

2022

Full Marks - 60

Time - 3 hours

The figures in the right-hand margin indicate marks

Answer *all* questions

**Part-I**

1. Answer the following : 1 × 8

- a) The value of  $(i)^{30} = \underline{\hspace{2cm}}$ .
- b) The point at which a function is not analytic is called  $\underline{\hspace{2cm}}$ .
- c) Write the complex form of Fourier integral representation.
- d) The Fourier transform of  $e^{-x^2/2}$  simply repeats itself. (True/false)
- e) If  $f(k)$  is the Fourier transform of  $f(t)$  then the Fourier transform of  $f(t \pm a)$  is  $\underline{\hspace{2cm}}$ .
- f) Write heat flow equation in ID.
- g)  $L\{t^5\} = \underline{\hspace{2cm}}$ .
- h) Define Laplace transform.

**Part-II**

2. Answer any *eight* of the following : 1½ × 8

- a) Find the complex conjugate of  $\frac{1+2i}{1-i}$ .
- b) State Cauchy's Integral theorem.
- c) Find  $\oint \frac{e^z}{z^2+9} dz$  inside C if  $|z|=2$  is C.
- d) Find the Taylor's series expansion of  $f(z) = \sin z$  about  $z=0$ .
- e) Find Fourier sine transform of  $a^{-at}$ .
- f) State convolution theorem.
- g) Prove change of scale property of Fourier-transform.
- h) Find Laplace's transform of  $e^{3t} + e^{-2t}$ .
- i) Find the Laplace's transform of  $f(t) = t$ .
- j) Write Linearity property of Inverse Laplace's transform.

**Part-III**

3. Answer any *eight* of the following : 2 × 8

- a) Find the location of inverse of  $4 - 3i$  in the argand diagram.
- b) State necessary and sufficient condition for a function to be analytic.

- c) Find the analytic function  $f(z) = u + iv$ , if  $v(x, y) = y^2 - x^2$ .
- d) Define zeroes and singular point of a complex function.
- e) Find the Fourier cosine integral representation of  $f(x) = \begin{cases} \sin x, & 0 \leq x \leq \pi \\ 0, & x > \pi \end{cases}$
- f) Prove shifting property of Fourier transform.
- g) Write down the properties of Dirac delta function.
- h) Find the value of  $\int x e^{-3x} \sin x \, dx$ .
- i) Find Laplace transform of first derivative of  $f(t)$ .
- j) Find  $f(t)$  whose Laplace transform is

$$F(s) = \frac{1}{s(s-a)}$$

#### Part-IV

4. a) Derive Cauchy-Reimann conditions in polar form. 6

OR

b) State and prove Cauchy's Residue theorem in multiply connected region.

5. a) Find the Fourier transform of Gaussian distribution function  $f(x) = Ne^{-\alpha x^2}$ . 6

OR

b) Derive expression for Fourier sine and cosine transform of 1st derivatives.

6. a) State and prove convolution theorem for Fourier-transform. 6

OR

b) Find a solution of heat flow equation in ID using Fourier transform.

7. a) Find Laplace transform  $f(t) = t^n, n = 0, 1, 2, \dots$  6

OR

b) Using Laplace's transform solve the differential equation  $y'' + 2y' + 5y = e^{-x} \sin x$ .

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**Part-I**

1. Answer the following : 1 × 8
- a) Photoelectric effect illustrates \_\_\_ nature of light.
  - b) Bohr's atom model could not explain about \_\_\_ of Hydrogen spectral line.
  - c) \_\_\_ waves are not electro magnetic in nature.
  - d) Davison-Garmer experiment confirms \_\_\_ nature of particles.
  - e) Write uncertainty principle in terms of time and energy.
  - f) Which nucleus is highly stable ?
  - g) The unit of Radioactivity is \_\_\_.
  - h) A positron has same mass as that of \_\_\_.

**Part-II**

2. Answer any *eight* of the following :  $1\frac{1}{2} \times 8$

- a) Define work function.
- b) Calculate the energy associated with a photon of wave length  $6000\text{\AA}$ .  
 $h = 6.62 \times 10^{-34} \text{ JS}$
- c) Write Bohr's postulate explaining frequency condition.
- d) Calculate the De Broglie wavelength of electron moving with a speed of  $10^5 \text{ m/s}$ , mass of electron  $= 9.1 \times 10^{-31} \text{ kg}$ .
- e) Calculate the wavelength of photon whose energy is  $6 \times 10^{-18} \text{ J}$ .
- f) Write the failures of shell model.
- g) Explain packing factor of nucleus.
- h) Write down uses of Nuclear Reaction.
- i) Define Nuclear fission.
- j) Find the radius of  ${}_8\text{O}^{16}$  nucleus.

[ 3 ]

### Part-III

3. Answer any *eight* of the following :  $2 \times 8$

- a) What is Compton shift ? Write its expression.
- b) Derive Einstein's photo electron equation.
- c) Explain wave particle duality.
- d) State Heisenberg's uncertainty principle.
- e) Write down the limitations of Bohr's atom model.
- f) Write down the properties of Nuclear force.
- g) Find the wavelength of second line of Balmer series of Hydrogen atom if wavelength of 1st line is  $6683 \text{ \AA}$ .
- h) Find the energy equivalent of mass of  $1 \text{ amu}$ .
- i) Derive a relation between decay constant and half life period.
- j) Show that density of nucleus is independent of mass number.

**Part-IV**

4. a) Explain the Compton effect. How this effect is different from photoelectric effect? 6

OR

- b) Describe Frank-Hertz experiment.

5. a) Explain Davison German experiment. 6

OR

- b) Discuss the validity of Huygen's berg uncertainty principle with the help gamma ray microscope and estimate the ground state energy of H-atom.

6. a) Write down few experimental facts in suport of magic numbers. Draw shell model for  $^{208}\text{pb}_{82}$ . 6

OR

- b) Explain the terms of semi-empirical mass formula those are Quantum origin.

7. a) State and explain laws of Radioactivity decay. Define decay constant. 6

OR

- b) Describe the construction and working of a Nuclear reactor.



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**Part-I**

1. Answer the following : 1 × 8
- a) Which component increases the power of a signal.
  - b) The binary equivalent of  $(0.75)_{10}$  is \_\_\_\_.
  - c) n-binary literals can be combined with an AND operation in \_\_\_\_ possible ways.
  - d) Karnaugh Map is a \_\_\_\_ method used to simplify Boolean expressions containing two or four variables.
  - e) The 1's complement of 11011001 is \_\_\_\_.
  - f) Write the expression for differential d at the the output of a half subtractor.

[ 2 ]

g) The heart of all digital circuits is \_\_\_\_.

h) 1 byte = \_\_\_\_ bits.

### Part-II

2. Answer any *eight* of the following :  $1\frac{1}{2} \times 8$

a) Write three applications of IC's.

b) What is a water ? Write its uses.

c) Convert  $(437)_8$  to decimal.

d) Simplify the expression using De-Morgan's theorem

$$Y = [(A + B') - (B + C')]$$

e) Find out the decimal equivalent of minterm  $ABC'$ .

f) What is a transducer ?

g) Add the binary numbers  $(101.11)_2$  and  $(110.01)_2$ .

h) Subtract 100 from 111 by is complement method.

i) Define decoder.

j) Name different units of a digital computer.

[ 3 ]

### Part-III

3. Answer any *eight* of the following :  $2 \times 8$

- a) Draw circuit diagram for two input diode or gate.
- b) Describe how NOT gate can be obtained from NAND gate.
- c) State duality principle.
- d) Simplify the expression  $Y = AB + B(A + B) + C(B + C)$ .
- e) Explain sum of product and product of sum.
- f) Draw block diagram of CRO.
- g) Distinguish between multiplexer and de-multiplexer.
- h) Write the applications of encoder.
- i) Subtract  $(1011)_2$  from  $(1001)_2$  by 2's complement method.
- j) Describe about control unit of a digital computer.

**Part-IV**

4. a) Define Integrated circuit. Write down the advantages and disadvantages of integrated circuit. 6

OR

- b) What is NAND gate ? Write the truth table and logic symbol. Explain how NAND gate can be realised using diodes and transistors.

5. a) State and prove De Morgan's theorem. 6

OR

- b) Describe the construction of CRO with diagram. Find expression for electrostatic deflection.

6. a) Describe a full adder with logic circuit. 6

OR

- b) What is IC-555 timer. Describe 8-pins IC-555 timer with block diagram.

7. a) Explain data storage giving brief description of RAM and ROM. 6

OR

- b) Describe ring counter with logic diagram using D-flip-flops.

2019

Full Marks - 40

Time - 2 hours

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Answer *all* questions

1. a) Discuss about non-conventional energy sources along with their advantages and disadvantages over conventional energy sources. 10
- b) Discuss about the procedure on the generation of biogas. 5
- c) Briefly discuss about Fossil fuel as a source of energy. 5

OR

- d) Discuss the characteristics of photovoltaic systems. 5
- e) Discuss the construction and working principle of solar cell. 10
- f) Briefly discuss about the procedure to be followed for the storage of solar energy. 5

2. a) Discuss how wind energy can be utilized as one of the alternative source of energy. 6
- b) Discuss the potential of ocean energy against wind and solar energy. 3 + 3
- c) Write notes on wave energy devices. 4
- d) Write notes on wind turbines. 4

OR

- e) Discuss about the hydropower resources and hence its impact on environment. 5 + 5
- f) Explain the technology involved in geothermal power plant. 6
- g) Write notes on ocean bio-mass. 4

2019

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Answer *all* questions

1. a) Define steady flow, incompressible flow and irrotational flow. 3
- b) Explain why the viscosity of liquid decreases with temperature while viscosity of gases increases with temperature. 3
- c) Define coefficient of viscosity. Explain with experimental details the determination of coefficient of viscosity of a liquid. 2 + 7

OR

- d) What are saw tooth wave and square wave? What are their applications? 3
- e) Define reverberation. How can the reverberation of a large auditorium be controlled? 3

- f) Define Q-factor of resonance. Explain with necessary mathematical theory how resonance is achieved in case of forced vibration. 2 + 7
2. a) Define group velocity and phase velocity. 3
- b) What are Lissajous figures and what are their uses ? 3
- c) Discuss with necessary theory the superposition of two perpendicular simple harmonic motions of equal frequencies but different amplitudes in detail. 9

OR

- d) A source of sound of frequency 500 Hz is producing longitudinal waves in air. The distance between two successive rarefactions in wave is 0.64 m and amplitude of vibration of particle is 0.002m. Find the distance-displacement equation of the wave. 3
- e) Differentiate between dispersive and non-dispersive medium. 3



- f) State the wave equation for one dimensional motion and obtain its solution. 9
3. a) What are conditions for sustained interference of light waves? 3
- b) What is biprism? How coherent sources are achieved in Fresnel's biprism. 3
- c) Describe the formation of interference fringes using two parallel slits in Young's experiments. Obtain an expression for fringe width. What is the effect of increasing the width of the slits. 9

OR

- d) A wedge shaped film is illuminated by light of wavelength  $4650 \text{ \AA}$ . The angle of wedge is  $40$  seconds. Calculate the fringe separation between two consecutive fringes. 3
- e) Differentiate between fringes of equal width and fringes of equal inclination. 3
- f) What are Newton's rings? With necessary diagram derive an expression for the radii of the rings. 9

4. a) Calculate the radius of first zone in a zone plate of focal length 16cm for light of wavelength  $6400\text{\AA}$ . 3
- b) What are the differences between interference and diffraction? 3
- c) Explain the concept of Fresnel's half period zones and show that the area of all the zones are nearly the same. 9

OR

- d) Distinguish between Fresnel and Fraunhofer class of diffraction. 3
- e) Microwaves of wavelength 20 cm are incident normally on a 5.0 cm wide slit. Deduce the angular width of the central maximum. 3
- f) Derive an expression for the intensity distribution due to Fraunhofer diffraction at a single slit and show that the intensity of the first subsidiary maximum is roughly 4.5% of that of the principal maximum. 9