

Subject Code: R13102/R13

Set No - 1

I B. Tech I Semester Regular Examinations Feb./Mar. - 2014

**MATHEMATICS-I**

(Common to All Branches)

Time: 3 hours

Max. Marks: 70

Question Paper Consists of **Part-A** and **Part-B**  
 Answering the question in **Part-A** is Compulsory,  
 Three Questions should be answered from **Part-B**

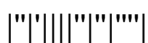
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**PART-A**

- 1.(i) Find the orthogonal trajectories of the curve  $r = a(1 + \cos \theta)$ .
- (ii) If  $x = r \sin \theta \cos \phi, y = r \sin \theta \sin \phi, z = r \cos \theta$ , find  $\frac{\partial(r, \theta, \phi)}{\partial(x, y, z)}$ , given that  $\frac{\partial(x, y, z)}{\partial(r, \theta, \phi)} = r^2 \sin \theta$ .
- (iii) Find the Laplace transform of  $f(t) = \begin{cases} t, & 0 < t < 1 \\ 0, & t > 1 \end{cases}$  using Heaviside function.
- (iv) Let the heat conduction in a thin metallic bar of length L is governed by the equation  $\frac{\partial u}{\partial t} = a^2 \frac{\partial^2 u}{\partial x^2}$ ,  $t > 0$ . If both ends of the bar are held at constant temperature zero and the bar is initially has temperature  $f(x)$ , find the temperature  $u(x, t)$ .
- (v) Solve  $p^2 + pq = z^2$ .
- (vi) Find  $\frac{1}{D^2 - 4D + 4} x^2 \sin x$ . [4+4+4+4+3+3]

**PART-B**

- 2.(a) Solve  $y(2x^2 - xy + 1)dx + (x - y)dy = 0$
- (b) Find the complete solution of  $y'' + 2y = x^2 e^{3x} + e^x \cos 2x$  [8+8]
- 3.(a) Solve  $\frac{dy}{dx} + x \sin 2y = x^3 \cos^2 y$
- (b) Find the solution of  $\frac{d^2 y}{dx^2} + 4y = \sin 3x + \cos 2x$ . [8+8]
- 4.(a) Find the Laplace transform of  $f(t) = \frac{\cos at - \cos bt}{t}$ .
- (b) If  $x = \sqrt{vw}, y = \sqrt{uw}, z = \sqrt{uv}$  and  $u = r \sin \theta \cos \phi, v = r \sin \theta \sin \phi$  and  $w = r \cos \theta$ , find  $\frac{\partial(x, y, z)}{\partial(r, \theta, \phi)}$ . [8+8]
- 5.(a) Expand  $f(x, y) = e^y \ln(1 + x)$  in powers of x and y using MacLaurin's Series
- (b) Solve  $y'' - 8y' + 15y = 9te^{2t}$ ,  $y(0) = 5$  and  $y'(0) = 10$  using Laplace transforms [8+8]
- 6.(a) Solve  $(y + xz)p - (x + yz)q = x^2 - y^2$ .
- (b) Solve the partial differential equation  $px + qy = 1$ . [8+8]
- 7.(a) Find the partial differential equation of all spheres whose centers lie on z- axis.
- (b) Find the solution of the wave equation  $\frac{\partial^2 u}{\partial t^2} = a^2 \frac{\partial^2 u}{\partial x^2}$ , if the initial deflection is  $f(x) = \begin{cases} \frac{2k}{l} x & \text{if } 0 < x < l/2 \\ \frac{2k}{l} (l - x) & \text{if } \frac{l}{2} < x < l \end{cases}$  and initial velocity equal to 0. [8+8]



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**PART-A**

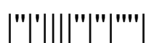
- 1.(i) Find the complete solution of  $(D^4 + 16)y = 0$ .
- (ii) If  $x = r\cos\theta, y = r\sin\theta, z = z$ , find  $\frac{\partial(r,\theta,z)}{\partial(x,y,z)}$ , given that  $\frac{\partial(x,y,z)}{\partial(r,\theta,z)} = r$ .
- (iii) Solve  $x^2p^2 + y^2q^2 = z^2$ .
- (iv) Find the solution, by Laplace transform method, of the integro-differential equation  

$$y' + 3y + 2 \int_0^t y(t)dt = t$$
- (v) Find the differential equation of the orthogonal trajectories for the family of parabola through the origin and foci on y-axis.
- (vi) Find the solution of wave equation in one dimension using the method of separation of variables.

[3+3+4+4+4+4]

**PART-B**

- 2.(a) Solve  $y(y^2 - 2x^2)dx + x(2y^2 - x^2)dy = 0$
- (b) Find the complete solution of  $y'' + 5y' - 6y = \sin 4x \sin x$ . [8+8]
- 3.(a) Solve  $\cos x dy = y(\sin x - y)dx$ .
- (b) Find the solution of  $\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 3y = 2xe^{3x} + 3e^x \cos 2x$ . [8+8]
- 4.(a) Find the Laplace transform of  $f(t) = \int_0^t e^{-u} \cos u du$ .
- (b) Find the shortest distance from origin to the surface  $xyz^2 = 2$ . [8+8]
- 5.(a) Find  $\frac{\partial(u,v)}{\partial(r,\theta)}$  if  $u = 2axy$  and  $v = a(x^2 - y^2)$ , where  $x = r\cos\theta$  and  $y = r\sin\theta$ .
- (b) Solve  $y'' - 8y' + 15y = 9te^{2t}$ ,  $y(0) = 5$  and  $y'(0) = 10$  using Laplace transforms [8+8]
- 6.(a) Form the partial differential equation by eliminating the arbitrary function from  $xyz = f(x + y + z)$ .
- (b) Find the solution of  $(D^2 - DD' - 2D'^2)z = (y - 1)e^x$ , where  $D = \frac{\partial}{\partial x}$  and  $D' = \frac{\partial}{\partial y}$ . [8+8]
- 7.(a) Solve the partial differential equation  $xzp + yzq = xy$ .
- (b) Find the temperature in a bar of length l which is perfectly insulated laterally and whose ends O and A are kept at  $0^\circ\text{C}$ , given that the initial temperature at any point P of the rod is given by f(x). [8+8]



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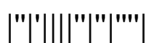
**PART-A**

- 1.(i) Find the dimensions of rectangular box of maximum capacity whose surface area is S.
- (ii) Find the orthogonal trajectories of the family of curves  $x^{2/3} + y^{2/3} = a^{2/3}$ .
- (iii) A generator having emf 100 volts is connected in series with a 10 ohm resistor and an inductor of 2 henries. If the switch is closed at a time  $t=0$ , find the current at time  $t>0$ .
- (iv) Find the Laplace transform of  $f(t) = \begin{cases} t, & 0 < t < 1 \\ 0, & t > 1 \end{cases}$  using Heaviside function.
- (v) Solve  $pq+qx = y$ .
- (vi) Find the solution of  $2x \frac{\partial z}{\partial x} - 3y \frac{\partial z}{\partial y} = 0$  by the method of separation of variables.

[4+4+4+4+3+3]

**PART- B**

- 2.(a) Solve  $y(1 + xy)dx + x(1 - xy)dy = 0$
- (b) Find the complete solution of  $y'' + 4y = e^x \sin^2 x$ . [8+8]
- 3.(a) Solve  $2x y' + y = \frac{2x^2}{y^3}, y(1) = 2$ .
- (b) Find the solution of  $\frac{d^2 y}{dx^2} - 4 \frac{dy}{dx} - 5y = e^{2x} + 3 \cos(4x + 3)$ . [8+8]
- 4.(a) Find the Laplace transform of  $f(t) = te^{-2t} \cos t$ .
- (b) Find the maxima and minima of  $x^3 + 3xy^2 - 15x^2 - 15y^2 + 72x$ . [8+8]
- 5.(a) Expand  $f(x, y) = e^{xy}$  in powers of  $(x-1)$  and  $(y-1)$ .
- (b) Solve  $y'' + 7y' + 10y = 4e^{-3t}, y(0) = 0$  and  $y'(0) = -1$  using Laplace transforms. [8+8]
- 6.(a) Form the partial differential equation by eliminating the arbitrary constants 'a' and 'b' from  $2z = \frac{x^2}{a^2} + \frac{y^2}{b^2}$ .
- (b) Find the solution of  $(4D^2 + 12DD' + 9D'^2)z = e^{3x-2y}$ , where  $D = \frac{\partial}{\partial x}$  and  $D' = \frac{\partial}{\partial y}$ . [8+8]
- 7.(a) Solve the partial differential equation  $p \tan x + q \tan y = \tan z$ .
- (b) A tightly stretched string with fixed end points  $x=0$  and  $x=l$  is initially in a position given by  $y = y_0 \sin^3 \frac{\pi x}{l}$ . If it is released from rest from this position, find the displacement  $y(x, t)$ . [8+8]



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**PART-A**

- 1.(i) Find the distance from the centre at which the velocity in simple harmonic motion will be 1/3rd of the maximum.
- (ii) Find a point with in a triangle such that the sum of the squares of its distances from the three vertices is minimum.
- (iii) Find the solution, by Laplace transform method, of the integro-differential equation  $y' + 4y = \int_0^t y(t)dt$ ,  $y(0) = 0$ .
- (iv) Uranium disintegrates at a rate proportional to the amount present at that time. If M and N grams of Uranium that are present at times  $T_1$  and  $T_2$  respectively, find the half life of Uranium.
- (v) Find the complete solution of  $(D^3 - 3D^2 D' + 3 DD'^2 - D'^3)z = 0$ .
- (vi) Solve  $z^2 = 1 + p^2 + q^2$ .

[4+4+4+4+3+3]

**PART-B**

- 2.(a) Solve  $(3y^2 + 4xy - x)dx + x(x + 2y)dy = 0$
- (b) Find the solution of  $\frac{d^2y}{dx^2} + 5\frac{dy}{dx} - 6y = \sin 4x \cos x$ . [8+8]
- 3.(a) Find the complete solution of  $y'' + 2y = x^2 e^{3x} + e^x \cos 2x$ .
- (b) Solve  $xz' + z \log z = z(\log z)^2$ . [8+8]
- 4.(a) Find the Laplace transform of  $f(t) = te^{2t} \cos 2t$ .
- (b) If  $u = \sin^{-1}\left(\frac{x^3+y^3}{\sqrt{x}+\sqrt{y}}\right)$ , prove that  $xu_x + yu_y = \frac{5}{2} \tan u$ . [8+8]
- 5.(a) If  $w = (y - z)(z - x)(x - y)$ , find the value of  $\frac{\partial w}{\partial x} + \frac{\partial w}{\partial y} + \frac{\partial w}{\partial z}$ .
- (b) Solve  $y'' + 2y' + 5y = e^{-t} \sin t$ ,  $y(0) = 0$  and  $y'(0) = 1$  using Laplace transforms. [8+8]
- 6.(a) Form the partial differential equation by eliminating the arbitrary constants 'a' and 'b' from  $z = ax + by + a^2 + b^2$ .
- (b) Using method of separation of variables, solve  $u_{xt} = e^{-t} \cos x$  with  $u(x, 0) = u(0, t) = 0$ . [8+8]
- 7.(a) Find the temperature in a thin metal rod of length L, with both ends insulated and with initial temperature in the rod is  $\sin\left(\frac{\pi x}{L}\right)$ .
- (b) Solve the partial differential equation  $px^2 + qy^2 = z^2$ . [8+8]

