MASENO UNIVERSITY

UNIVERSITY EXAMINATIONS 2012/2013

FIRST YEAR SECOND SEMESTER EXAMINATIONS FOR THE DEGREE OF MASTER OF SCIENCE IN PHYSICS (MAIN CAMPUS)

SPH 822: MATHEMATICAL METHODS FOR PHYSICS

Date: 31st July, 2013 *Time: 9.00 – 12.00 noon*

INSTRUCTIONS

- Answer ANY THREE questions

ISO 9001:2008 CERTIFIED

Q1. a) Find the cube root of 8 using Eulers method (4M

b) Given the following two functions: (6M

a) $e^{3z}(z+1)^{-3}$, b) $(z+2)sin\left(\frac{1}{z+1}\right)$

find Laurent series about the singularity for each of the functions, name the singularity, and give the region of convergence.

c) Solve $y'' - 2y' + y = 2cosx$ by use of successive integration (5M

d) The function $f(z) = (4-3z)/(z^2-z)$ is analytic except at $z=0$ and $z=1$ where it has simple poles. Find the residues at these poles. (5M

Q2. a) Show that $\int_0^{\infty} \frac{\sin x}{x} dx = \frac{\pi}{2}$ (10M

b) Evaluate (10M

$$\int_0^{2\pi} \frac{d\theta}{3-2cos\theta+sin\theta}.$$

Q3. Distinguish between

a) ABELIAN AND CYCLIC groups (2M

b) Define REDUCIBLE and IRREDUCIBLE representations. Given the Cyclic group $C_4 = (A, A^2, A^3, A^4 = E)$ and its two dimensional representation. (8M

$$D(A) = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}, \ D(A^2) = \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$$

$$D(A^3) = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}, \ D(E) = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

Show that C_4 is reducible and can be decomposed into the one dimensional representation $D^{(3)}$ and $D^{(4)}$ i.e. $D^{(1)} = D^{(3)} + D^{(4)}$

c) i) For an equilateral triangle define the elements for C_{3V} **(10Mk**

ii) Set up the multiplication table for C_{3V}

iii) Define the class structure of C_{3V}

Q4. Find the particular solution of the heat conduction equation **(20Mk**

$$u_{xx} = (1/\sigma)u_t, \text{ for } u_x(0,t) = u_x(1,t) = 0$$

and

$$u_t(x,0) = f(x)$$

Q5. The wave function for a single electron atom (like hydrogen) is separable in spherical polar coordinates r, θ, ϕ, in the form

$$\Psi(r,\theta,\phi) = \mathrm{R(r)F(\theta)\beta(\phi)}$$

a) Write down the completely separated differential equation for $F(\theta)$. **(5Mks)**

b) i) Transform the $F(\theta)$ equation into the equivalent Legendre polynomial equation. **(5Mks)**

ii) Use the power series method to obtain the general solution of the Legendre polynomial equation. **(10Mk**

END