

Exam.	Back		
Level	BE	Full Marks	80
Programme	All (Except B.Arch.)	Pass Marks	32
Year / Part	1 / I	Time	3 hrs.

**Subject:** - Engineering Mathematics I (SH401)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. State Leibnitz's theorem on higher order derivative. If  $y = e^{a \tan^{-1} x}$ , prove that  $(1+x^2)y_{n+2} + (2nx + 2x - a)y_{n+1} + n(n+1)y_n = 0$
2. State difference between Roll's Theorem and Lagrange's Mean value theorem. Verify Lagrange's mean value theorem for  $f(x) = x(x-1)(x-2)$  when  $x \in \left[0, \frac{1}{2}\right]$ .
3. Define indeterminate form of a function. Evaluate

$$\lim_{x \rightarrow 0} \left( \frac{\tan x}{x} \right)^{1/x^2}$$

4. Define asymptote to a curve. Find the asymptotes of curve  $y^3 + 2xy^2 + x^2y - y + 1 = 0$ .
5. Find radius of curvature of the curve  $x^3 + y^3 = 3axy$  at origin.

**OR**

Find the pedal equation of the polar curve  $r^m = a^m \cos m\theta$ .

6. Integrate :  $\int_0^{\pi/2} \frac{\cos x \, dx}{(1 + \sin x)(2 + \sin x)}$
7. Apply differentiation under integral sign to evaluate  $\int_0^\infty \frac{e^{-ax} \sin x}{x} dx$ .
8. Define Beta and Gamma function. Use them to evaluate  $\int_0^{2a} x^5 \sqrt{2ax - x^2} dx$ .
9. Show that the area of the curve  $x^{2/3} + y^{2/3} = a^{2/3}$  is  $\frac{3}{8} \pi a^2$ .

**OR**

Find the volume of the solid formed by the revolution of the cardioid  $r = a(1 + \cos \theta)$  about the initial line.

10. Solve:  $(1+y^2)dx = (\tan^{-1} y - x)dy$
11. Solve:  $y = px - \sqrt{m^2 + p^2}$  where  $p = \frac{dy}{dx}$ .

12. Solve:  $(D^2 + 2D + 1)y = e^x + x^2$ .

13. Solve:  $x^2 \frac{d^2 y}{dx^2} - 2x \frac{dy}{dx} - 4y = x^4$ .

**OR**

A resistance of 100 ohms, an inductance of 0.5 Henry are connected in series with a battery of 20 volts. Find the current in the circuit as a function of time.

14. What does the equation of lines  $7x^2 + 4xy + 4y^2 = 0$  become when the axes are the bisectors of the angles between them?

15. Derive the equation of hyperbola in standard form.

16. Find the foci and eccentricity of the conic  $x^2 + 4xy + y^2 - 2x + 2y - 6 = 0$ .

**OR**

Describe and sketch the graph of the conic  $r = \frac{12}{6 + 2\sin\theta}$ .

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- State Leibnitz theorem. If  $\log y = \tan^{-1} x$ , then show that  
 $(1+x^2)y_{n+2} + (2nx+2x-1)y_{n+1} + (n^2+n)y_n = 0$  [1+4]
- State Rolle's theorem. Is the theorem true when the function is not continuous at the end points? Justify your answer. Verify Rolle's theorem for  $f(x) = x^2 5x + 6$  on  $[2,3]$ . [1+2+2]
- State L-Hospital's rule. Evaluate  $\lim_{x \rightarrow 1} (2-x)^{\tan\left(\frac{\pi x}{2}\right)}$  [1+4]
- Find the asymptotes of the curve  $(x+y)^2(x+2y+2) = x+9y-2$  [5]
- Find the pedal equation of the ellipse  $\frac{x^2}{b^2} + \frac{y^2}{a^2} = 1$ . [5]
- Evaluate the integral  $\int_{-1}^1 \frac{1}{x^2} dx$  [5]
- Apply the rule of differentiation under integral sign to evaluate  $\int_0^{\infty} \frac{e^{-ax} \sin x}{x} dx$  and hence deduce that  $\int_0^{\infty} \frac{\sin x}{x} dx = \frac{\pi}{2}$  [5]
- Define Beta function. Apply Beta and Gamma function to evaluate  $\int_0^{2a} x^5 \sqrt{2ax-x^2} dx$  [5]
- Find the area common to the circle  $r = a$  and the cardioid  $r = a(1+\cos\theta)$  [5]
- Through what angle should the axes be rotated to reduce the equation  $3x^2 + 2xy + 3y^2 - \sqrt{2}x = 0$  into one with the  $xy$  term missing? Also obtain the transformed equation. [2+3]
- Derive the equation of an ellipse in standard form. [5]
- Find the product of semi-axis of the conic  $x^2 - 4xy + 5y^2 = 2$  [5]

**OR**

Describe and sketch the graph of conic  $r = \frac{12}{3+2\cos\theta}$

- Solve the differential equation of  $(x^2 - y^2)dx + 2xydy = 0$  [5]
- Solve:  $y = yp^2 + 2px$  where  $p = \frac{dy}{dx}$  [5]
- Solve  $(D^2 - 6D + 9)y = x^2 e^{2x}$  [5]



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- State Leibnitz's theorem. If  $y = (\sin^{-1} x)^2$ , show that  

$$(1 - x^2)y_{n+2} - (2n+1)xy_{n+1} - n^2y_n = 0$$
- Verify Rolle's Theorem for  $f(x) = \log \frac{x^2 + ab}{(a+b)x}$ ;  $x \in [a, b]$ . How does Rolle's Theorem differ from Lagrange's mean value theorem.
- Evaluate  $\lim_{x \rightarrow 0^+} \left( \frac{\sin x}{x} \right)^{\frac{1}{x}}$
- Find the asymptotes to the curve  $y^3 + 2xy^2 + x^2y - y + 1 = 0$
- Find the radius of curvature at origin for the curve  $x^3 + y^3 = 3axy$ .
- Show that  $\int_0^{\pi} x \log(\sin x) dx = \frac{\pi^2}{2} \log \frac{1}{2}$
- Apply the rule of differentiation under integral sign to evaluate  $\int_0^{\infty} \frac{e^{-ax} \sin x}{x} dx$  and hence deduce that  $\int_0^{\infty} \frac{\sin x}{x} dx = \frac{\pi}{2}$
- Define Beta function. Apply Beta and Gamma function to evaluate  $\int_0^{2a} x^5 \sqrt{2ax - x^2} dx$
- Find the volume generated by revolution of astroid  $x^{2/3} + y^{2/3} = a^{2/3}$  about x-axis.
- What does the equation  $3x^2 + 3y^2 + 2xy = 2$  becomes when the axes are turned through an angle of  $45^\circ$  to the original axes?
- Find center, length of axes, eccentricity and directrices of the conic  

$$3x^2 + 8xy - 3y^2 - 40x - 20y + 50 = 0$$

**OR**

Describe and sketch the conic  $r = \frac{12}{2 - 6\cos\theta}$

- Deduce standard equation of ellipse.
- Solve the differential equation:  $(1 + y^2) + (x - e^{\tan^{-1}y}) \frac{dy}{dx} = 0$
- Solve:  $xp^2 - 2yp + ax = 0$  where  $p = \frac{dy}{dx}$
- Solve:  $\frac{d^2y}{dx^2} + 3\frac{dy}{dx} + 2y = e^{2x} \cdot \sin x$
- Resistance of 100 ohms, an inductance of 0.5 Henry are connected in series with battery

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1. State Leibnitz theorem. If  $y = e^{x^2}$ , then show that  $y_{n+1} - 2xy_n - 2ny_{n-1} = 0$ .
2. Expand  $e^x \log_e(1+x)$  in ascending powers of  $x$  upto the term containing  $x^4$  in Maclaurin's series.
3. State L-hospital's rule. Evaluate,

$$\lim_{x \rightarrow 0} \left( \frac{1}{x^2} \right)^{\tan x}$$

4. State the types of asymptotes to a curve. Find the asymptotes of the curve  $(x^2 - y^2)(x + 2y + 1) + x + y + 1 = 0$ .
5. Find the chord of curvature through the pole for the curve  $r = a(1 + \cos\theta)$ .
6. Show that  $\int_0^\infty \frac{\log(1+x^2)}{1+x^2} dx = \pi \log 2$
7. Apply the method of differentiation under integral sign to prove

$$\int_0^{\pi/2} \frac{dx}{(a^2 \sin^2 x + b^2 \cos^2 x)^2} = \frac{\pi(a^2 + b^2)}{4a^3 b^3}$$

8. Using Beta -Gamma Function, show that

$$\int_0^{\pi/4} \sin^4 x \cdot \cos^2 x \, dx = \frac{3\pi - 4}{192}$$

9. Find the area included between an arc of cycloid  $x = a(\theta - \sin\theta)$ ,  $y = a(1 - \cos\theta)$  and its base.

**OR**

Find the volume of the solid formed by the revolution of the cardioid  $r = a(1 + \cos\theta)$  about the initial base.

10. What does the equation  $x^2 + 2\sqrt{3}xy - y^2 = 2a^2$  become when the axes are turned through an angle  $30^\circ$  to the original axes?
11. Derive the equation of an ellipse in the standard form.

12. Find the eccentricity of the conic,

$$x^2 + 4xy + y^2 - 2x + 2y - 6 = 0$$

**OR**

Describe and sketch the conic

$$r = \frac{10 \operatorname{cosec} \theta}{2 \operatorname{cosec} \theta + 3}$$

13. Solve:  $\frac{dy}{dx} = \frac{x + 2y - 3}{2x + y - 3}$

14. Solve:  $\frac{dy}{dx} + y \tan x = \sec x$

15. Solve:  $y = 2px + p^3 y^2$ ; where  $p = \frac{dy}{dx}$

16. Solve:  $x^2 \frac{d^2 y}{dx^2} - 2x \frac{dy}{dx} + 2y = \frac{1}{x}$

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**Examination Control Division**  
2072 Kartik

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- If  $y = (\sin^{-1} x)^2$ , then show that:
  - $(1-x^2)y_2 - xy_1 - 2 = 0$
  - $(1-x^2)y_{n+2} - (2n+1)xy_{n+1} - n^2 y_n = 0$
- State Rolle's Theorem and verify the theorem for  $f(x) = \frac{x(x+3)}{e^{x/2}}$ ;  $x \in [-3, 0]$
- Evaluate:  $\lim_{x \rightarrow 0} \left( \frac{\tan x}{x} \right)^{1/x}$
- Find the asymptotes of the curve:  $(a+x)^2(b^2+x^2) = x^2 \cdot y^2$
- Find the pedal equation of the curve  $r^2 = a^2 \cos 2\theta$
- Evaluate  $\int_0^{\pi/4} \frac{(\sin x + \cos x)}{(9+16 \sin 2x)} dx$
- Use Beta Gamma function to evaluate  $\int_0^{2a} x^5 \cdot \sqrt{2ax-x^2} \cdot dx$
- Evaluate by using the rule of differentiation under the sign of integration.

$$\int_0^{\infty} \frac{e^{-x} \sin bx}{x} \cdot dx$$

- Find the area of one loop of the curve  $r = a \sin 3\theta$

OR

Find the volume of the solid formed by the revolution of the cardioid  $r = a(1+\cos\theta)$  about the initial line.

Find center and eccentricity of conic  $x^2 + 4xy + y^2 - 2x + 2y - 6 = 0$

OR

Describe and sketch the graph of the equation  $r = \frac{10}{3+2\cos\theta}$

10. Find the condition that the line  $lx + my + n = 0$  may be a normal to the ellipse

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

11. Show that the pair of tangents drawn from the center of a hyperbola are its asymptotes.

12. Solve the differential equation:  $\frac{dy}{dx} = \frac{y}{x} + \tan \frac{y}{x}$

13. Solve:  $y - 2px + ap^2 = 0$  where  $p = \frac{dy}{dx}$

14. Solve the differential equation:  $x \frac{dy}{dx} + y \log y = xy e^x$

15. Solve the differential equation:  $x^2 \frac{d^2y}{dx^2} + x \frac{dy}{dx} - 4y = x^2$

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1. State Leibnitz's theorem. If  $y = (x^2 - 1)^n$ , then prove that

$$(x^2 - 1)y_{n+2} + 2xy_{n+1} - n(n-1)y_n = 0$$

2. Assuming the validity of expansion, expand  $\log(1 + \sin x)$  by Maclaurin's theorem.

3. Evaluate  $\lim_{x \rightarrow 0} \frac{(1+x)^{1/x} - e}{x}$

4. Find the asymptotes of the curve:  $x(x-y)^2 - 3(x^2 - y^2) + 8y = 0$

5. Find the radius of curvature at any point  $(r, \theta)$  for the curve  $a^2 = r^2 \cos 2\theta$  ✓✓

6. Show that:  $\int_0^\pi \frac{x \sin x}{1 + \cos^2 x} dx = \frac{\pi^2}{4}$

7. Apply differentiation under integral sign to evaluate  $\int_0^{\pi/2} \log \frac{a + b \sin x}{a - b \sin x} \frac{dx}{\sin x}$

8. Define Gamma function. Apply Beta and Gamma function to evaluate:

$$\int_0^{\pi/6} \cos^2 6\theta \sin^4 3\theta = \frac{7\pi}{192}$$

9. Find the area inclosed by  $y^2(a-x) = x^3$  and its asymptotes.

10. If the axes be turned through an angle of  $\tan^{-1} 2$ , what does the equation  $4xy - 3x^2 - a^2 = 0$  become?

11. Find the center, length of axes, eccentricity and directrices of the conic.

$$2x^2 + 3y^2 - 4x - 12y + 13 = 0$$

**OR**

Describe and sketch the graph of the conic  $r = \frac{10}{3 + 2 \cos \theta}$ .

12. Deduce standard equation of hyperbola.

13. Solve the differential equation:  $x \log x \frac{dy}{dx} + y = 2 \log x$

14. Solve:  $(x-a)p^2 + (x-y)p - y = 0$ : where  $p = \frac{dy}{dx}$

15. Solve:  $(D^2 - D - 2)y = e^x + \sin 2x$

16. Find a current  $i(t)$  in the RLC circuit assuming zero initial current and charge  $q$ , if  $R = 80$  ohms,  $L = 20$  Henry,  $C = 0.01$  Farads and  $E = 100$  volts.

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1. If  $y = \log(x + \sqrt{a^2 + x^2})$ , then show that  $(a^2 + x^2)y_{n+2} + (2n+1)xy_{n+1} + n^2y_n = 0$  [5]
2. State and prove Logrange's Mean Value theorem. [5]
3. Evaluate:  $\lim_{x \rightarrow \pi} (\sin x)^{\tan x}$  [5]
4. Find the asympn of the curve  $a^2y^2 + x^2y^2 - a^2x^2 + 2ax^3 - x^4 = 0$  [5]
5. Find the radius of curvature at the origin for the curve  $x^3 + y^3 = 3axy$
6. Evaluate  $\int_0^a \frac{\sqrt{x}}{\sqrt{x} + \sqrt{a-x}} dx$  [5]
7. Apply differentiation under integral sign to evaluate  $\int_0^\infty \frac{e^{-ax} - e^{-bx}}{x} dx$  [5]
8. Using Gamma function show that  $\int_0^{\frac{\pi}{4}} \sin^4 x \cos^2 x dx = \frac{3\pi - 4}{192}$  [5]
9. Find the area bounded by the curve  $x^2 = 4y$  and the line  $x = 4y - 2$

**OR**

Find the volume of the solid generated by the revolution of the cardioid  $r = a(1 - \cos\theta)$  about the initial line.

10. Solve:  $\sin x \frac{dy}{dx} + y \cos x = x \sin x$  [5]
11. Solve:  $xp^2 - 2yp + ax = 0$  where  $p = \frac{dy}{dx}$  [5]
12. Solve:  $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = x^2e^{3x}$  [5]
13. Solve:  $x^2 \frac{d^2y}{dx^2} - x \frac{dy}{dx} + y = \log x$  [5]
14. Transform the equation  $x^2 - 2xy + y^2 + x - 3y = 0$  to axes through the point  $(-1, 0)$  parallel to the lines bisecting the angles between the original axes. [5]
15. Find the center, length of axes and the eccentricity of the ellipse  $2x^2 + 3y^2 - 4x - 12y + 13 = 0$  [5]
16. Find the length of axes and ecentricity of the conic [5]

$$14x^2 - 4xy + 11y^2 - 44x - 58y + 71 = 0$$

**OR**

01 TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
**Examination Control Division**  
2071 Chaitra

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1. State Leibniz's theorem on Leibniz derivatives:

If  $y = \sin(m \sin^{-1} x)$  then show that

$$(1-x^2)y_{n+2} - (2n+1)xy_{n+1} + (m^2-n^2)y_n = 0$$

2. Assuming the validity of expansion, find the expansion of the function  $\frac{e^x}{1+e^x}$  by Maclaurin's theorem.
3. Evaluate  $\lim_{x \rightarrow 0} \frac{xe^x - (1+x)\log(1+x)}{x^2}$
4. Find the asymptotes of the curve  $y^3 + 2xy^2 + x^2y - y + 1 = 0$
5. Find the radius of curvature of the curve  $y = x^2(x-3)$  at the points where the tangent is parallel to x-axis

**OR**

Find the pedal equation of the curve  $r^2 = a^2 \cos 2\theta$

6. Show that  $\int_0^a \frac{dx}{x + \sqrt{a^2 - x^2}} = \frac{\pi}{4}$
7. Apply differentiation under integral sign to evaluate  $\int_0^{\pi/2} \frac{dx}{(a^2 \sin^2 x + b^2 \cos^2 x)^2}$
8. Use gamma function to prove that  $\int_0^1 \frac{dx}{(1-x^6)^{1/6}} = \pi/3$
9. Find the volume or surface area of solid generated by revolving the cycloid  $x = a(\theta + \sin\theta)$ ,  $y = a(1 - \cos\theta)$  about its base.



10. If the line  $lx+my+n=0$  is normal to the ellipse  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$  then show that

$$\frac{a^2}{l^2} + \frac{b^2}{m^2} = \frac{(a^2 - b^2)^2}{n^2}$$

11. Solve the locus of a point which moves in such a way that the difference of its distance from two fixed points is constant is Hyperbola.

12. Solve the differential equation  $x \frac{d^2y}{dx^2} + 2 \frac{dy}{dx} = 6x$

13. Solve  $(x^2 D^2 + xD + 1)y = \sin(\log x^2)$

14. Solve  $y = yp^2 + 2px$  where  $p = \frac{dy}{dx}$

15. Solve:  $\frac{d^2y}{dx^2} + 3 \frac{dy}{dx} + 2y = e^{2x} \sin x$

16. Describe and sketch the graph of the equation  $r = \frac{10}{2 - 3 \sin \theta}$

**OR**

Show that the conic section represented by the equation

$14x^2 - 4xy + 11y^2 - 44x - 58y + 71 = 0$  is an ellipse. Also find its center, eccentricity, latus rectum and foci

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1. State Leibnitz's Theorem on higher derivatives. If  $y = \sin (m \sin^{-1}x)$  then show that  $(1-x^2) y_{n+2} - (2n+1) x y_{n+1} + (m^2 - n^2) y_n = 0$

2. State Rolle's Theorem and verify it for the function  $f(x) = \frac{x(x+3)}{e^{\frac{x}{2}}}$ ,  $x \in [-3, 0]$

3. Evaluate:  $\lim_{x \rightarrow 0} \left( \frac{\tan x}{x} \right)^{\frac{1}{x^2}}$

4. Find the asymptotes of the curve  $(x^2 - y^2)^2 - 2(x^2 + y^2) + x - 1 = 0$

5. Show that the radius of curvature at any point  $(r, \theta)$  of the curve  $r^m = a^m \cos m\theta$  is  $\frac{a^m}{(m+1)r^{m+1}}$

6. Show that  $\int_0^1 \frac{\log(1+x)}{1+x^2} dx = \frac{\pi}{8} \log 2$

7. Evaluate by using the rule of differentiation under the sign of integration  $\int_0^\infty \frac{e^{-x} \sin bx}{x} dx$

8. Use Gamma function to prove  $\int_0^{\frac{\pi}{6}} \cos^4 3\theta \cdot \sin^2 6\theta = \frac{5\pi}{192}$

9. Find the area bounded by the curve  $x^2 y = a^2(a - y)$  and X-axis

**OR**

Show that the volume of the solid formed by revolving the ellipse  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$  about the line  $x = 2a$  is  $4\pi^2 a^2 b$  cubic units.

10. Solve the differential equation  $(1+y^2) dy = (\tan^{-1} y - x) dx$

11. Solve the differential equation  $y = yp^2 + 2px$  where  $p = \frac{dy}{dx}$

12. Solve the differential equation  $(D^2 - 2D + 5)y = e^{2x} \cdot \sin x$

13. Solve the differential equation  $x^2 \frac{d^2 y}{dx^2} - x \frac{dy}{dx} + 2y = x \log x$

**OR**

Newton's law of cooling states that the temperature of an object changes at the rate proportional to the difference of temperature between the object and its surroundings. Supposing water at  $100^\circ\text{C}$  cools to  $80^\circ\text{C}$  in 10 minutes in a room temperature of  $30^\circ\text{C}$  find the time when the temperature of water will become  $40^\circ\text{C}$ ?

14. If the axes be turned through an angle  $\tan \theta = 2$  what does the equation  $4xy - 3x^2 - a^2 = 0$  becomes.

15. Find the condition that the straight line  $x \cos \alpha + y \sin \alpha = p$  touches the ellipse  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

16. Find the centre, length of axes and eccentricity of the conic  $9x^2 + 4xy + 6y^2 - 22x - 16y + 9 = 0$

**OR**

Describe and sketch the graph of the equation  $r = \frac{12}{3 + 2\cos \theta}$

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- If  $Y = \sin(m \sin^{-1} x)$ , then show that  $(1-x^2)y_{n+2} - (2n+1)xy_{n+1} + (m^2 - n^2)y_n = 0$
- Apply Maclaurin's series to find the expansion of  $\frac{e^x}{1+e^x}$  as far as the term in  $x^3$
- Evaluate:  $\lim_{x \rightarrow a} \left(2 - \frac{x}{a}\right)^{\tan \frac{\pi x}{2a}}$
- Find the asymptotes of the curve  $x(x-y)^2 - 3(x^2 - y^2) + 8y = 0$
- Find the pedal equation of the curve  $x^{\frac{2}{3}} + y^{\frac{2}{3}} = a^{\frac{2}{3}}$
- Apply the method of differentiation under integral sign to evaluate  $\int_0^{\infty} \frac{\log(1+a^2x^2)}{1+b^2x^2} dx$
- Show that  $\int_0^{\infty} \frac{\log(1+x^2)}{1+x^2} dx = \pi \log 2$
- Use Gamma function to prove that  $\int_0^1 \frac{dx}{(1-x^6)^{\frac{1}{6}}} = \frac{\pi}{3}$
- Find the area of two loops of the curve  $a^2y^2 = a^2y^2 - x^4$

**OR**

Find the volume of the solid formed by the revolution of the cycloid  $x = a(\theta + \sin \theta)$ ,  $y = a(1 - \cos \theta)$  about the tangent at the vertex.

- Solve the differential equation  $(1+y^2) + (x - e^{\tan^{-1}y}) \frac{dy}{dx} = 0$
- Solve:  $y - 3px + ayp^2 = 0$
- Solve:  $(D^2 - 2D + 5)y = e^{2x} \cdot \sin x$
- A resistance of 100 Ohms, an inductance of 0.5 Henry are connected in series with a battery 20 volts. Find the current in the circuit as a function of time.
- What does the equation  $3x^2 + 3y^2 + 2xy = 2$  becomes when the axes are turned through an angle  $45^\circ$  to the original axes.
- Show that the locus of a point which moves in such a way that the differences of its distance from two fixed points is constant is a hyperbola.
- Find the center, length of the axes and eccentricity of the conic  $2x^2 + 3y^2 - 4x - 12y + 13 = 0$

**OR**

Describe and sketch the graph of the polar equation of conic  $r = \frac{10 \csc \theta}{\theta}$



Level	BE	Full Marks	80
Programme	All (Except B. Arch.)	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

**Subject: - Engineering Mathematics (SH 401)**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. If  $y = (x^2 - 1)^n$ , prove that  $(x^2 - 1)y_{n+2} + 2xy_{n+1} - n(n+1)y_n = 0$ .
2. State and prove Lagrange's mean value theorem and verify  $f(x) = \log x$ ,  $x \in [1, e]$ .
3. Evaluate  $\lim_{x \rightarrow 0} \left( \frac{1}{x^2} - \frac{1}{\sin^2 x} \right)$ .
4. Find the asymptotes of the curve  $x(x-y)^2 - 3(x^2 - y^2) + 8y = 0$ .
5. Find the tangent at  $(a, b)$  to the curve  $\left(\frac{x}{a}\right)^3 + \left(\frac{y}{b}\right)^3 = 2$ .
6. Evaluate  $\int_{-\infty}^{\infty} \frac{dx}{x^3}$ .
7. Use Gamma function to prove  $\int_0^{\pi} \sin^6 \frac{x}{2} \cos^6 \frac{x}{2} dx = \frac{5\pi}{2^{11}}$ .
8. Use method of differentiation under integral sign, evaluate  $\int_0^{\infty} \frac{\tan^{-1}(ax)}{x(1+x^2)} dx$ .
9. Find the area between the curve and its asymptotes  $y^2(a-x) = x^3$ .

OR

Find the volume of the ellipsoid formed by the revolution of an ellipse  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ .

10. Transform the equation  $3x^2 - 2xy + 4y^2 + 8x - 10y + 8 = 0$  by translating the axis into an equation with linear term missing.
11. Find the equation of ellipse whose centre is origin and whose axis are the axis of coordinates and passes through the pair of curves  $(1, 6)$  and  $(2, 3)$ .
12. Prove that the product of the semi axis of conic  $5x^2 + 6xy + 5y^2 + 12x + 4y - 4 = 0$  is 3.
13. Solve the differential equation  $xdy - ydx = \sqrt{x^2 + y^2} dx$ .
14. Find the general solution of the differential equation  $xy^2(p^2 + 2) = 2py^3 + x^3$ .
15. Find the general solution of the differential equation  $(x^2 D^2 + 4xD + 2)y = e^x$ .
16. A tank contains 1000 liters of fresh water. Salt water which contains 150gms of salt per liter, runs into it at the rate of 5 liter per minute and well-stirred mixture runs out of it at the same rate. When will the tank contain 5000gms of salt?

OR

Solve  $\frac{d^2 y}{dx^2} - y = x^2 \cos x$ .



Exam.	Regular		
Level	BE	Full Marks	80
Programme	All (Except B.Arch)	Pass Marks	32
Year / Part	1 / 1	Time	3 hrs.

**Subject:** - Engineering Mathematics I (SH401)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. If  $y = \log(x + \sqrt{a^2 + x^2})$  show that  $(a^2 + x^2)y_{n+2} + (2n+1)xy_{n+1} + n^2y_n = 0$
2. State and prove Lagrange's Mean Value theorem.
3. If  $\lim_{x \rightarrow 0} \frac{a \sin x - \sin 2x}{\tan^3 x}$  is finite, find the value of  $a$  and the limit.
4. Find asymptotes of  $(x^2 - y^2)^2 - 2(x^2 + y^2) + x - 1 = 0$
5. Find the radius of curvature at any point  $(x, y)$  for the curve  $x^{2/3} + y^{2/3} = a^{2/3}$
6. Prove that  $\int_0^\infty \frac{\sin bx}{x} dx = \frac{\pi}{2} (b > 0)$
7. Use Beta and Gamma function to evaluate  $\int_0^{2a} x^5 \sqrt{2ax - x^2} dx$
8. Evaluate  $\int_0^\infty \frac{e^{-x} \sin bx}{x} dx$  by using the rule of differentiation under the sign of integration.
9. Find the volume of the solid formed by the revolution of the cardioid  $r = a(1 + \cos\theta)$  about initial line.

**OR**

Find the area bounded by the curve  $x^2y = a^2(a - y)$  and the  $x$ -axes

10. Solve the differential equation  $\frac{dy}{dx} = \frac{y}{x} + \tan \frac{y}{x}$
11. Solve the differential equation  $x \frac{dy}{dx} + y \log y = xye^x$
12. Solve the differential equation  $\frac{d^2y}{dx^2} + 2 \frac{dy}{dx} = e^x + e^{-x}$
13. Solve  $y = px - \sqrt{m^2 + p^2}$  where  $p = \frac{dy}{dx}$

**OR**

A resistance of 100 ohms, an inductance of 0.5 henry are connected in series with a battery of 20 volts. Find the current in the circuit as a function of time.

14. Solve that locus of a point which moves in such a way that the differences of its distance from two fixed points is constant is Hyperbola.
15. Find the equation of ellipse of the form  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$  where  $a > b$

16. Describe and sketch the graph of the equation  $r = \frac{4 \sec \theta}{2 \sec \theta - 1}$

**Subject :- Engineering Mathematics I**  
**2068 - Shrawan**

1. If  $y = \log (x + \sqrt{a^2 + x^2})$ , show that  $(a^2 + x^2)y_{n+2} + (2n + 1)xy_{n+1} + n^2y_n = 0$ .
2. State and prove Lagrange's mean value theorem.
3. Evaluate:  $\lim_{x \rightarrow 0} \left( \frac{\tan x}{x} \right)^{1/x}$ .
4. Find the asymptotes of the curve  $(x^2 - y^2)(x + 2y + 1) + x + y + 1 = 0$ .
5. Show that for the ellipse  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ , the radius of curvature at the extremity of the major axis is equal to half of the latus rectum.
6. Evaluate:  $\int_0^{\pi/2} \frac{dx}{1 + \sqrt{\tan x}}$ .
7. Use Gamma function to prove that  $\int_0^1 \frac{dx}{(1-x^6)^{1/6}} = \frac{\pi}{2}$ .
8. Using method of differentiation under integral sign, evaluate:  $\int_0^\infty \frac{e^{-x} \sin bx}{x} dx$ .
9. Find the angle through which the axes must be turned so that the equation  $ax^2 + 2hxy + by^2 = 0$  may become an equation having no term involving  $xy$ .
10. Obtain the equation of an ellipse in the standard form.
11. Find the Center of Conic  $3x^2 + 8xy - 3y^2 - 40x - 20y + 50 = 0$ .
12. Solve the differential equation  $(x + y + 1) \frac{dy}{dx} = 1$ .
13. Find the general Solution of the differential equation:  $P^3 - 4xyp + 8y^2 = 0$ .
14. Find the general solution of the differential equation:  $(D^2 + 2D + 1)y = e^x \cos x$ .
15. Newton's Law of cooling states that "The temperature of an object changes at a rate proportional to the differences of temperatures between the object and its surrounding". Supposing water at a temperature  $100^\circ\text{C}$ . cools to  $80^\circ\text{C}$  in 10 minutes., in a room maintained at  $30^\circ\text{C}$ . Find when the temperature of water will become  $40^\circ\text{C}$ .

OR

Solve:  $x^2 \frac{d^2 y}{dx^2} - 4x \frac{dy}{dx} + 6y = x$



Exam.	Regular		
Level	BE	Full Marks	80
Programme	ALL	Pass Marks	32
Year / Part	1 / 1	Time	3 hrs.

**Subject:** - Engineering Mathematics I (SH 401)

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. If  $y^{1/m} + y^{-1/m} = 2x$  Show that:

- a)  $(x^2-1)y_2 + xy_1 - m^2y = 0$   
b)  $(x^2-1)y_{n+2} + (2n+1)xy_{n+1} + (n^2-m^2)y_n = 0$ .

2. State the Rolle's theorem and use it to prove Lagrange's mean value theorem.

3. Evaluate:  $\lim_{x \rightarrow 0} \left( \frac{1}{x^2} - \frac{1}{\sin^2 x} \right)$

4. Find the asymptotes of the curve  $a^2b^2 + 2ab^2x + b^2x^2 + a^2x^2 + 2ax^3 + x^4 - x^2y^2 = 0$ .

5. Find the pedal equation of the curve  $r^m = a^m \cos m\theta$ .

6. Show that  $\int_0^{\frac{\pi}{2}} \frac{x}{(\sin x + \cos x)} dx = \frac{\pi}{2\sqrt{2}} \log(\sqrt{2}+1)$

7. Apply differentiation under integral sign to evaluate  $\int_0^{\infty} \frac{e^{-x} \sin bx}{x} dx$

8. Use Gamma function to evaluate  $\int_0^1 x^6 \sqrt{1-x^2} dx$

9. Find the area of curve  $y^2(2a-x) = x^3$  and its asymptotes.

OR

Find the volume of solid formed by the revolution of the cardioid  $r = a(1 + \cos\theta)$  about the initial line.

10. Solve the differential equation  $\frac{dy}{dx} - 2y \tan x = y^2 \tan x$

11. Solve the differential equation  $xp^2 - 2yp + ax = 0$  where  $p = dy/dx$ .

12. Solve  $(D^2 - 2D + 5)y = 10 \sin x$

13. Solve the differential equation  $x^2 \frac{d^2y}{dx^2} + 4x \frac{dy}{dx} + 2y = e^x$

14. Derive the equation of an ellipse in standard form.

15. Prove that the normal at a point  $t$  of the rectangular Hyperbola  $xy = c^2$  meets the curve again at a point  $t_1$  such that  $t^3 t_1 = -1$ .

16. Find the equation of axes and length of axes of conic  $x^2 - 4xy - 2y^2 + 10x + 4y = 0$

OR



INSTITUTE OF ENGINEERING  
Examination Control Division

2067 Ashadh

I-67	BE	Full Marks	80
Programme	All (Except B.Arch.)	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

Subject: - Engineering Mathematics I

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ The figures in the margin indicate Full Marks.
- ✓ Assume suitable data if necessary.

1. If  $y = e^{a \tan^{-1} x}$ , prove that  $(1+x^2)y_{n+2} + (2nx + 2x - a)y_{n+1} + n(n+1)y_n = 0$ .

2. State and prove Lagrange's mean value theorem.

3. Evaluate  $\lim_{x \rightarrow 0} \left( \frac{\sin x}{x} \right)^{\frac{1}{x}}$

4. Find the asymptotes of the curve  $(x+y)^2(x+2y+z) = x+9y-2$ .

5. Find the radius of curvature of the curve  $r = a(1 - \cos \theta)$ .

6. Apply the method of differentiation under integral sign to evaluate  $\int_0^\infty \frac{\tan^{-1}(ax)}{x(1+x^2)} dx$ .

7. Prove that  $\int_0^{\pi/2} \frac{\sin^2 x dx}{\sin x + \cos x} = \frac{1}{\sqrt{2}} \log(\sqrt{2} + 1)$ .

8. Use Gamma function to prove  $\int_0^{\pi/6} \cos^4 3\theta \sin^2 6\theta = \frac{5\pi}{192}$ .

9. Find, by method of integration, the area of the loop of the curve  $ay^2 = x^2(a-x)$ .

10. Solve the differential equation  $(1+x^2) \frac{dy}{dx} + y = e^{\tan^{-1} x}$ .

11. Solve  $y = yp^2 + 2px$ , where  $p = dy/dx$

12. Solve  $(D^2 - 3D + 2)y = x^2 + x$

13. Newton's law of cooling states that the temperature of an object changes at a rate proportional to the difference of temperature between the object and its surroundings. Supposing water at  $100^\circ\text{C}$  cools to  $80^\circ\text{C}$  in 10 minutes, in a room temperature of  $30^\circ\text{C}$ , find when the temperature of water will become  $40^\circ\text{C}$ ?

OR

Solve the differential equation  $x^2 \frac{d^2 y}{dx^2} - x \frac{dy}{dx} + y = \log x$ .

14. Find the condition that the line  $lx + my + n = 0$  may be the tangent to the ellipse  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ .

15. Derive the equation of a hyperbola in standard form.

16. Find the centre, length of axes and eccentricity of the conic  $2x^2 + 3y^2 - 4x - 12y + 13 = 0$ .

OR

Identify and sketch the conic  $r = \frac{10}{3 + 2 \cos \theta}$ .



01 TRIBHUVAN UNIVERSITY  
INSTITUTE OF ENGINEERING  
**Examination Control Division**  
2067 Ashwin

Exam.	New Back (2066 Batch)		
Level	BE	Full Marks	80
Programme	All (Except B.Arch.)	Pass Marks	32
Year / Part	I / I	Time	3 hrs.

**Subject: - Engineering Mathematics I**

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ Attempt All questions.
- ✓ All questions carry equal marks.
- ✓ Assume suitable data if necessary.

1. If  $y = \sin(m \sin^{-1} x)$ , Prove that

a)  $(1 - x^2)y_2 - xy_1 + m^2y = 0$

b)  $(1 - x^2)y_{n+2} - (2n+1)xy_{n+1} + (m^2 - n^2)y_n = 0$

2. Obtain the series expansion of  $e^{\sin x}$  by Machaurin's theorem as far as the term  $x^4$ .

3. Evaluate  $\lim_{x \rightarrow 0} \left( \frac{\tan x}{x} \right)^{\frac{1}{x}}$ .

4. Find the asymptotes of the curve  $(x + y)^2(x + 2y) + 2(x + y)^2 - x - 9y + 2 = 0$ .

5. Show that the radius of curvature for the curve  $r^m = a^m \cos m\theta$  is  $\frac{a^m}{(m+1)r^{m+1}}$ .

6. Show that  $\int_0^{\pi/2} \frac{x \sin x \cos x}{\cos^4 x + \sin^4 x} dx = \frac{\pi^2}{16}$ .

OR

Evaluate  $\int_1^{\infty} \frac{xdx}{(1+x^2)^2}$ .

7. Apply differentiation under integral sign to evaluate  $\int_0^{\infty} \frac{\log(1+a^2x^2)}{(1+b^2x^2)} dx$ .

8. Prove that  $\int_0^1 \frac{dx}{(1-x^6)^{1/6}} = \frac{\pi}{3}$ . (Using Gamma function)

9. Find the area of astroid,  $x^{2/3} + y^{2/3} = a^{2/3}$ .

OR

Find the surface area of solid generated by the revolution of cardioid  $r = a(1 + \cos\theta)$ .

10. Through what angle should the axes be rotated so that the equation  $9x^2 - 2\sqrt{3}xy + 7y^2 = 10$  may be changed to  $3x^2 + 5y^2 = 5$ .