This question paper contains 8+4 printed pages]

CODE : FS-17

ELECTRONICS ENGINEERING

Time : 3 *Hours* *Maximum Marks* : 200

Note :— (1) The question paper consists of two parts i.e., Part-I and Part-II, each having four questions.

(2) Candidates are required to attempt *five* questions.

(3) Question Number **1** of Part-I and Question Number **5** of Part-II are compulsory.

(4) Candidates are required to attempt *one* compulsory and *one* optional question from each part. The fifth question can be attempted from either Part-I or Part-II.

(5) *All* questions carry equal marks i.e **40** each.

P.T.O.

(6) Parts of same questions must be attempted together and not to be attempted in between the answers to other questions.

Part-I

1. (*a*) What is meant by Meissner effect in super-conductors ? Show that a superconductor exhibits perfect diamagnetism. Draw magnetization versus magnetic field plot for Type-I and Type-II superconductors. 15

(*b*) Explain the Hall effect. An electric field of 100 V/m is applied to a sample of *n*-type semi-conductor whose Hall coefficient is –0.0125 m^3/C. Determine the current density in the sample assuming mobility of electron as 0.36 $m^2/V\text{-}s$. 10

(*c*) Define piezoelectricity. Calculate the frequency of the fundamental note emitted by a quartz crystal. Given, thickness of the quartz plate is 5.5 mm, Young's modulus is 8×10^{10} N/m^2 and density of the crystal is 2.65×10^3 kg/m^3. 15

2. (*a*) Find the inverse Laplace transform of the following function : 15

$$\frac{12s}{(s+3)\left(s^2+9\right)}.$$

(*b*) Draw the block diagram of phase-locked loop (PLL) showing its basic components. 10

(*c*) What are DC choppers ? What is the use of these devices in industrial electronics ? Draw the circuit for Type B chopper and explain its main feature. 15

3. (*a*) For the circuit shown in Fig.1, calculate the current i through the inductor and voltage v across the capacitor for time $t < 0$ and $t > 0$. 20

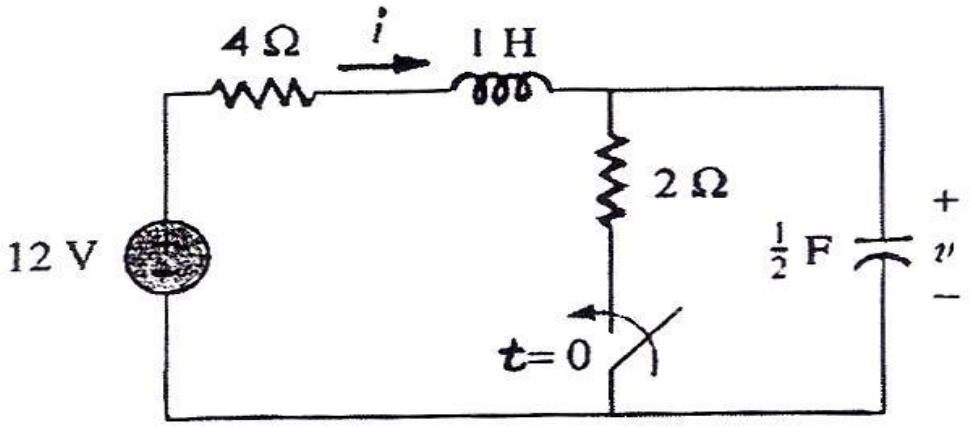

Fig. 1

(*b*) For the circuit shown in the Fig. 2, suppose that $R_B = 2\ k\Omega$, $R_{C1} = 1\ k\Omega$, $R_{C2} = 500\ \Omega$, $R_E = 250\ \Omega$, and $V_{CC} = 5$ V. Given that transistor Q_1 operates in the active region and has a dc beta of $h_{FE1} = 100$, find the minimum value of

h_{FE2} for which transistor Q_2 will saturate. 20

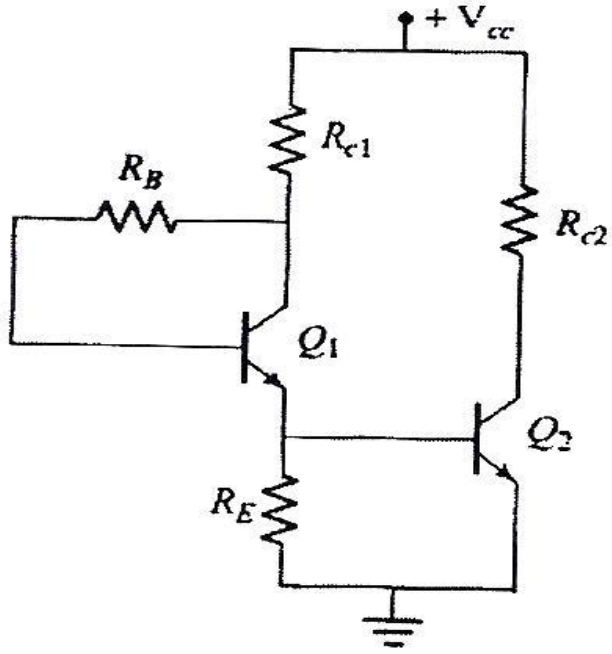

Fig. 2

4. (a) Show that the minimum conductivity of a semiconductor sample occurs when concentration of electron is given by :

$$n = n_i \sqrt{\frac{\mu_p}{\mu_n}}$$

where n_i is the intrinsic concentration, μ_p and μ_n are the mobilities of hole and electron respectively. 10

(*b*) Define the following terms (in 2-3 lines only) associated with measurements and error :

Accuracy; Precision; Resolution; Hysteresis and Linearity. 15

(*c*) Write down the Mason's gain formula for signal flow graphs (SFG). For the SFG shown in Fig. 3, find the transfer function C(*s*)/R(*s*) using Mason's gain formula. 15

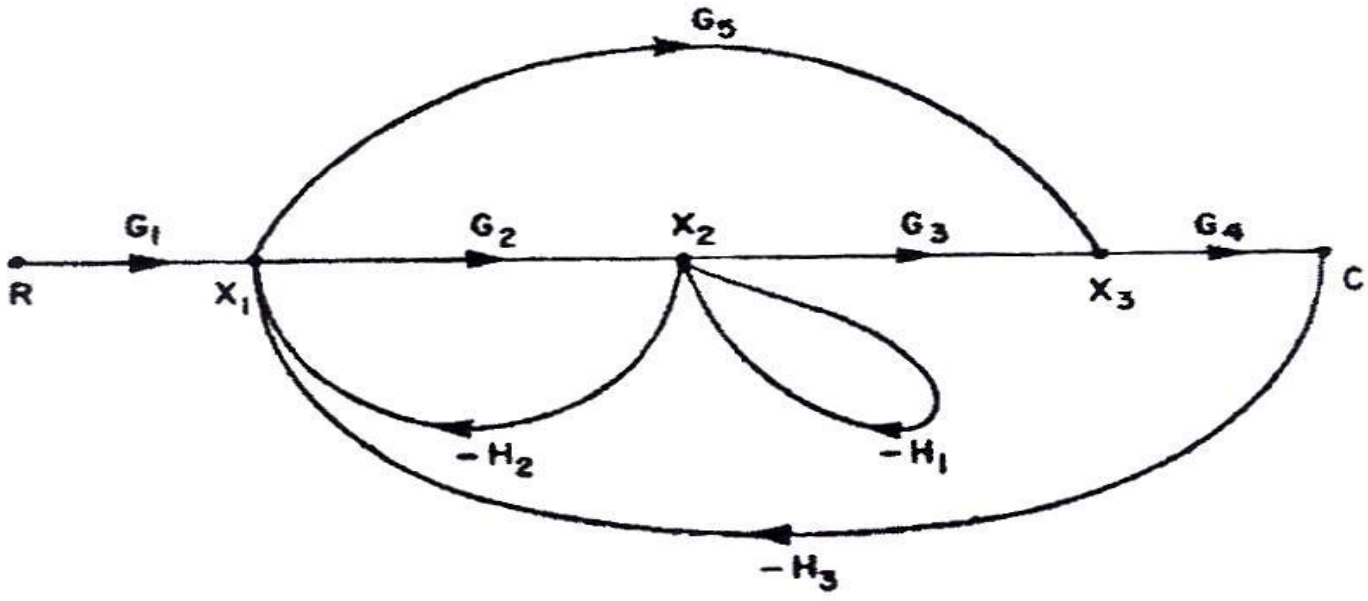

Fig. 3

Part-II

5. (*a*) Find the simplified sum-of-products form of the Boolean function : 15

$$\bar{A}(\bar{B} + \bar{C}) + \bar{A}B + ABC.$$

(*b*) An electric field in free space is given by :

$$\mathbf{E} = 50\cos(10^8 t + kx)\mathbf{a}_y \text{ V/m}$$

(*i*) Represent the field **E** in phasor form.

(*ii*) Find the direction of wave propagation.

(*iii*) Calculate k and the time it takes to travel a distance of $\lambda/2$.

(*iv*) Sketch the wave at $t = T/2$. 15

(*c*) An optical fibre is made of glass with refractive index 1.55 and is clad with another glass with refractive index 1.51. The fibre has a core diameter

of 50 μm and is used at a light wavelength of 0.8 μm. What is the numerical aperture of the fibre and acceptance angle ? 10

6. (*a*) An angle-modulated signal with carrier frequency $\omega_c = 2\pi \times 10^5$ rad/s is described by the equation :

$$\phi_{FM}(t) = 12 \cos(\omega_c t + 5 \sin 3000t + 10 \sin 2000\,\pi t)$$

(*i*) Determine the power of the modulating signal.

(*ii*) What is frequency deviation (Δf) ?

(*iii*) What is modulation index (β) ?

(*iv*) Estimate the bandwidth of FM signal. 20

(*b*) In a superheterodyne AM receiver the mixer translates the carrier frequency f_c to a fixed IF of 455 kHz by using a local oscillator of frequency f_{LO}. The broadcast band frequencies range from 540 to 1600 kHz.

(*i*) Determine the range of tuning that must be provided in the local oscillator when $f_{LO} > f_c$ and also when $f_{LO} < f_c$.

(*ii*) Explain why usual AM radio receiver uses superheterodyne system. 20

7. (*a*) A transverse magnetic wave in a rectangular wave guide for which $a = 1.5$ cm, $b = 0.8$ cm, $\sigma = 0$, $\mu = \mu_0$, and $\varepsilon = 4\varepsilon_0$, is :

$$H_x = 2\sin\left(\frac{\pi x}{a}\right)\cos\left(\frac{3\pi y}{b}\right)\sin\left(\pi \times 10^{11} t - \beta z\right) \text{ A/m.}$$

Determine :

(*i*) The mode of operation

(*ii*) The cut-off frequency

P.T.O.

(*iii*) The propagation constant γ

(*iv*) The intrinsic wave impedance Z

[Take : $\mu_0 = 4\pi \times 10^{-7}$ H/m and

$\varepsilon_0 = 8.854 \times 10^{-12}$ F/m] 15

(*b*) A 50 Ω lossless transmission line uses an insulating material with $\varepsilon_r = 2.25$. When terminated in an open circuit, how long (in cm) should the line be for its input impedance to be equivalent to a 10-pF capacitor at 50 MHz ? 10

(*c*) Write down the time-harmonic form of Maxwell's equations for a simple, conducting source-free medium. A lucite sheet ($\varepsilon_r = 3.2$) is introduced perpendicularly in a uniform electric field $\mathbf{E}_o = \mathbf{a}_x E_0$ in free space, as shown in Fig. 4. Determine $\mathbf{E}_i$ inside the lucite. Does the solution of the problem change if the original electric field in

not uniform : i.e. $\mathbf{E}_o = \mathbf{a}_x E(y)$? 15

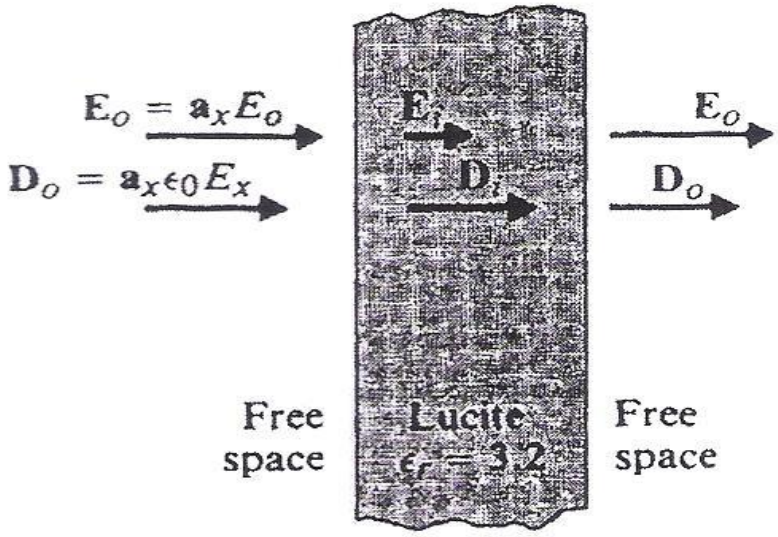

Fig. 4

8. (*a*) The logic circuit shown in Fig. 5 is an example of a **reset-dominate** SR flip-flop. Construct the truth table for this device. 15

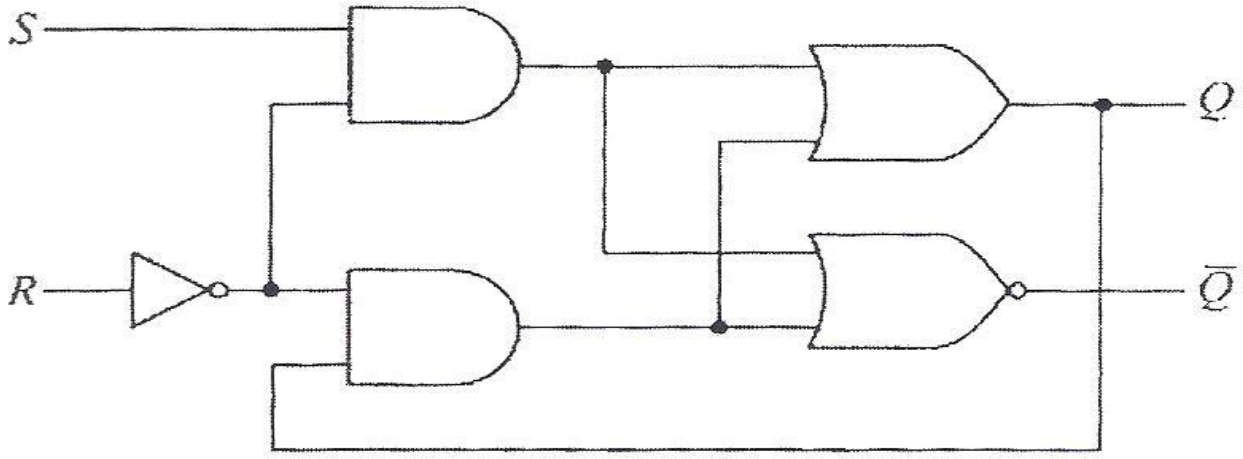

Fig. 5

P.T.O.

(*b*) Write down the differences between Isolated I/O and Memory Mapped I/O. 15

(*c*) Write the assembly language programming to find 2's complement for the string of 100 bytes. 10