

2023

6th Semester Examination

PHYSICS (Honours)

Paper : DSE 4-T

[CBCS]

*The figures in the margin indicate full marks.
Candidates are required to give their answers
in their own words as far as practicable.*

[Digital Signal Processing]

Full Marks : 40

Time : Two Hours

Group - A

Answer any *five* questions : $2 \times 5 = 10$

1. Define convolution theorem. 2
2. Explain the advantages of digital filters over analog filters. 2
3. Find the inverse Z-transform of $X(z) = \sin Z$. 2
4. Define ROC in Z-transform. 2
5. Write down properties of Discrete Time Fourier transform (DTFT). 2
6. Define IIR and FIR filters. 2

P.T.O.

(2)

7. What is an LTI system. 2

8. What are phase delay and group delay? 2

Group - B

Answer any **four** questions : 5×4=20

9. Prove the Convolution theorem for DTFT. 5

10. Find the inverse Fourier transform of

$$X(e^{j\omega}) = \frac{1}{1 - \frac{1}{3}e^{-j\omega}} \quad 5$$

11. What is the magnitude of the frequency response of the cascade of the following two systems :

$$(a) H_1(e^{j\omega}) = \frac{e^{-j\omega} - 0.5}{1 - 0.5e^{-j\omega}}$$

$$(b) h_2(n) = \delta(n) - \frac{\sin\left(\frac{n\pi}{4}\right)}{n\pi} \quad 2+3=5$$

12. Evaluate the integral : 5

$$\int_{-\pi}^{+\pi} \frac{e^{j\omega}}{1 - 0.3e^{-j\omega}} d\omega$$

13. Consider the discrete time sequence 5

$$x(n) \cos\left(\frac{n\pi}{8}\right)$$

14. Find the inverse of the following Z-transform

5

$$X(Z) = 4 + 3(Z^2 + Z^{-2})$$

$$0 < |z| < \infty$$

Group - C

Answer any *one* question :

10×1=10

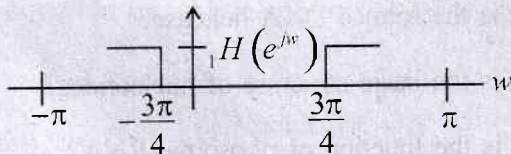
15. Find the group delay for each of the following systems :

5+5=10

(a) $H_1(e^{j\omega}) = 1 - \alpha e^{-j\omega}$

(b) $H_2(e^{j\omega}) = \frac{1}{1 - \alpha e^{-j\omega}}$

16. Consider the high-pass filter that has cut off frequency $\omega_c = 3H/4$ as shown in the following figure.



(a) Find the unit sample response, $h(n)$.

(b) A new system is defined so that its unit sample response is $h_1(n) = h(2n)$. Sketch the frequency response, $H_1(e^{j\omega})$.

5+5=10

P.T.O.

(4)

OR

[Biological Physics]

Full Marks : 60

Time : Three Hours

Group - A

Answer any *ten* questions : $2 \times 10 = 20$

1. What is the structure of amino acid? What is the number of essential amino acids in a human body?
2. What is the composition of cell membrane?
3. Which neurotransmitter is responsible for calmness and pleasure?
4. Compare mitosis with meiosis.
5. What are the functions of cytoskeleton?
6. What is the role of RNA primer?
7. What is the role of DNA helicase?
8. What is the basic structure of nucleotides?
9. What is the function of ribosomal RNA?
10. What is the difference between active and passive transport?
11. What are the steps of enzymatic catalysis?
12. What do you mean by "codon"? How many codons are there?

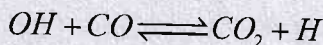
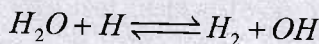
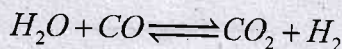
(5)

13. What is paracrine signalling?
14. Which type of stem cell gives rise to red and white blood cells?
15. Name the proteins that influence the external phenotype of drosophila fruit fly.

Group - B

Answer any *four* questions : $5 \times 4 = 20$

16. Discuss how circadian oscillators work to maintain time.
17. What are the various mechanism by which cells migrate from one place to other?
18. Obtain an expression for the binding probability of RNA polymerase to promoter region.
19. Explain how DNA transcription takes place.
20. Write down the stoichiometric matrix for the following reactions :



21. Write down the various classifications of memory.

P.T.O.

(6)

Group - C

Answer any *two* question : $10 \times 2 = 20$

22. Discuss how bicoid protein gives rise to morphogenic stripes on drosophila fruit fly. Establish the equation involving decay constant. What is synaptic plasticity? Write down the names of three excitatory neurotransmitters. $5+2+3$
23. The elasticity of polymer chains in our body can be well explained by random walk model in 3D. Develop the model and show why circular structure of DNA is statistically preferred. $5+5$
24. What are the three most important energy storage units in cells? Describe the storage mechanism in each case. $3+7$
25. What is the objectives and motivation behind FRAP experiment? Establish the diffusion equation from Fick's law and mass conservation. $5+5$
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OR

[Experimental Techniques]

Full Marks : 40

Time : Two Hours

Group - A

1. Answer any *five* of the following questions. $2 \times 5 = 10$

(i) Count the total number of significant figures in the following measurements :

(a) 0.0500

(b) 2400

(c) 9500

(d) 5.70×10^5

(ii) Round off the following numbers to three significant figures :

(a) 24.937

(b) 36.350

(c) 42.450×10^9

(d) 742396

(iii) The mass and density of a solid sphere are measured to be $(12.4 \pm 0.1)\text{kg}$ and $(4.6 \pm 0.2)\text{kg/m}^3$. Calculate the volume of the sphere with error limits.(iv) Calculate equivalent resistance with error limit of two resistors R_1 and R_2 in parallel, where $R_1 = (9 \pm 0.2)\Omega$ and $R_2 = (6 \pm 0.1)\Omega$.

(v) Write down the working pressure ranges of Rotary pump, Diffusion pump, Pirani gauge and Penning gauge.

P.T.O.

- (vi) What do you mean by noise figure?
- (vii) What is thermal noise?
- (viii) Write two differences between analog and digital instruments.

Group - B

Answer any *four* of the following questions :

$$5 \times 4 = 20$$

2. The diameter of a wire as measured by a screw gauge in a number of measurements was found to be 2.620, 2.625, 2.630, 2.628 and 2.626 cm.

Calculate (i) mean value of diameter (rounding off to three decimal places) (ii) mean absolute error (iii) fractional error and (iv) percentage error. 5

3. Write down the properties of transfer functions of an instrument. What do you mean by the zero-order instrument? Give two examples of it. $2+2+1=5$

4. A rotary pump removes air from a 300-litre chamber at the rate of 0.5 litre/sec. What would be the pressure in the chamber after 20 sec if the initial pressure were 1 atm. 5

5. Write down the two methods for measurement of linear displacement using capacitive transducer. $2\frac{1}{2}+2\frac{1}{2}=5$

6. What is Q meter? Write its uses. 3+2

7. What are periodic and non-periodic signals? Determine whether the signal $x(t) = [\cos(2\pi t)]^2$ is periodic or not. If periodic, find the fundamental period. 2+3

Group - C

Answer any *one* of the following questions :

10×=10

8. (a) Define Gauge factor (G) of a strain gauge. Derive the expression,

$$G = 1 + 2\sigma + \frac{\Delta\rho/\rho}{\Delta l/l}, \text{ where, } \sigma \text{ is the Poisson's ratio}$$

and ρ is the resistivity of the wire.

- (b) Write down the working principle of a metallic strain gauge and a semiconductor type strain gauge.

1+4+2½+2½=10

9. What is transducer? Write the working principle of a Linear Variable Differential Transformer (LVDT). How does a scintillation detector work? What are the different temperature transducers? 2+4+2+2