UG (CBCS) EVEN SEMESTER EXAMINATION, 2024

EDUCATION
(B.Sc. B.Ed.)

6th Semester

Course No. : BSPH – 601

(Theory of Relativity, Computational Physics & Mathematical Physics II)

Full Marks : 50
Pass Marks : 20

Time : 2 hours

The figures in the margin indicate full marks for the questions

1. (a) Derive the Einstein's mass energy relation $E=mc^2$ 8

   (b) Find the velocity of a particle if its K.E is equal to the rest mass energy. 2

Or

2. (a) Half-life of a particle at rest is 17.8 ns. What will be the half-life when its speed is 0.8 c? 2

   (b) Derive the transformation equations of relativistic velocities : 8

$$u_x{}' = \frac{u_x - v}{1 - \frac{vu_x}{c^2}}, \qquad u_y{}' = \frac{u_y\sqrt{1-\beta^2}}{1 - \frac{vu_x}{c^2}}, \qquad u_z{}' = \frac{u_z\sqrt{1-\beta^2}}{1 - \frac{vu_x}{c^2}}$$

3. (a) A function $f(x)$ is defined by $f(x) = 0$ if $x \leq 0$ or $x \geq 1$

(Turn Over)

and $f(x) = \frac{1}{2\sqrt{x}}$ for $0<x<1$. Check that the function $f(x)$ satisfies the two properties of a probability density function. 7

(b) Let event L be "born in a long month" and R be "born in a month with letter r". Find the probabilities P(L), P(R) and P(R|L). 3

Or

4. (a) Find the constant c such that the function $f(x) = \begin{cases} cx^2, & if\ 0 < x < 3 \\ 0, & otherwise \end{cases}$ is a probability density function. Also compute P(1<x<2) 7

(b) Show that a slight error in measurement in time period of simple pendulum will produce two times error in the measurement of acceleration due to gravity. 3

5. (a) Describe bisection method to find the solution of $f(x) = 0$ 6

(b) Derive the Newton-Raphson method for finding the solution of $f(x) = 0$ 4

Or

6. (a) Derive Simpson's $\frac{1}{3}$ rule for numerical integration. 6

(b) Evaluate $\int_0^1 e^x\, dx$ using Simpson's $\frac{1}{3}$ rule. 4

7. (a) Write an algorithm to find the factorial of a number n. Also draw its corresponding flowchart. 5

(b) Write an algorithm to find the sum of a series 1+2+3+ .... +N. Also draw its corresponding flowchart. 5

Or

8. (a) Write an algorithm to find the solutions of a quadratic equation $ax^2 + bx + c = 0$ 5

(b) Write an algorithm to find the sum of a series $1 - x + x^2 - x^3 + \ldots\ldots\ldots x^N$. Also draw its corresponding flowchart. 5

9. Find the solutions of Legendre's equation. 10

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

Or

10. Derive the orthogonal properties of Legendre's polynomial. 5+5=10

i) $\int_{-1}^{1} p_m(x)\, p_n(x) dx = 0, \quad m \neq n$

ii) $\int_{-1}^{1} [p_m(x)]^2\ dx = \frac{2}{2n+1}, \quad m = n$

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