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**UNIVERSITY EXAMINATIONS  
2022/2023 ACADEMIC YEAR  
SECOND/ THIRD YEAR FIRST/ SECOND SEMESTER  
SPECIAL/SUPPLEMENTARY EXAMINATION  
FOR THE DEGREE OF BACHELOR OF EDUCATION AND  
BACHELOR OF SCIENCE**

**COURSE CODE: MAA311/MAT321/MAA 224**

**COURSE TITLE: ORDINARY DIFFERENTIAL EQUATIONS I**

**DATE: 15/08/2023**

**TIME: 11:00AM- 1:00PM**

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**INSTRUCTIONS TO CANDIDATES**

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of 3 Printed Pages. Please Turn Over.

**QUESTION ONE COMPULSORY (30 MARKS)**

- a) Classify each of the following ordinary differential equations by stating their order, degree and linearity.

i.  $\left(\frac{d^2y}{dx^2}\right)^2 + \left(\frac{d^3y}{dx^3}\right)^{10} + 5y = 5x^7$

ii.  $\frac{d^3y}{dx^3} + 4\frac{dy}{dx} = x^2y^5$  (4 marks)

- b) Solve  $(x^3 + 2y)dy + (3x^2y - 6x)dx = 0$  (6 marks)

- c) Form a differential equation whose general solution is given by the equation

$$y = C_1x + C_2x^3 \quad (4 \text{ marks})$$

- d) Solve the linear differential equation  $\frac{dy}{dx} + \frac{2x+1}{x}y = e^{-2x}; y(0) = 1$  (6 marks)

- e) Test for exactness and solve the following ordinary differential equation  $(\cos x - x \sin x + y^2)dx + 2xy dy = 0$  (5 marks)

- f) Using an appropriate method, solve  $\frac{dy}{dx} = \frac{y}{x} + \frac{y^2}{x^2}$  (5 marks)

**QUESTION TWO (20 MARKS)**

- a) Define the term Wronskian of functions. (2 marks)

- b) Test for homogeneity and solve the following ordinary differential equations

i.  $(x^3 + y^3)dx - 3xy^2dy = 0$  (7 marks)

ii.  $(x + 2y - 1)dx + (3x + 6y)dy = 0$  (6 marks)

- c) Solve  $\frac{d^3y}{dx^3} - 4\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 18y = 0$  (5 marks)

**QUESTION THREE (20 MARKS)**

- a) Solve the following ordinary differential equation using the method of integrating factors:

i.  $(3x^2y^4 + 2xy)dx + (2x^3y^3 - x^2)dy = 0$  (7 marks)

ii.  $\frac{dy}{dx} + \frac{3x+1}{x}y = e^{-3x}$  (5 marks)

- b) Use the method of variation of parameters to solve

$$\frac{d^2y}{dx^2} - \frac{dy}{dx} - 2y = e^{3x}$$

(8 marks)

**QUESTION FOUR (20 MARKS)**

- a) A bacteria culture has a population  $P_0$  number of bacteria. At  $t = 1$  hours, the number of bacteria is measured to be  $\frac{3}{2}P_0$

If the rate of growth is proportional to the number of bacteria  $P$  present at time  $t$ ,

- (i) Form a differential equation for this growth (6 marks)

- (ii) Determine the time necessary for the number of bacteria to triple

(6 marks)

- b) Use the method of undetermined coefficients to solve  $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} - 4y = 3xe^{2x}$

(8 marks)

**QUESTION FIVE (20 MARKS)**

- a) Test for exactness and solve the following ordinary differential equation

$$(ye^{xy} - 2y^3)dx + (xe^{xy} - 6xy^2 - 2y)dy = 0 \quad (7 \text{ marks})$$

- b) Solve the following Bernoulli's equation

$$4x^2 \frac{d^2y}{dx^2} + 8x \frac{dy}{dx} + y = 0 \quad (5 \text{ marks})$$

- c) A metal bar at a temperature of  $100^\circ\text{C}$  is placed in a room at a constant temperature of  $0^\circ\text{C}$ . If after 20 minutes, the temperature of the bar is  $50^\circ\text{C}$ , find the time it will take the bar to reach a temperature of  $25^\circ\text{C}$ . (8 marks)

**END**