FYUGP/Sem-2/PY-CE1

2026
(Regular)
Physics (Core)
Paper Code : PY-CE-2114

Paper Name : Mathematical Physics II and Properties of Matter

Time : 2 hours ***Full Marks : 45***

The figures in the margin indicate full marks for the questions.

1. Answer the following questions : 1×4=4

   a) Find the order of the differential equation :

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

   b) Write Newton's law of cooling equation.

   c) What is the dimensional formula for modulus of elasticity ?

   d) Define coefficient of viscosity.

2. Answer the following questions : 2×3=6

   a) Distinguish between exact and inexact differential equations.

   b) Show that work done in elongation of a wire is load elongation.

   c) Define neutral surface and neutral axis of a beam.

3. Answer ***any three*** of the following questions : 5×3=15

   a) Solve the first-order linear differential equation :

$$\frac{dy}{dx}+y=e^x.$$

Contd...

b) Solve by separation of variables : $\frac{\partial u}{\partial t} = k\frac{\partial^2 u}{\partial x^2}$

c) Find the pressure difference inside a soap bubble of radius r.

d) What is terminal velocity ? Define the formula for a body moving in a viscous medium. 1+4=5

e) Solve the differential equation :

$$\frac{dy}{dx} + ky = 0$$

f) Show that the elastic constants are related by $Y = 2G(1+\sigma)$, where Y is Young's modulus, G is the shear modulus and σ is Poisson's ratio.

4. Answer ***any two*** of the following questions : 10×2=20

a) i) Solve Laplace's equation :

$$\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = 0$$

using separation of variables. 5

ii) Chech the exactness of the differential equation and then solve it : $(2xy + y^2)dx + (x^2 + 2xy)dy = 0$. 5

b) i) Derive the expression for the rise of liquid in a capillary tube:

$$h = \frac{2T\cos\theta}{\rho g r}$$

clearly stating the meaning of each symbol. 6

ii) State Jurin's law. 2

iii) Calculate the height to which water rises in a capillary tube of radius 0.5 mm. The surface tension of water is 0.075 N/m, its density is 1000 kg/m^3, and acceleration due to gravity is 9.8 m/s^2. Assume the angle of contact is zero. 2

c) i) Show that for steady, incompressible and non-viscous fluid flow, the quantity $P+\frac{1}{2}pv^2+pgh$ remains constant along a streamline (Bernoulli's theorem). 6

ii) Using this result, show how the velocity of efflux of a liquid from a small orifice is given by Torricelli's theorem. 4

d) i) Derive Poiseuille's equation for flow of liquid through a capillary tube. 6

ii) Calculate the Reynolds number for liquid through a pipe of diameter 2 cm with velocity 0.5 m/s. The density of water is 1000 kg/m^3 and coefficient of viscosity is 1.0×10^{-3} N.s/m^2 and state whether the flow is laminar or turbulent. 3+1=4

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