EMBU UNIVERSITY COLLEGE

(A Constituent College of the University of Nairobi)

2015/2016 ACADEMIC YEAR

SECOND SEMESTER EXAMINATION

SECOND YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE
SPH 204: MATHEMATICAL PHYSICS I

DATE: APRIL 5, 2016 **TIME:11:00-01:00**

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions

QUESTION ONE

a) Differentiate between the order and degree of a differential equation giving physics example of a first order second degree and second order second degree equation. (6 Marks)

b) Differentiate between line, surface and volume integrals giving two features of each. (6 Marks)

c) Give the physical meaning and equations for the gradient, curl and divergence of a vector. (6 Marks)

d) What is Laurent expansion? (2 Marks)

e) State two key features of a group and two applications of group theory in physics. (4 Marks)

f) Write the formulae for Taylor series and maclaurin series (2 Marks)

g) Differentiate between series convergence and series divergence. (4 Marks)

QUESTION TWO

a) In the Eigen vector equation $A\mathbf{X} = \lambda\mathbf{X}$, the operator A is given by

$$A = \begin{bmatrix} 3 & 2 \\ 4 & 1 \end{bmatrix}$$

Find:

i) The Eigen values λ

ii) The Eigen vector $\mathbf{X}$

iii) The modal matrix C and it's inverse C^{-1}

iv) The product $C^{-1}AC$ (14 Marks)

b) Expand $\log x$ in powers of $(x - 1)$ by Taylor's series. (6 Marks)

QUESTION THREE

a) Show that the divergence of the Coulomb or gravitational force is zero. (8 Marks)

b) i) If the field is centrally represented by $\boldsymbol{F} = f\,(x,\ y,\ z),\ \boldsymbol{r} = f\,(r\ )\boldsymbol{r}$, then itconservative conditioned by curl $\boldsymbol{F} = 0$, that is the field is irrotational. ii) What should be the function $F(r\ )$ so that the field is solenoidal? (12 Marks)

QUESTION FOUR

a) Find the general solution of the following differential equations and writedown the degree and order of the equation and whether it is homogenous orin-homogenous.

(12 Marks)

i) $y' - \frac{2}{x}y = \frac{1}{x^3}$

ii) $y'' + 5y' + 4y = 0$

b) A cylinder of mass m is allowed to roll on a spring attached to it so that it encounters simple harmonic motion about the equilibrium position. Use theenergy conservation to form the differential equation. Solve the equation and find the time period of oscillation. Assume k to be the spring constant. (8 Marks)

QUESTION FIVE

a) i) Calculate the area bounded by the curves $y = x^2 + 2$ and $y = x - 1$ andthe lines $x = -1$ to the left and $x = 2$ to the right. ii) Find the volume of the solid of revolution obtained by rotating the areaenclosed by the lines $x = 0$, $y = 0$, $x = 2$ and $2x + y = 5$ through 2πradians about the y-axis.

(12 Marks)

b) Consider the curve $y = x \sin x$ on the interval $0 \le x \le 2\pi$.(i) Find the area enclosed by the curve and the x-axis.(ii) Find the volume generated when the curve rotates completely about the$x$-axis.

(8 Marks)

--END--