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Reg. No. :

Code No. : 7523

Sub. Code : HPHM 12

M.Sc.(CBCS) DEGREE EXAMINATION,
NOVEMBER 2012.

First Semester

Physics

MATHEMATICAL PHYSICS — I

(For those who joined in July 2012 onwards)

Time : Three hours

Maximum : 75 marks

PART A — (10 × 1 = 10 marks)

Answer ALL questions.

1. What is meant by orthogonal set in vector space?
2. List out the main classification of the vector fields.
3. Write the relation between beta and gamma function.
4. Prove that $\Gamma(0) = \infty$.

5. Write the transformation equation for contravariant vectors.
6. Define gradient of a scalar in tensor form.
7. Define factor group.
8. What is Homomorphism?
9. State Laplace's equation.
10. What are D'Alembert's equations?

PART B — (5 × 5 = 25 marks)

Answer ALL questions, choosing either (a) or (b).

11. (a) Compare Gauss divergence, Stoke's and Green's theorem.

Or

- (b) Explain linear independence of vectors and dimensions in linear vector space.

12. (a) Prove the recurrence formula
 $P'_{n+1}(x) - P'_{n-1}(x) = (2n+1) P_n(x)$.

Or

- (b) Prove the recurrence relation
 $2x H_n(x) = 2n H_{n-1}(x) + H_{n+1}(x)$.

13. (a) "Symmetry property of a tensor is independent of coordinate system" prove it.

Or

- (b) Explain contraction of tensors in algebraic operation.
14. (a) Prove that two right cosets of a subgroup in a group are either equal or else have no elements in common.

Or

- (b) What are reducible and irreducible representations of a group?
15. (a) A string of length "l" fixed at both ends is plucked at distance "d" from one fixed point by an amount "h". Find the displacement at any position at any instant of time.

Or

- (b) Obtain the solution of Heat flow equation using methods of separation of variables.

PART C — (5 × 8 = 40 marks)

Answer ALL questions, choosing either (a) or (b).

16. (a) For a position vector that $\mathbf{r} = (ix+jy+kz)$, show that

(i) $\text{curl } \mathbf{r} = 0$

(ii) $\text{curl } \frac{\mathbf{r}}{r} = \frac{-iy + jx}{r^3}$

(iii) $\text{curl } \left(\frac{\mathbf{r}}{r^3}\right) = 0$

Or

- (b) State and prove expansion theorem.

17. (a) Derive Rodrigue formula for legendre polynomials.

Or

- (b) Derive the Hermite polynomials degree n, using the series solution of Hermite equation.

18. (a) Explain the associate tensors with the help of raising and lowering of indices.

Or

- (b) Derive the moment of inertia of a rigid body using tensors.

19. (a) Prove the representation theorem. If $\Gamma^{(1)}$ and $\Gamma^{(2)}$ are two irreducible representations of dimension l_1 and l_2 respectively of a group G and if a matrix M of order $l_1 \times l_2$ satisfies the relation $\Gamma^{(1)}(A_i) M = M \Gamma^{(2)}(A_i)$ then either

- (i) If $l_1 = l_2$; $M = 0$, the null matrix

Or

- (ii) $|M|$ not equal to zero in which case $\Gamma^{(1)}$ and $\Gamma^{(2)}$ are equivalent representations.

Or

- (b) Construct the characteristics table for D_3 group.

20. (a) Derive the Fourier series solution for vibrating string.

Or

- (b) Derive the one dimensional heat flow equation when it flows from the region of higher temperature to the lower region.