the dish antenna with respect to an isentropic antenna is 55 dB. Compute the EIRP with reference to 1 KW.

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7. (a) Draw a neat sketch of the ω—β plot of a rectangular waveguide for its dominant mode and show how phase velocity and group velocity may be obtained from this curve.

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(b) A rectangular hollow metal waveguide has internal dimensions as 2.286 cm and 1.016 cm. Find

(i) Frequency range for single mode operation

(ii) Decay rates for next higher order modes like $TE_{2,0}$ and $TM_{1,1}$ at 9.00 GHz.

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8. (a) Distinguish between

(i) High Level Language and Low Level Language

(ii) Macro-Programming and Micro-Programming

(iii) Machine Cycle and Instruction Cycle

(iv) Hardware Interrupts and Software Interrupts

(v) Memory mapped I/O and I/O mapped I/O.

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(b) A list of ten integer numbers (both even and odd) are stored in a memory. Write an assembly language program of 8085 to separate EVEN and ODD numbers and store them separately.

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9. (a) In a radio broadcast transmitter, the carrier signal is sinusoidal with amplitude of 3 volt and frequency of 15 KHz. The carrier signal is modulated by a square wave that does not have any dc component, yet does have peak-to-peak amplitude of 2.0 volt and frequency of 2 KHz. Write down the mathematical expressions of the carrier signal, the modulating signal and the modulated signal. Neatly plot those waveforms as a function of time. Obtain the plots in frequency domain as well.

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(b) (i) Perfect matching at all three ports of a reciprocal, loss-less 3-port junction is impossible to achieve. Do you agree ? Justify your comment.

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(ii) Obtain the scattering matrix of a loss-less transmission line with propagating constant β and length L.

3

(c) The contents of some memory locations of an 8085 microprocessor system are shown below. What will be the contents of H-L Pair after the execution of the program given below:

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LHLD	3000H
MoV	E, M
INX	H

MoV	D, M
LDAX	D
MoV	L, A
INX	D
LDAx	D
MoV	H,A

Memory address (Hex)	Memory contents (Hex)
3000	02
3001	30
3002	00
3003	30

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