

Code No: 151AA

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech I Year I Semester Examinations, May/June - 2019

MATHEMATICS-I

(Common to CE, EEE, ME, ECE, CSE, EIE, IT, MCT, MMT, AE, MIE, PTM)

Time: 3 hours

Max. Marks: 75

Note: This question paper contains two parts A and B.

Part A is compulsory which carries 25 marks. Answer all questions in Part A.

Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

PART-A**(25 Marks)**

- 1.a) If A is orthogonal matrix, prove that A^T and A^{-1} are also orthogonal. [2]
- b) Find the Eigen values of A^2 , if $A = \begin{bmatrix} 1 & 2 & 0 \\ 0 & 2 & 1 \\ 0 & 0 & 1 \end{bmatrix}$. [2]
- c) State Cauchy's integral test. [2]
- d) State Rolle's theorem. [2]
- e) State Euler's theorem for homogeneous function in x and y . [2]
- f) State the conditions when the system of non homogenous equations $AX=B$ will have
i) unique solution ii) Infinite no of solutions iii) No solution. [3]
- g) Prove that the Eigen values of a skew- Hermitian matrix are purely imaginary or zero. [3]
- h) State Leibnitz test. [3]
- i) Evaluate $\int_0^{\infty} e^{x^3} x^7 dx$. [3]
- j) Find $\frac{\partial(u,v,w)}{\partial(x,y,z)}$, if $u = x + y + z, v = x + y$ and $z = z$. [3]

PART-B**(50 Marks)**

2. Using Gauss Seidel method solve $25x + 2y + 2z = 69, 2x + 10y + z = 63, x + y + z = 43$. [10]
3. OR
Solve the system of equations $x - y + 2z = 4, 3x + y + 4z = 6, x + y + z = 1$ using Gauss elimination method. [10]
4. Find Eigen values and Eigen vectors of $\begin{bmatrix} 2 & 1 & -1 \\ 1 & 1 & -2 \\ -1 & -2 & 1 \end{bmatrix}$. [10]

OR

5. Find Eigen values and Eigen vectors of $\begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$. [10]

- 6.a) Test the convergence of the series $\sum_{n=0}^{\infty} \frac{n!(n+1)!}{(3n)!}$.

- b) Find the radius of convergence of the series $\sum_{n=0}^{\infty} \frac{n^3 x^{3n}}{n^4 + 1}$. [5+5]

OR

7. Does the series $\sum_{n=0}^{\infty} \frac{(-1)^n}{\sqrt{n^2 + 1}}$ converge absolutely, conditionally or diverge? [10]

- 8.a) Expand $\tan^{-1}x$ in powers of $(x-1)$ using Maclaurin's theorem.

- b) Find the volume of the solid that results when the region enclosed by the curves $xy = 1$, x - axis and $x = 1$ rotated about x - axis. [5+5]

OR

- 9.a) Verify Cauchy mean value theorem for the functions e^x and e^{-x} in the interval (a, b) .

- b) Evaluate $\int_0^{\infty} x^4 e^{-x^2} dx$ Beta and Gamma. [5+5]

- 10.a) If $u = \log\left(\frac{x^2 + y^2}{x + y}\right)$ prove that $x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} = 1$.

- b) If $x + y + z = u$, $y + z = uv$, $z = uvw$, then evaluate $\frac{\partial(x, y, z)}{\partial(u, v, w)}$. [5+5]

OR

- 11.a) Show that $U = x^2 e^{-y} \cosh z$, $V = x^2 e^{-y} \sinh z$, $w = x^2 + y^2 + z^2 - xy - yz - zx$ are functionally dependent. If dependent find the relationship between them.

- b) Find the maximum of $x^2 + y^2 + z^2$ such that $2x + 3y + z = 14$ using Lagrange's multiplier method. [5+5]

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Code No: 131AA

R16

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MATHEMATICS-I

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PART-A

(25 Marks)

- 1.a) Solve the following differential equation $x \frac{dy}{dx} - y = x^2$. [2]
- b) Find the complimentary function for the equation $\frac{d^4y}{dx^4} + 4y = \cos 2x + \cos 4x$. [3]
- c) Find the value of k such that the rank of the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 2 & k & 7 \\ 3 & 6 & 10 \end{bmatrix}$ is 2. [2]
- d) Find the LU decomposition of $A = \begin{bmatrix} 1 & 3 \\ 4 & -1 \end{bmatrix}$. [3]
- e) If a square matrix A has an Eigen value λ then what is the Eigen value of the matrix kA^T where $k \neq 0$ is a scalar. [2]
- f) If a matrix $A = \begin{bmatrix} -1 & 0 & 0 \\ 2 & -3 & 0 \\ 1 & 4 & 2 \end{bmatrix}$ then what are the Eigen values of A^2 ? [3]
- g) If $u = e^{xyz}$ find the value of $\frac{\partial^3 u}{\partial x \partial y \partial z}$. [2]
- h) If $v = \frac{x^3 y}{x^3 + y^3}$ find the value of $x \frac{\partial v}{\partial x} + y \frac{\partial v}{\partial y}$. [3]
- i) Form the partial differential equation by eliminating the arbitrary constants a, b $z = (x+a)(y+b)$. [2]
- j) Solve $zp + yq = x$. [3]

PART-B

(50 Marks)

- 2.a) Solve $(D^2 - 4)y = x \sin x$
 - b) Find the current at any time $t > 0$ in a circuit having in series a constant electromotive force 40V, a resistor 10Ω , and an inductor 0.2 H given that the initial current is zero. Find the current when emf is $150 \cos 200t$. [5+5]
- OR
- 3.a) Solve $(D^2 + 2D^2 + 1)y = x^2 \cos x$
 - b) Solve by the method of variation of parameters: $\frac{d^2y}{dx^2} - y = \frac{2}{1+e^x}$. [5+5]

4. Factorize the matrix by the LU decomposition method $\begin{bmatrix} 2 & -3 & 1 \\ 3 & 4 & 2 \\ 2 & -3 & 4 \end{bmatrix}$ [10]

- 5.a) For what values of λ and μ do the system of equations $x+y+z=6$, $x+2y+3z=10$, $x+2y+\lambda z=\mu$ have i) no solution, ii) unique solution iii) more than one solution?
b) Find the value of k for which the system of equations:
 $(k+1)x + 8y = 4k$, $kx + (k+3)y = 3k-1$ has infinitely many solutions. [5+5]

6. Verify Cayley Hamilton theorem for the matrix $A = \begin{bmatrix} 1 & 2 & 0 \\ -1 & 1 & 2 \\ 1 & 2 & 1 \end{bmatrix}$ and obtain A^{-1} and A^3 . [10]

7. Reduce the quadratic form $3x^2 + 3y^2 + 3z^2 - 2yz + 2zx + 2xy$ to its canonical form. [10]

- 8.a) Determine the functional dependence and find the relation between $u = \frac{x-y}{x+y}$, $v = \frac{xy}{(x-y)^2}$.
b) If $y_1 = \frac{x_2 x_3}{x_1}$, $y_2 = \frac{x_3 x_1}{x_2}$, $y_3 = \frac{x_1 x_2}{x_3}$, Find the Jacobian of y_1, y_2, y_3 with respect to x_1, x_2, x_3 . [5+5]

- 9.a) Obtain the Taylor's expansion of $\tan^{-1} \frac{y}{x}$ about (1,1) upto and including second degree terms.
b) Find a point within a triangle such that the sum of the squares of its distances from the three angular points is a minimum. [5+5]

10. Solve the partial differential equations:
a) $(x^2 - yz)p + (y^2 - zx)q = (z^2 - xy)$
b) $x^2 \frac{\partial z}{\partial x} + y^2 \frac{\partial z}{\partial y} = (x+y)z$. [5+5]

11. Solve the partial differential equations
a) $p^2 + q^2 = z^2(x+y)$
b) $x^2 p^2 + y^2 q^2 = z$. [5+5]

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Code No: 121AC

R15

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech I Year Examinations, May/June - 2019

ENGINEERING MECHANICS

(Common to CE, ME, AE, MIE, PTM)

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PART- A

(25 Marks)

- 1.a) With the help of an example explain the Parallelogram law of forces. [2]
- b) State and prove Lami's theorem. [3]
- c) Distinguish between Static and Dynamic Friction. [2]
- d) What is 'Centrifugal Tension', and how does it affect the belt tensions? [3]
- e) What is the difference between Centroid and Centre of gravity of a plane? [2]
- f) What is 'Polar Moment of Inertia'? Write the expressions for the Polar Moment of Inertia of a circular area with respect to its centre, its M.I. with respect to the diameter of circle, and the M.I. of the quarter circle with respect to the x - axis. [3]
- g) What is the difference between the analysis as a Particle and analysis as a Rigid body in Translation? [2]
- h) Write the equation of the velocity vector of a particle, having curvilinear motion, in terms of the Rectangular components. From this expression, derive the magnitude and direction of the velocity vector. [3]
- i) Write the equation of work - energy for rectilinear motion of a particle. [2]
- j) What is the effect of the inertia of mass of the spring on the natural frequency of a vibratory system having a mass suspended freely from the end of a spring? [3]

PART-B

(50 Marks)

- 2.a) How can you resolve a force into a force and couple? Where is it useful?
- b) A 4 kN force is shown in figure 1. Resolve this force into i) two parallel components P and Q , acting along aa and bb respectively, and ii) a force P at B and a couple. Represent the couple by Forces F acting along bb and cc . [5+5]

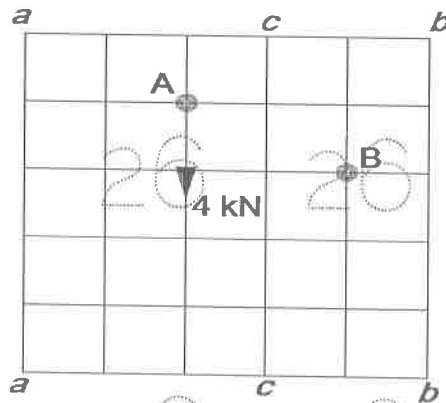


Figure: 1
OR

- 3.a) A man of weight $W = 712 \text{ N}$ holds one end of a rope that passes over a pulley vertically above his head, and to the other end of which is attached a weight $Q = 534 \text{ N}$. Find the force with which the man's feet press against the floor.
- b) Determine the resultant of two equal parallel forces acting in the opposite directions.

- 4.a) A turnbuckle with right and left hand single start square threads is used to couple two railway coaches. The pitch of threads is 10 mm over a mean diameter of 30 mm . The coefficient of friction is 0.15 . Find the work to be done in drawing the coaches together a distance of 300 mm against a steady load of 25 kN . [5+5]
- b) Derive an expression for the Angle of Contact in the case of Cross belt drive. [5+5]

OR

- 5.a) A pulley is driven by a flat belt running at 200 m/minute speed. Find the power transmitted by the belt, if the maximum tension in the belt is 1000 N . Assume the coefficient of friction between the belt and pulley surface as 0.3 , and the angle of lap is 160° .
- b) Show that for an ideal screw-jack, the efficiency is independent of the weight lifted. [5+5]

6. Find the centroid of the composite area ABCDEF shown in figure 2. A circle of radius 0.5 units has been cut out. A triangle and a quarter circle have also been cut out in a similar way. [10]

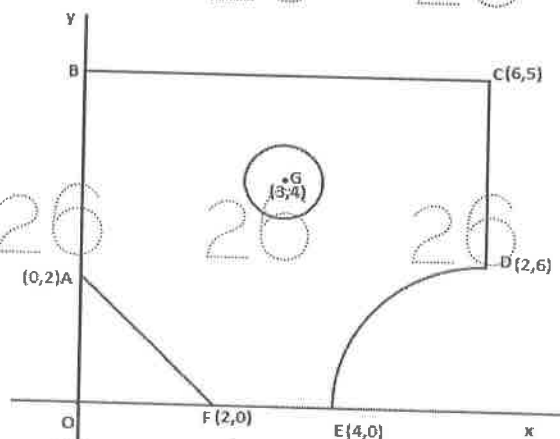


Figure: 2
OR

- 7.a) Find the centroid of the plane lamina OAB shown in figure 3.

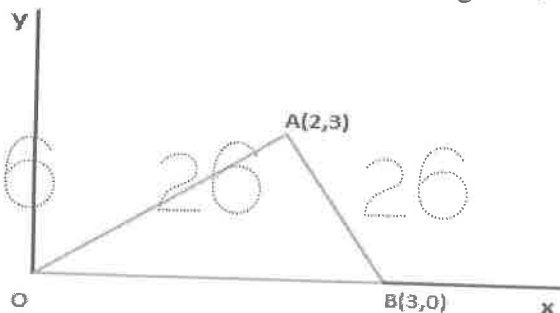


Figure: 3

- b) State and explain the first theorem of pappus.

[5+5]

- 8.a) A locomotive of weight $W = 534 \text{ kN}$ goes around a curve of radius $r = 300 \text{ m}$ at a uniform speed of 72 kmph . Determine the total lateral thrust on the rails.
- b) Write the governing equations for angular velocity and angular rotation of a rigid body rotating about a fixed axis under the action of a constant moment. [5+5]

OR

- 9.a) The rectilinear motion of a particle is defined by the equation $x = x_0(2e^{-kt} - e^{2kt})$, in which x_0 is the initial displacement, k is a constant, and e is the natural logarithm base. Sketch the displacement-time and velocity-time curves for this motion, and find the maximum velocity of the particle.
- b) Define the normal and tangential accelerations of a particle in curvilinear motion. [5+5]

- 10.a) State and prove the Work energy theorem.

- b) In a spring-mass vibrating system, the natural frequency of vibration is reduced to half the value when a second spring is added to the first spring in series. Determine the stiffness of the second spring in terms of that of the first spring. [5+5]

OR

- 11.a) A wood block weighing 22.25 N rests on a smooth horizontal surface. A revolver bullet weighing 0.14 N is shot horizontally into the side of the block. If the block attains a velocity of 3 m/s , what was the muzzle velocity of the bullet?

- b) Derive the expression for the natural frequency of vibration of a spring-mass system without damping. [5+5]

Code No: 121AL

R15

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B.Tech I Year Examinations, May/June - 2019

MATHEMATICAL METHODS

(Common to EEE, ECE, CSE, EIE, IT)

Time: 3 hours

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PART- A

(25 Marks)

1.a) If $\sum x = 10$, $\sum x^2 = 26$, $\sum y = 15$, $\sum xy = 18$, $n = 6$, find the values a and b for best fit of a straight line $y = a + bx$. [2]

b) Find the missing value from the following data:

x	1	3	5
y	-	9	26

[3]

c) How many number of subintervals are required for applying trapezoidal and Simpson rules to evaluate an integral. [2]

d) Derive an iterative formula for reciprocal of a non-zero number using Newton's Raphson method. [3]

e) Find the Fourier sine series of $f(x) = x^2$ in $[0, \pi]$. [2]

f) Find the Fourier cosine Transform of $f(x) = e^{-ax}$, $a > 0$. [3]

g) Solve the partial differential equation $p + q = 1$. [2]

h) Solve $\frac{\partial u}{\partial t} = 4 \frac{\partial u}{\partial x} + u$ by method of separation of variables. [3]

i) Define solenoidal and irrotational vector. [2]

j) Find $\text{Curl}(\vec{r})$ where $\vec{r} = xi + yj + zk$. [3]

PART-B

(50 Marks)

2.a) Prove that n^{th} difference of a polynomial of degree n is constant and higher order differences are zero.

b) Fit a straight line of the following data

x	1	3	5	7	9
y	1.5	2.8	4.0	4.7	6.0

OR

3.a) Interpolate by means of Gauss backward formula, the population of town for the year 1974, given that

Year	1939	1949	1959	1969	1979	1989
Population (000)	12	15	20	27	39	52

b) Prove that (i) $\mu = \sqrt{1 + \frac{\delta^2}{4}}$ and (ii) $E = e^{hD}$, where h is step size, D is differentiable operator. [5+5]

4. Solve by Jacobi iteration method for the system of equations
 $8x - 3y + 2z = 20$; $6x + 3y + 12z = 35$ and $4x + 11y - z = 33$.

[10]

OR

5. Evaluate $\int_0^2 e^{-x^2} dx$ using Trapezoidal rule as well as Simpson's rule, taking step size $h=0.2$.

[10]

6. Find the Fourier series of $f(x) = \begin{cases} 0, & -\pi \leq x \leq 0 \\ \sin x, & 0 \leq x \leq \pi \end{cases}$; Hence show that

$$\frac{1}{1.3} + \frac{1}{3.5} + \frac{1}{5.7} + \dots = \frac{1}{4}(\pi - 2).$$

[10]

OR

7. Find the Fourier sine and cosine transform of $f(x) = \frac{e^{-ax}}{x}$, and hence show that

$$\int_0^{\infty} \frac{e^{ax} - e^{-ax}}{x} \sin sx dx = \tan^{-1}\left(\frac{s}{a}\right) - \tan^{-1}\left(\frac{s}{b}\right), \quad a, b > 0.$$

[10]

- 8.a) Solve $p^2 - q^2 = x - y$.

- b) Solve $x^2(y - z)p + y^2(z - x)q = z^2(x - y)$.

[5+5]

OR

9. If a string of length l is initially at rest in equilibrium position and each of its points is given the velocity $v_0 \sin^3\left(\frac{\pi x}{l}\right)$, find the displacement $y(x, t)$.

[10]

- 10.a) Prove that $\text{div}(r^n \bar{r}) = (n+3)r^n$, where $r = |\bar{r}| = \sqrt{x^2 + y^2 + z^2}$.

- b) Calculate the work done by a force $F = 3xy\mathbf{i} - y^2\mathbf{j}$ in moving a particle in xy -plane from $(0, 1)$ to $(1, 2)$ along the parabola $y = x^2$.

[5+5]

OR

11. Verify Stokes theorem for $F = (x^2 + y^2)\mathbf{i} - 2xy\mathbf{j}$ taken around a rectangle bounded by the lines $x = a$, $x = -a$, $y = 0$ and $y = b$.

[10]

---ooOoo---

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R13

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- b) Find the missing value from the following data: [2]

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- c) How many number of subintervals are required for applying trapezoidal and Simpson rules to evaluate an integral. [3]
d) Derive an iterative formula for reciprocal of a non-zero number using Newton's Raphson method. [2]
e) Find the Fourier sine series of $f(x) = x^2$ in $[0, \pi]$. [3]
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PART-B

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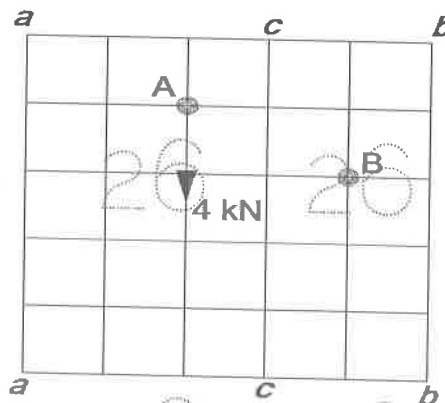


Figure: 1
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- 3.a) A man of weight $W = 712 \text{ N}$ holds one end of a rope that passes over a pulley vertically above his head, and to the other end of which is attached a weight $Q = 534 \text{ N}$. Find the force with which the man's feet press against the floor.

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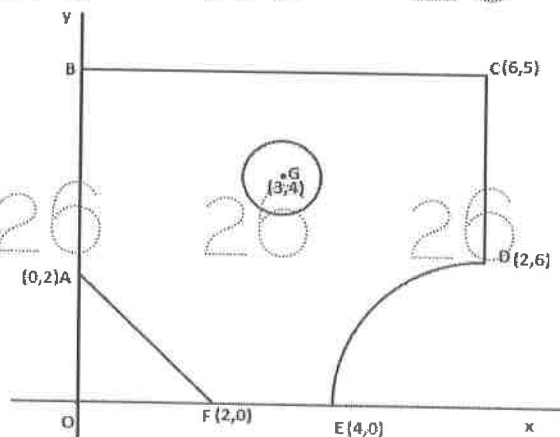


Figure: 2

OR

- 7.a) Find the centroid of the plane lamina OAB shown in figure 3.

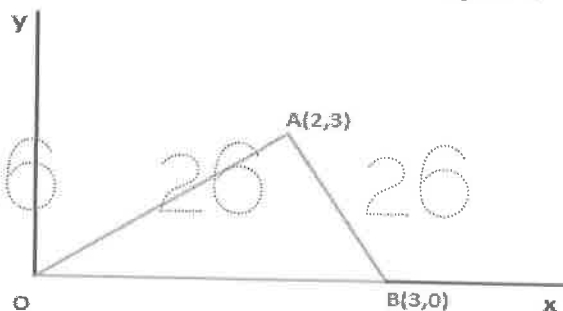


Figure: 3

- b) State and explain the first theorem of pappus.

[5+5]

- 8.a) A locomotive of weight $W = 534 \text{ kN}$ goes around a curve of radius $r = 300 \text{ m}$ at a uniform speed of 72 kmph . Determine the total lateral thrust on the rails.
- b) Write the governing equations for angular velocity and angular rotation of a rigid body rotating about a fixed axis under the action of a constant moment. [5+5]

OR

- 9.a) The rectilinear motion of a particle is defined by the equation $x = x_0(2e^{-kt} - e^{2kt})$, in which x_0 is the initial displacement, k is a constant, and e is the natural logarithm base. Sketch the displacement-time and velocity-time curves for this motion, and find the maximum velocity of the particle.
- b) Define the normal and tangential accelerations of a particle in curvilinear motion. [5+5]

- 10.a) State and prove the Work energy theorem.

- b) In a spring-mass vibrating system, the natural frequency of vibration is reduced to half the value when a second spring is added to the first spring in series. Determine the stiffness of the second spring in terms of that of the first spring. [5+5]

OR

- 11.a) A wood block weighing 22.25 N rests on a smooth horizontal surface. A revolver bullet weighing 0.14 N is shot horizontally into the side of the block. If the block attains a velocity of 3 m/s , what was the muzzle velocity of the bullet?

- b) Derive the expression for the natural frequency of vibration of a spring-mass system without damping. [5+5]