Z(6th Sm.)-Physics-H/CC-13/CBCS
(Syllabus : 2019-20 & 2018-19)

2023

PHYSICS — HONOURS

Paper : CC-13

(Syllabus : 2019-2020)

[Digital Electronics]

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***question no.* 1** and ***any four*** questions from the rest.

1. Answer ***any five*** questions : 2×5

(a) What is monolithic IC?

(b) Convert the hexadecimal number C1.A to a binary number.

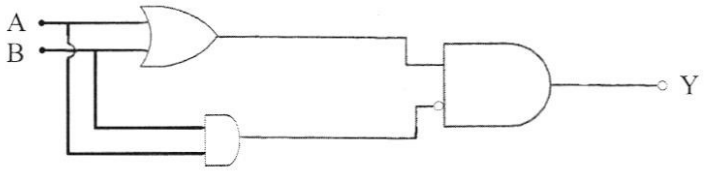
(c) Reduce the Boolean expression $Y = A\bar{B} + \overline{AB} + AB + \bar{A}\bar{B}$ in its simplest form.

(d) Which logic gate can be used as parity checker? Explain.

(e) Using 2's complement method subtract 00111 from 10101.

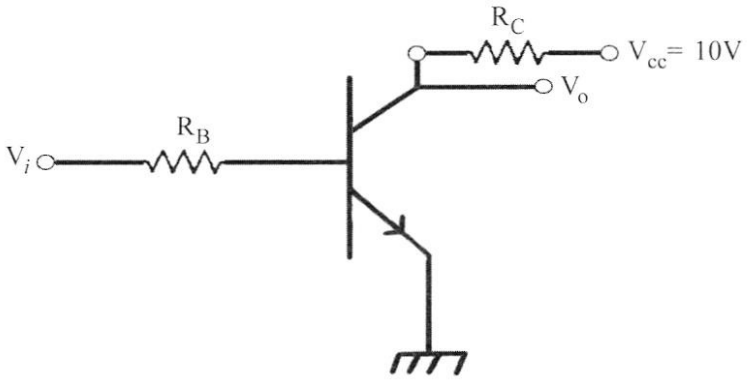
(f) Write at least two differences between latches and flip-flops.

(g) Write the Boolean expression for the output Y in the following figure and simplify it.



2. (a) Draw the circuit diagram for realising AND gate using transistors.

(b) In the following NOT gate, calculate the base resistance (R_B) and collector resistance (R_C).
[Given : h_{FE} = 250, I_C(Sat) = 10 mA, V_{CC} = 10 V and V_i = 0 to 10V]



(c) Perform the binary operations : 11111 + 1011 – 111

Use 1's complement method for subtraction.

(d) What are the two advantages of higher density ICs? 2+3+3+2

3. (a) Simplify the following logic function in SOP form using K-map and implement it by using NAND gates only.

$$F(A, B, C, D) = \sum m(0, 2, 3, 5, 7, 8, 12, 13)$$

(b) Implement XOR gate using NOR gates only and give its truth table.

(c) Write two advantages of CMOS logic over TTL logic. (3+2)+(2+1)+2

4. (a) Show that a full adder circuit can be realised using half adders and an OR gate.

(b) What is a demultiplexer? Draw the block diagram of a 4 to 16 line demultiplexer.

(c) Using a 3 to 8 decoder and an OR gate, draw the circuit diagram to realise the following Boolean functions simultaneously : $F_1(A, B, C) = \sum m(0, 4, 6)$ and $F_2(A, B, C) = \sum m(1, 2, 3, 7)$.

3+(1+2)+4

5. (a) Draw the circuit diagram of a clocked SR-Flip-flop. How does the trigger pulse controls the change of state of this flip-flop? Explain.

(b) Discuss the differences between D and T type flip-flops using block diagrams and truth-tables.

(c) Convert an SR flip-flop into a JK flip-flop. [circuit diagram only] (2+2)+(2+2)+2

6. (a) Draw the block diagram of a 4-bit SISO shift register.

(b) The clock frequency is 2 MHz. How long will it take to serially load an 8-bit shift register?

(c) The bit sequence 0010 is serially entered (right most bit first) into a 4-bit parallel out left shift register that is initially clear. What are the outputs after two clock pulses?

(d) Draw the circuit diagram and explain how to convert a MOD-16 counter to a decade counter.

2+2+(1+1)+(2+2)

7. (a) What is A/D conversion? Find the output voltage from a 5-bit ladder that has a digital input of 11101.
[Take state 0 = 0V, State 1 = +10V.]

(b) Write at least two differences between RAM and ROM.

(c) Implement the following Boolean function using Programmable Logic Array (PLA).

$F = A + \bar{C}B$. (2+3)+2+3

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(Syllabus : 2019-20 & 2018-19)

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(Syllabus : 2018-2019)

[Electromagnetic Theory]

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer ***question no.*** **1** and ***any four*** questions from the rest.

1. Answer ***any five*** questions : 2×5

(a) Consider a parallel plate capacitor which is maintained at potential of 200 V. If the separation distance between the plates of the capacitor is 1 mm and area of the plates are 20 cm^2, calculate the displacement current for the time in 1 μs.

(b) Find the velocity of light in a medium for which relative permittivity and relative permeability are 3 and 2, respectively.

(c) The vector potential $\vec{\mathbf{A}} = \beta x\,\hat{\mathbf{i}} + 2y\,\hat{\mathbf{j}} - 3yz\,\hat{\mathbf{k}}$ satisfies Coulomb Gauge condition. Find β.

(d) Explain the terms 'good conductor' and 'poor conductor' depend on frequency.

(e) What do you mean by 'anomalous dispersion' and 'normal dispersion'?

(f) What is Brewster's angle?

(g) Calculate the thickness of a half-wave plate for a light of wavelength 500 nm.

[Given : $n_o = 1.5442$; $n_e = 1.5533$]

2. (a) Using Maxwell's equations, establish that light is a transverse electromagnetic wave.

(b) Given $\vec{\mathbf{E}} = E_m \sin(\omega t - \beta z)\,\hat{\mathbf{j}}$ in free space. Calculate $\vec{\mathbf{B}}$. Hence show that $\vec{\mathbf{E}}$ and $\vec{\mathbf{B}}$ are mutually perpendicular. The symbols have their usual meanings.

(c) Prove that EM energy is equipartitioned between the magnetic and electric energies for a plane EM wave in linear dielectric medium. (2+3)+(2+1)+2

3. (a) What is Poynting vector?

(b) Show how Maxwell's equations in free space imply local conservation of charge.

(c) Show that time varying electric field is non-conservative. Hence or otherwise express the time varying electric field in terms of vector and scalar potentials.

(d) A radio station transmits a 10 kW signal at a frequency of 100 MHz. Assume it radiates as a point source. At a distance of 1 km from the antenna, find the amplitude of the electric and magnetic field strengths, and the energy incident normally on a square plate of side 10 cm in 5 min.

1+2+(1+3)+(1+1+1)

4. (a) A plane polarized electromagnetic wave is incident at an angle θ with the normal at the interface of two dielectric media. Find the relation between the angles of incidence, reflection and refraction.

(b) A monochromatic electromagnetic wave in vacuum is incident normally on a substance having refractive index of 1.5. Assume that the permeability is the same on both sides of the interface, (i) calculate the ratio of magnitude of the electric field vector of the reflected wave to that of the incident wave, (ii) what percentage of the total intensity of the incident wave is transmitted into the substance? 4+(3+3)

5. (a) Derive electromagnetic wave equations in a conducting medium.

(b) Show that a plane electromagnetic wave is attenuated as it propagates through a conducting medium.

(c) What is skin depth? 3+5+2

6. (a) A left circularly polarized light propagating along z direction falls on a half-wave plate made from calcite crystal. Optic axis of the plate is cut parallel to the surface. Write down x and y components of electric field after the wave emerges out of the plate. What is the state of polarization of the emergent light?

(b) A thin polaroid, placed between two crossed polaroids is allowed to rotate at a rate 'ω' about their common central axis. Determine the intensity of transmitted light in terms of intensity of unpolarized light.

(c) What are uniaxial and biaxial crystals? What is the basic difference between an elliptically and a circularly polarized wave? (3+1)+3+(2+1)

7. (a) A 20 cm length of a certain optically active solution causes right-handed rotation of 40° and a 30 cm length of another solution, which does not chemically react with the first solution, causes left-handed rotation of 24°. What will be the optical rotation produced by 30 cm length of a mixture of the above solutions in volume ratio 1:2?

(b) A ray of yellow light ($\lambda = 5893$Å) incident on a doubly refracting plate at an angle 50°. The plate is cut so that the optic axis is perpendicular to the plane of incidence and parallel to the front face. Find the angular separation between two emerging rays. (Given : $n_o = 1.662$, $n_e = 1.474$)

(c) Explain Fresnel's theory of rotation of plane of polarization by an optically active substance. 3+4+3
