

# JHARGRAM RAJ COLLEGE



**PHYSICS**  
**Assignment-1**  
**Semester I**  
**(Mathematical Methods and Mechanics)**

1. Write down the *order* and *degree* of the following equations

(a)  $\left(\frac{d^4y}{dx^4}\right)^5 - (2x + y)\left(\frac{d^3y}{dx^3}\right)^6 + \frac{dy}{dx} = 3x$

(b)  $x^2\left(\frac{d^3y}{dx^3}\right) - y\left(\frac{d^2y}{dx^2}\right)^3 + 2\left(\frac{dy}{dx}\right)^4 = e^x$

(c)  $\left(\frac{d^3y}{dx^3}\right)^2 + x\sqrt{\frac{dy}{dx}} + x^2y = 0$

2. Find the general solution of the following homogeneous differential equations.

(a)  $y' + 5y = 0$

(b)  $y' - 2y = 0$

(c)  $y' + \frac{y}{1+t^2} = 0$

(d)  $y' + t^2y = 0$

3. Find the general solution of the following non-homogeneous differential equations

(a)  $2y' + y = t$

(b)  $y' + e^ty = -2e^t$

(c)  $y' - y = t^2$

4. Solve the following differential equations

(a)  $(x + 1)\frac{dy}{dx} - y = e^x(x + 1)^2$

(b)  $\frac{dy}{dx} = \cot x \tan y$

(c)  $\cos^2 x \left(\frac{dy}{dx}\right) + y = \tan x$

(d)  $\frac{dy}{dx} - \frac{3y}{x+1} = (x+1)^4$

(e)  $\frac{dy}{dx} + \frac{2y}{x} = \frac{\sin x}{x^2}$

(f)  $\frac{dy}{dx} - \frac{y}{x} = -xe^{-x}$

(g)  $\frac{dy}{dx} + 2xy = x$

5. Solve the initial value problem

$$y' + y \cos t = 0$$

subject to (a)  $y(0) = 1/2$  and (b)  $y(2) = 1/2$

6. Solve the initial value problem  $ty' + 3y = 0$ ,  $y(1) = 2$ , assuming  $t > 0$ .

7. A bacterial culture grows at a rate proportional to its population. If the population is one million at  $t = 0$  and 1.5 million at  $t = 1$  hour, find the population as a function of time. [Hint: Assume the population of the bacterial culture to be  $y(t)$  at a time  $t$  and the culture rate to be  $y'(t)$ .]

8. A radioactive element decays with a half-life of 6 years. If a mass of the element weighs 10 kg at  $t = 0$ , find the amount of the element at time  $t$ .