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3 SEM TDC PHYH (CBCS) C 5

2 0 2 4

(Nov/Dec)

PHYSICS

(Core)

Paper : C-5

(Mathematical Physics—II)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

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

1. Choose the correct answer : 1×5=5

(a) The following differential equation

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

is known as

- (i) Legendre's equation
- (ii) Bessel's equation
- (iii) Laguerre's equation
- (iv) Hermite's equation

(2)

(b) The value of $\operatorname{erf}_c(x) + \operatorname{erf}_c(-x)$ is

- (i) 1 (ii) 2
(iii) -1 (iv) 0

(c) The value of $\Gamma(\frac{1}{2})$ is

- (i) $\sqrt{\pi}$ (ii) $\frac{-\pi}{2}$
(iii) $-2\sqrt{\pi}$ (iv) 0

(d) The value of Legendre polynomial $P_1(x)$ is

- (i) 1 (ii) x
(iii) $\frac{1}{2}$ (iv) None of the above

(e) The value of $P_n(-1)$ is

- (i) 1 (ii) -1
(iii) 0 (iv) None of the above

2. (a) Write down the Parseval's formula for Fourier series. 2

(b) Expand the function $f(x)$ in a Fourier series where $-\pi < x < \pi$ and $f(x)$ is given by

$$f(x) = 0 \text{ when } -\pi < x \leq 0 \\ = \frac{\pi x}{4} \text{ when } 0 < x \leq \pi$$

Hence show that $\frac{\pi^2}{8} = 1 + \frac{1}{3^2} + \frac{1}{5^2} + \dots$ 4+2=6

(c) Expand $f(x) = e^x$ in a cosine series over $(0, 1)$. 3

(3)

3. (a) What do you mean by ordinary and singular points of a differential equation? Find the nature of the point $x = -1$ with reference to the differential equation

$$x^2(x+1)\frac{d^2y}{dx^2} + (x^2-1)\frac{dy}{dx} + 2y = 0 \quad 1+2=3$$

(b) Solve any one of the following using Frobenius method : 5

- (i) $9x(1-x)y'' - 12y' + 4y = 0$
(ii) $xy'' + y + xy = 0$

(c) Prove that

$$\int_{-1}^1 P_m(x)P_n(x)dx = \frac{2}{2n-1}\delta_{mn} \quad 3$$

Or

Express $2-3x+4x^2$ in terms of Legendre polynomials.

(d) Prove the following : 2×2=4

- (i) $P_n(1) = 1$
(ii) $P'_n(1) = \frac{1}{2}n(n+1)$

4. Show that

$$\beta(l, m) = \frac{\Gamma(l)\Gamma(m)}{\Gamma(l+m)} \quad 3$$

Or

$$\Gamma(n)\Gamma(1-n) = \frac{\pi}{\sin n\pi}$$

5. Answer any *two* of the following : 3×2=6

(a) Define absolute error, relative error and percentile error. 3

(b) $R = \frac{4xy^2}{z^3}$ and errors in x, y, z be 0.001,

show that the maximum relative error at $x = y = z = 1$ is 0.006. 3

(c) State and prove the normal law of errors. 3

6. (a) Solve any *two* of the following partial differential equations by the method of separation of variables : 4×2=8

(i) $\frac{\partial^2 z}{\partial x^2} - 2 \frac{\partial z}{\partial x} - \frac{\partial z}{\partial y} = 0$

(ii) $\frac{\partial^2 u}{\partial x \partial t} = e^{-t} \cos x$ under the following conditions :

$$u = 0 \text{ at } t = 0; \quad \frac{\partial u}{\partial t} = 0 \text{ at } x = 0$$

(iii) $\frac{\partial^2 u}{\partial x^2} = \frac{\partial u}{\partial y} + 2u$ under the following conditions :

$$\text{At } x = 0, u = 0 \text{ and } \frac{\partial u}{\partial x} = 1 + e^{-3y}$$

(b) Find the solution of one-dimensional wave equation in Cartesian coordinates. 5

Or

Find the solution of 2-D Laplace's equation in spherical coordinates.

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2 0 2 4

(Nov/Dec)

PHYSICS

(Core)

Paper : C-6

(Thermal Physics)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

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

1. Choose the correct answer : 1×5=5

(a) If the temperature of the source of the Carnot engine is increased, then its efficiency

(i) increases

(ii) decreases

(iii) remains same

(iv) first increases then decreases

(2)

- (b) The thermodynamic process in which there is no heat exchange between system and surroundings is
- (i) isothermal
 - (ii) isobaric
 - (iii) isochoric
 - (iv) adiabatic
- (c) If a liquid crystallises into solid, the entropy will
- (i) increase
 - (ii) decrease
 - (iii) remain same
 - (iv) become zero
- (d) The relationship between translational kinetic energy (E) of a gas and the temperature (T) is
- (i) $3E = 2NK_B T$
 - (ii) $3E = 4NK_B T$
 - (iii) $2E = 3NK_B T$
 - (iv) $2E = NK_B T$
- (e) The SI unit of thermal conductivity is
- (i) $\text{Wm}^{-1}\text{K}^{-1}$
 - (ii) $\text{Wm}^{-2}\text{K}^{-1}$
 - (iii) $\text{W}^{-1}\text{mK}^{-1}$
 - (iv) WmK^{-1}

(3)

2. Answer any *five* of the following : 2×5=10
- (a) Write the expressions for compressibility and expansion coefficients.
 - (b) Distinguish between reversible and irreversible processes.
 - (c) "The entropy of the universe is always increasing." Justify the statement.
 - (d) Calculate the most probable speed for oxygen molecules at 300 K. Given, mass of O_2 molecule is 5.31×10^{-26} kg and $K_B = 1.38 \times 10^{-23} \text{ JK}^{-1}$.
 - (e) Find an expression for entropy in an isothermal-isochoric process in terms of Helmholtz free energy.
 - (f) Obtain a relation between thermal conductivity and viscosity.
3. Establish a relation between C_p and C_v with the help of first law of thermodynamics. 5
- Or
- Discuss the concept of temperature in the light of zeroth law of thermodynamics.
4. State and prove the Carnot theorem. 5
5. Write the expression for work done in a Carnot cycle and hence, obtain an expression for efficiency of a Carnot engine. 3

6. Establish the Clausius inequality. 4

Or

Discuss how entropy changes in an irreversible process.

7. Deduce the first and second TdS equations, where the symbols have their usual meanings. 4

8. The van der Waal's constants of hydrogen are

$$a = 2.47 \times 10^{-2} \text{ Nm}^4 \text{ mol}^{-2}$$

$$\text{and } b = 26.5 \times 10^{-6} \text{ m}^3 \text{ mol}^{-1}$$

Calculate the temperature of inversion. Given $R = 8.3 \text{ JK}^{-1} \text{ mol}^{-1}$. 4

9. Derive an expression for Boyle temperature on the basis of van der Waals' equation. 5

Or

Obtain the law of corresponding states using reduced variables. 5

10. Write short notes on any two of the following : $4 \times 2 = 8$

(a) Brownian motion

(b) Adiabatic demagnetization

(c) Thermodynamic scale of temperature

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3 SEM TDC PHYH (CBCS) C 7

2 0 2 4

(Nov/Dec)

PHYSICS

(Core)

Paper : C-7

(Digital Systems and Applications)

Full Marks : 53

Pass Marks : 21

Time : 3 hours

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

1. Choose the correct answer : 1×5=5

(a) For observing a signal in an oscilloscope, it is to be applied

- (i) across its X-plates
- (ii) across its Y-plates
- (iii) to the horizontal amplifier
- (iv) to the trigger circuit

(b) The expression $\overline{ABC}$ can be simplified to

- | | |
|--|---|
| (i) $\overline{A} \cdot \overline{B} \cdot \overline{C}$ | (ii) $AB + BC + CA$ |
| (iii) $AB + \overline{C}$ | (iv) $\overline{A} + \overline{B} + \overline{C}$ |

(2)

- (c) An X-OR gate produces high output only when its two inputs are
- (i) high
 - (ii) low
 - (iii) different
 - (iv) same
- (d) The half adder is constructed from
- (i) two X-OR gates
 - (ii) one X-OR gate and one OR gate with their inputs connected in parallel
 - (iii) one X-OR gate and one AND gate with their inputs connected in parallel
 - (iv) one X-OR gate and one NAND gate
- (e) If an inverter is placed at the input of an S-R flip-flop, the result is
- (i) D flip-flop
 - (ii) J-K flip-flop
 - (iii) T flip-flop
 - (iv) BCD decade counter

2. What is integrated circuit? How can a transistor be fabricated in an IC? 3

Or

Deduce an expression for deflection sensitivity of CRT.

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(Continued)

(3)

3. (a) Convert hexadecimal number 4DFA into binary number. 2
- (b) Describe how NOR gate can be constructed using diodes and transistors. Explain their action with their truth table. 3
4. (a) State and prove De Morgan's two theorems. 3
- (b) Show that $AB + \bar{A}\bar{B}C + \bar{A}B\bar{C} = AC + \bar{B}C$ using Boolean algebra. 3

Or

Simplify the expression

$$Y = ABCD + ABC\bar{D} + A\bar{B}CD + A\bar{B}\bar{C}\bar{D}$$

using Karnaugh map and draw the logic circuit for the reduced expression. 3

5. Draw the logic diagram of multiplexer and explain it. 3
6. (a) Explain the circuit diagram of a full adder with truth table. 4

Or

What is the difference between adder and subtractor? Explain the circuit diagram of a half-subtractor. 1+3=4

- (b) Draw the logic diagram of 4-bit parallel-in parallel-out shift register. 2

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(Turn Over)

7. What is flip-flop? Explain the operation of *J-K* flip-flop. 1+3=4
8. (a) Explain the operation of astable multivibrator using IC-555. 3
- Or
- Draw and explain the functional diagram of IC-555.
- (b) What is the difference between decade counter and synchronous counter? 2
9. Write a short note on asynchronous counter. 4
10. (a) Write a short note on Random Access Memory (RAM). 2
- (b) Define primary and secondary memories. 2
11. (a) Explain with necessary diagram, the function of different pins of 8085 microprocessor. 5
- (b) Draw and explain the timing diagram for instruction MVI reg, data. 3

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