

**2021/TDC/CBCS/ODD/  
PHSHCC-301T/150**

**TDC (CBCS) Odd Semester Exam., 2021  
held in March, 2022**

**PHYSICS**

**( 3rd Semester )**

Course No. : PHS HCC-301T

**( Mathematical Physics—II )**

Full Marks : 50

Pass Marks : 20

Time : 3 hours

*The figures in the margin indicate full marks  
for the questions*

**SECTION—A**

Answer any ten of the following questions :  $2 \times 10 = 20$

1. Explain what you understand by odd function and even function.
2. State whether  $y = \tan x$  can be expressed as a Fourier series. If so, how? If not, why?

( 2 )

3. State Parseval's identity.
4. Explain what you understand by regular and irregular singular points.
5. Find the ordinary point and singular point of the differential equation

$$x^2 \frac{d^2 y}{dx^2} + x \frac{dy}{dx} + (1-x)y = 0$$

6. What is the degree and order of the following differential equation?

$$\frac{dy}{dx} = \frac{x^4 - y^4}{(x^2 + y^2)xy}$$

7. Write the Rodrigues' formula for Legendre polynomial. What is the orthogonality condition of the Legendre polynomial?
8. Prove that  $P_n(1) = 1$ .
9. Expand  $J_0(x)$ .
10. Find the value of  $\Gamma\left(\frac{1}{2}\right)$ .
11. Prove that beta function  $\beta(m, n)$  is symmetric in  $m$  and  $n$ .

( 3 )

12. Prove that  $\delta(x) = \delta(-x)$ .
13. Express Laplace's equation in cylindrical coordinates.
14. Solve
 
$$\frac{\partial^2 z}{\partial x \partial y} = x^2 y$$
15. Write down two applications of PDE in physics.

## SECTION—B

Answer any *five* of the following questions :  $6 \times 5 = 30$ 

16. Find the Fourier series of  $f(x) = x + x^2$  in  $(-\pi, \pi)$ . 6
17. A sawtooth wave is defined as  $f(x) = x$ ,  $-\pi \leq x \leq \pi$ . Find the Fourier series of the function. 6
18. Write down Legendre's differential equation and obtain the power series solution for it. 6
19. Discuss Frobenius method of solving a differential equation. 6

( 4 )

20. Find the expand of  $J_{1/2}(x)$  using the general expression for Bessel function of first kind. 6

21. Prove the recurrence relations : 3+3=6

$$(i) \quad xJ'_n(x) = nJ_n(x) - xJ_{n+1}(x)$$

$$(ii) \quad 2nJ_n(x) = x[J_{n-1}(x) + J_{n+1}(x)]$$

22. (a) Prove that

$$\beta(m, n) = \frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$$

(b) Show that

$$\beta(m+1, n) = \frac{m}{m+n} \beta(m, n) \quad 4+2=6$$

23. Explain how Dirac delta function can be expressed as a limit of (a) Gaussian function and (b) rectangular function. 3+3=6

24. The displacement  $y$  of a viscously damped string is given by

$$\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2} - 2k \frac{\partial y}{\partial t}$$

Find the general solution of the above equation by the method of separation of variables. 6

( 5 )

25. Solve the boundary value problem

$$\frac{\partial u}{\partial x} = 4 \frac{\partial u}{\partial y}$$

given  $u(0, y) = 8e^{-3y}$ , by the method of separation of variables. 6

★ ★ ★

**TDC (CBCS) Odd Semester Exam., 2021  
held in March, 2022**

**PHYSICS**

**( 3rd Semester )**

Course No. : PSHCC-302T

**( Thermal Physics )**

Full Marks : 50

Pass Marks : 20

Time : 3 hours

*The figures in the margin indicate full marks  
for the questions*

**SECTION—A**

Answer any ten of the following questions :

2×10=20

1. What are reversible and irreversible processes?
2. Explain why gases have two specific heats while solids have only one.
3. Distinguish between isothermal and adiabatic processes.

( 2 )

4. Narrate the third law of thermodynamics.
5. Explain in brief the concept of 'heat death of the Universe'.
6. State the significance of thermodynamic potential.
7. What do you mean by Joule-Kelvin coefficient for an ideal gas?
8. Discuss in brief the change of temperature during adiabatic process.
9. Define phase transition. What is first order phase transition?
10. Define free path and mean free path.
11. State the law of equipartition of energy.
12. What is the effect of temperature and pressure on thermal conductivity?
13. State the law of corresponding states.
14. What is temperature of inversion?
15. In what way a real gas differs from an ideal gas?

( 3 )

## SECTION—B

Answer any *five* of the following questions :  $6 \times 5 = 30$ 

16. (a) Show that for one mole of an ideal gas  $C_p - C_v = R$  (symbols have their usual meanings). 3  
 (b) A Carnot engine has an efficiency of 30% when the temperature of the sink is  $27^\circ\text{C}$ . What must be the change in temperature of the source to make its efficiency 50%? 3
17. (a) State the first law of thermodynamics. Explain how first law of thermodynamics leads to the concept of internal energy. 1+2=3  
 (b) Write the second law of thermodynamics as stated by Kelvin-Planck and Clausius, and discuss their equivalence. 3
18. (a) Show that the entropy of a perfect gas remains constant in a reversible process. 3  
 (b) State and explain the temperature-entropy diagram for Carnot's cycle. 3
19. (a) Prove that for a complete reversible cycle, change in the state of substance  $\oint dS = 0$ . 3

( 4 )

- (b) Define the following : 3  
 (i) Enthalpy  
 (ii) Helmholtz free energy  
 (iii) Gibbs' free energy
20. (a) Derive the Clausius-Clapeyron equation. 3  
 (b) From the consideration of Maxwell's thermodynamic relations, show that  $C_p - C_v = R$  (here symbols have their usual meanings). 3
21. (a) Deduce Maxwell's first thermodynamic relation using the laws of thermodynamics. 3  
 (b) Explain how the boiling point of a liquid and melting point of a solid are affected with the change of pressure. 3
22. (a) Using Maxwell-Boltzman distribution law of velocities, find an expression for the mean speed in an ideal gas. 3  
 (b) What do you mean by Doppler broadening of spectral lines? 3
23. (a) Discuss in brief the Brownian motion and its significance. 3

( 5 )

- (b) Derive the relation for coefficient of self-diffusion  $D$  and show that it is directly proportional to  $T^{3/2}$ . 3
24. (a) What is Joule-Thomson effect? How will you interpret the effect experimentally? 3  
 (b) Discuss in brief Andrews experiment on  $\text{CO}_2$  gas. 3
25. (a) Define critical coefficient of a gas. Is it same for all gases? Does experimental value agree with the theoretical value? 3  
 (b) Define temperature of inversion. Derive the expression for the inversion temperature for van der Waals' gas  

$$T_i = \frac{2a}{R_b}.$$
 3

\*\*\*

**2021/TDC/CBCS/ODD/  
PHSHCC-303T/152**

**TDC (CBCS) Odd Semester Exam., 2021  
held in March, 2022**

**PHYSICS**

**( 3rd Semester )**

Course No. : PSHHCC-303T

**( Digital Systems and Applications )**

Full Marks : 50

Pass Marks : 20

Time : 3 hours

*The figures in the margin indicate full marks  
for the questions*

**SECTION—A**

Answer any *ten* of the following questions :

2×10=20

1. Obtain the expression for deflection sensitivity of a CRO.
2. Give two examples each of linear and digital ICs.
3. Convert 4DF hexadecimal number to octal number.

( 2 )

4. What do you mean by minterms and maxterms?
5. Draw the block logic diagram of the following Boolean equation :

$$Y = AC + B\bar{C}$$

6. Write briefly about decoders.
7. Discuss how 2's complement method is used in representing a negative number.
8. What do you mean by race-around conditions in a  $J-K$  flip-flop?
9. Briefly describe the working of a 2-bit binary adder.
10. What is the function of shift registers in digital computers?
11. Describe briefly how data is stored in digital computers.
12. Write a brief note on ring counters.
13. Draw the block diagram of the organization of an 8085 microprocessor.

( 3 )

14. Why is stack memory used in microprocessors?
15. Write MOV and MVI instructions used in 8085 microprocessor.

## SECTION—B

Answer any *five* of the following questions :  $6 \times 5 = 30$

16. Using labelled diagram, realize two-input OR and AND gates using diodes and hence explain their working. 3+3=6
17. (a) Explain active and passive components used in electronics with examples. 2  
 (b) Explain how phase difference between two sinusoidal signals is measured by using a CRO. 4
18. (a) Verify the following Boolean laws : 2  
 (i)  $A \cdot \bar{A} = 0$   
 (ii)  $A + \bar{A} = 1$   
 (b) State and prove De Morgan's laws. 4
19. (a) Simplify the following expression : 1  

$$\overline{AB + \bar{A} + AB}$$
  
 (b) What is a multiplexer? Explain the working of a 4-bit multiplexer. 5



( 4 )

20. (a) What is the function of *D* flip-flop in digital electronics? 2
- (b) Develop the truth table for a half-adder and then draw its logic circuit diagram along with its Boolean expressions. 4
21. Explain the working of a *J-K* flip-flop with proper logic diagram. 6
22. Describe in detail about parallel-in parallel-out shift register used in digital computers. 6
23. With proper diagram, describe various functional units of a digital computer. 6
24. (a) Write an example of instruction code each for 1-byte and 2-byte instructions. 2
- (b) With proper diagram, describe the internal organization of an 8085 micro-processor. 4
25. Explain the pin-out configurations of a 555 timer IC. Explain its working as a monostable multivibrator of a given duration.

2+4=6

★ ★ ★