# MARRI LAXMAN REDDY
## INSTITUTE OF TECHNOLOGY AND MANAGEMENT
(AN AUTONOMOUS INSTITUTION)
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# DEPARTMENT OF MATHEMATICS

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| **Course Name** | **ENGINEERING MATHEMATICS-1** |
| **Course Faculty** | **V.SRINIVASA RAO, A.SUDHAKAR, A.AJAY BABU, M.RAMANUJA, B.SRIDHR REDDY, P.VIJAYA LAKSHMI, M.SATEESH.** |

## PART-A (SHORT ANSWER QUESTIONS)

### UNIT-I: MATRICES

| SNO | QUESTION | Course Outcome | Bloom's Taxonomy |
|---|---|---|---|
| 1. | Define symmetric matrix and give an Example. | CO1 | Remember |
| 2. | Show that the matrix $\begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$ is orthogonal | CO1 | Understand |
| 3. | Prove that the inverse of an orthogonal matrix is orthogonal. | CO1 | Apply |
| 4. | Find the rank of the matrix A = $\begin{bmatrix} 2 & 3 & 7 \\ 3 & -2 & 4 \\ 1 & -3 & -1 \end{bmatrix}$ by reducing it to Echelon form. | CO1 | Understand |
| 5. | Define Rank of a matrix. | CO1 | Remember |
| 6. | Prove that inverse of a non – singular symmetric matrix A is symmetric | CO1 | Apply |
| 7. | Find the rank of the matrix $\begin{bmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \\ 8 & 7 & 0 & 5 \end{bmatrix}$ | CO1 | Apply |
| 8. | Prove that the matrix $\frac{1}{3}\begin{bmatrix} -1 & 2 & 2 \\ 2 & -1 & 2 \\ 2 & 2 & -1 \end{bmatrix}$ is orthogonal | CO1 | Apply |
| 9. | Prove that transpose of an orthogonal matrix is Orthogonal. | CO1 | Apply |

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| 10. | Find the value of k such that the rank of $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & K & 7 \\ 3 & 6 & 10 \end{bmatrix}$ is 2. | CO1 | Apply |
| 11. | Express the matrix A as sum of symmetric and skew – symmetric matrices. Where A = $\begin{bmatrix} 3 & -2 & 6 \\ 2 & 7 & -1 \\ 5 & 4 & 0 \end{bmatrix}$ | CO1 | Apply |
| 12. | Determine the rank of the given matrix $\begin{bmatrix} 1 & 2 & 3 \\ 3 & 4 & 4 \\ 7 & 10 & 12 \end{bmatrix}$ | CO1 | Apply |
| 13. | Show that the matrix $A = \begin{bmatrix} 2 & -3 & 1 \\ 4 & 3 & 1 \\ -3 & 1 & 9 \end{bmatrix}$ is orthogonal. | CO1 | Remember |
| 14. | If $\begin{bmatrix} 3 & a & b \\ -2 & 2 & 4 \\ 7 & 4 & 5 \end{bmatrix}$ is symmetric, then find the values of a and b. | CO1 | Understand |
| 15. | Predict the value of the rank for the matrix A= $\begin{bmatrix} 1 & 2 & 3 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix}$. | CO1 | Understand |
| 16. | Explain Diagonally dominant Property for non-homogenous system | CO1 | Apply |
| 17. | Define Skew-symmetric matrix and give an Example. | CO1 | Remember |
| 18. | Define orthogonal matrix and give an Example. | CO1 | Remember |
| 19. | Prove that product of orthogonal matrices is Orthogonal | CO1 | Apply |
| 20. | Find the rank of the matrix $\begin{bmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \\ 8 & 7 & 0 & 5 \end{bmatrix}$ | CO1 | Understand |

## UNIT-II: EIGEN VALUES AND EIGEN VECTORS

| SNO | QUESTION | Course Outcome | Bloom's Taxonomy |
|---|---|---|---|
| 1. | Find the Eigen values of $\begin{bmatrix} 8 & -4 \\ 2 & 2 \end{bmatrix}$ | CO2 | Understand |
| 2. | If $\lambda$ is an Eigen value of a non-singular matrix A corresponding to the Eigen vector X, then Prove that $\lambda^{-1}$ *is an Eigen value of* $A^{-1}$ *and corresponding Eigen vector X itself.* | CO2 | Understand |

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| 3. | State Cayley Hamilton theorem. | CO2 | Remember |
| 4. | Find the Sum and Product of the Eigen values of $\begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$. | CO2 | Understand |
| 5. | Determine the Characteristic roots of the matrix $\begin{bmatrix} 5 & 4 \\ 1 & 2 \end{bmatrix}$ | CO2 | Understand |
| 6. | Are the vectors $\begin{pmatrix} 2 \\ 1 \\ 1 \end{pmatrix}$ $\begin{pmatrix} 2 \\ 0 \\ -1 \end{pmatrix}$ $\begin{pmatrix} 4 \\ 2 \\ 1 \end{pmatrix}$ Linearly independent? | CO2 | Understand |
| 7. | Identify the matrix of the quadratic form $x^2 + 5y^2 + 6xy$. | CO2 | Understand |
| 8. | If $\lambda$ is an Eigen value of a non-singular matrix A, show that $\frac{\|A\|}{\lambda}$ is an Eigen value of the matrix adj(A). | CO2 | Understand |
| 9. | Predict the Eigen values of $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$. | CO2 | Understand |
| 10. | Find the sum and product of Eigen values of the matrix $\begin{bmatrix} 3 & 1 & 4 \\ 0 & 2 & 6 \\ 0 & 0 & 5 \end{bmatrix}$ | CO2 | Understand |
| 11. | Write the matrix of the quadratic form $2x^2 + 4y^2 + 8xy$. | CO2 | Remember |
| 12. | Verify the vectors $\begin{pmatrix} 1 \\ 2 \\ 4 \end{pmatrix}$ $\begin{pmatrix} 2 \\ -1 \\ 3 \end{pmatrix}$ $\begin{pmatrix} 0 \\ 1 \\ 2 \end{pmatrix}$ are Linearly Independent or not? | CO2 | Understand |
| 13. | Write the Characteristic equation of $\begin{bmatrix} 1 & 2 \\ 2 & -1 \end{bmatrix}$. | CO2 | Remember |
| 14. | Find the sum and product of Eigen values of the matrix $\begin{bmatrix} 2 & -3 \\ 4 & -2 \end{bmatrix}$ | CO2 | Understand |
| 15. | Prove that a Square matrix A and its transpose $A^T$ have the same Eigen values | CO2 | Understand |
| 16. | Identify the matrix of the quadratic form $3x^2 + 6y^2 + 2xy$ | CO2 | Understand |
| 17. | $\lambda$ is an eigen value of an orthogonal matrix then $\frac{1}{\lambda}$ is also an eigen value | CO2 | Understand |
| 18. | If $\lambda$ is Eigen value of A then prove that the Eigen value of $B = a_0A^2+a_1A+a_2I$ is $a_0\lambda^2+a_1\lambda+a_2$ | CO2 | Understand |
| 19. | Suppose that A and P be square matrices of order n such that P is non-singular. Then A and $P^{-1}AP$ have the same Eigen values. | CO2 | Understand |
| 20. | Prove that the Eigen values of an idempotent matrix are 0 or 1. | CO2 | Understand |

| UNIT-III: CALCULUS OF SINGLE VARIABLE | | | |
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| 1. | State Lagrange's mean value theorem | CO3 | Remember |
| 2. | Verify Roll's mean value theorem for f(x) = $\frac{1}{x^2}$ in [-1, 1]. | CO3 | Understand |
| 3. | Verify Role's theorem for the function f(x) =$\tan x$ in [0, $\pi$ ]. | CO3 | Understand |
| 4. | Write the geometrical interpretation of Lagrange's MVT | CO3 | Remember |
| 5. | State Cauchy's mean value theorem | CO3 | Remember |
| 6. | Verify Rolle's Theorem for $f(x) = x^2$ in [2,3] | CO3 | Understand |
| 7. | State Rolle's mean value theorem. | CO3 | Remember |
| 8. | Explain why mean value theorem does not hold for $f(x) = x^{2/3}$ in (-1, 1). | CO3 | Understand |
| 9. | Write the geometrical interpretation of Rolle's MVT | CO3 | Remember |
| 10. | Find $\sqrt[5]{245}$ using mean value theorem. | CO3 | Understand |
| 11. | State Taylor's Theorem with Lagrange form of remainder. | CO3 | Remember |
| 12. | State Maclaurin's Theorem with Lagrange form of remainder. | CO3 | Remember |
| 13. | Prove that $\Gamma(1) = 1$ | CO3 | Understand |
| 14. | Use $\beta - \Gamma$ functions to evaluate $\int_0^{\pi/2} \text{Sin}^3\theta \, \text{Cos}^4\theta \, d\theta$ | CO3 | Understand |
| 15. | P.T $\beta(m,n) = \beta(n,m)$ | CO3 | Understand |
| 16. | Show that $\Gamma(1/2) = \sqrt{\Pi}$ | CO3 | Understand |
| 17. | P.T $\beta(m,n) = 2\int_0^{\frac{\Pi}{2}} \sin^{2m-1}\theta \cos^{2n-1}\theta \, d\theta$ | CO3 | Understand |
| 18. | Evaluate $\int_0^1 x^5 (1-x)^3 \, dx$ | CO3 | Evaluate |
| 19. | Evaluate $\int_0^1 x^3 \sqrt{1-x} \, dx$ | CO3 | Evaluate |
| 20. | P.T $\int_0^\infty e^{-y^{1/m}} \, dy = m\Gamma(m)$ | CO3 | Understand |

| UNIT-IV: MULTIVARIABLE CALCULUS | | | |
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| 1. | Define jacobian and its properties | CO4 | Remember |
| 2. | Define the functional dependence and independence | CO4 | Remember |
| 3. | Define the saddle point. | CO4 | Remember |

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| 4. | Find the stationary points of xy+x-y. | CO4 | Understand |
| 5. | Write the condition for the maximum and minimum of the function x,y. | CO4 | Remember |
| 6. | Write the procedure of Lagrange's method of undetermined multipliers. | CO4 | Remember |
| 7. | If u=x+y, v = xy, find $\frac{\partial(u,v)}{\partial(x,y)}$ | CO4 | Understand |
| 8. | | CO4 | Understand |
| 9. | Find first and second order partial derivatives of $ax^2+2hxy+by^2$ and *verify* $\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial x \partial y}$. | CO4 | Understand |
| 10. | Write the relation between the functions u=2x-y+3z ,v=2x-y+z,w=2x-y-z | CO4 | Remember |
| 11. | If x = u(1-v), y = uv find J. | CO4 | Understand |
| 12. | If u=2x+3$Y^2$ V=3 $X$□3□+Y$X^2$ find the first order partial derivatives w.r.t Y | CO4 | Understand |
| 13. | Find the maximum and minimum values of $x^3 + y^3 - 3axy$ | CO4 | Understand |
| 14. | Prove that JJ′ =1 | CO4 | Understand |
| 15. | If $u = e^x \sin y, v = e^x \cos y$ then find. $\frac{\partial(u,v)}{\partial(x,y)}$ | CO4 | Understand |
| 16. | If $u = x^2$-2y,$v = x + y + z$, $w=x-2y+3z$ find □ $\frac{\partial(u,v,w)}{\partial(x,y,z)}$ | CO4 | Understand |
| 17. | Discuss the max and minimum value of $x^2 + y^2 + 6x + 2y$ | CO4 | Understand |
| 18. | State Euler's theorem | CO4 | Remember |
| 19. | Define total derivative. | CO4 | Remember |
| 20. | Write the Chain rule for implicit functions | CO4 | Remember |

## UNIT-V: MULTIPLE INTEGRALS AND APPLICATIONS

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| 1. | Calculate the integral value of $\int_0^1\int_0^2 y^2 dydx$ | CO5 | Remember |
| 2. | Calculate the integral value of $\int_0^\infty\int_0^\infty e^{-(x^2+y^2)} dydx$ | CO5 | Remember |
| 3. | Find the integral $\int_0^{\frac{\Pi}{2}}\int_{-1}^1 (x^2y^2) dydx$ | CO5 | Understand |
| 4. | Calculate the integral value of $\int_0^a\int_0^b (x^2+y^2) dydx$ | CO5 | Remember |
| 5. | Calculate the integral value of $\int_0^2\int_0^3 xydydx$ | CO5 | Remember |

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| 6. | Find the value of $\int_{-1}^{1}\int_{-2}^{2} dxdy$ | CO5 | Understand |
| 7. | Estimate the area enclosed by the parabolas $y^2 = x$ and $x^2 = y$ | CO5 | Remember |
| 8. | Estimate the area enclosed by the parabola $x^2 = y$ and the line $y = x$ | CO5 | Remember |
| 9. | Find the value of $\int_{0}^{1}\int_{x}^{\sqrt{x}} (x^2 + y^2) dydx$ | CO5 | Understand |
| 10. | Evaluate $\int_{0}^{2}\int_{0}^{x} e^{x+y} dydx$ | CO5 | Evaluate |
| 11. | Evaluate $\iint_R x^2 dxdy$ over the region bounded by the hyperbola xy=4, y=0, x=1 and x=4. | CO5 | Evaluate |
| 12. | Find the integral $\int_{0}^{5}\int_{0}^{x^2} x(x^2 + y^2)dxdy$ | CO5 | Understand |
| 13. | Change the order of Integration $\int_{x=0}^{4a}\int_{y=x^2/4a}^{2\sqrt{ax}} dy\,dx$ | CO5 | Apply |
| 14. | Write the change of variables from Cartesian to Cylindrical polar coordinates in Triple integrals | CO5 | Remember |
| 15. | Write the change of variables from Cartesian to Spherical polar coordinates in Triple integrals | CO5 | Remember |
| 16. | Find the area bounded by the Parabola $y = x^2$ and $y = 2x + 3$ | CO5 | Understand |
| 17. | Calculate the integral value of $\int_{0}^{3}\int_{1}^{2} (x^2 + 3y^2) dydx$ | CO5 | Remember |
| 18. | Write the change of variables from Cartesian to polar coordinates in double integrals | CO5 | Remember |
| 19. | Change the order of Integration $\int_{0}^{a}\int_{x^2/a}^{2a-x} xy\,dydx$ | CO5 | Apply |
| 20. | Evaluate $\int_{-a}^{a}\int_{-b}^{b}\int_{-c}^{c} \pi\, dxdydz$ | CO5 | Evaluate |

## PART-B (LONG ANSWER QUESTIONS)

### UNIT-I: MATRICES

| SNO | QUESTION | Course Outcome | Bloom's Taxonomy |
|---|---|---|---|
| 1. | Express the matrix A as sum of symmetric and skew – symmetric matrices. Where $A = \begin{bmatrix} 3 & -2 & 6 \\ 2 & 7 & -1 \\ 5 & 4 & 0 \end{bmatrix}$ | CO1 | Apply |

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| 2. | For what values of k the matrix $\begin{bmatrix} 4 & 4 & -3 & 1 \\ 1 & 1 & -1 & 0 \\ k & 2 & 2 & -2 \\ 9 & 9 & k & 3 \end{bmatrix}$ has rank '3'. | CO1 | Analyze |
| 3. | Translate the Matrix A= $\begin{bmatrix} 2 & -2 & 0 & 6 \\ 4 & 2 & 0 & 2 \\ 1 & -1 & 0 & 3 \\ 1 & -2 & 1 & 2 \end{bmatrix}$ into Normal form by elementary row and column operations. | CO1 | Apply |
| 4. | Solve the system of equations $2x+4y+z=14; 5x+y-z=10; x+y+8z=20.$ using Gauss Seidel method. | CO1 | Design |
| 5. | Find the inverse of the matrix by elementary row operations A= $\begin{bmatrix} 1 & 1 & 3 \\ 1 & 3 & -3 \\ -2 & -4 & -4 \end{bmatrix}$ | CO1 | Understand |
| 6. | Solve the system of equations $x+2y-3z=9; 2x-y+z=0; 4x-y+z=4.$ using Gauss Elimination method | CO1 | Design |
| 7. | Find for what values of $\lambda$ and $\mu$ the system of equations $x+y+z=6$, $x+2y+5z=10$ and $2x+3y+\lambda z=\mu$ will have<br>(i) No solution<br>(ii) Unique Solution<br>(iii) Infinite Solution | CO1 | Understand |
| 8. | Determine the values of a,b,c when $\begin{bmatrix} 0 & 2b & c \\ a & b & -c \\ a & -b & c \end{bmatrix}$ is orthogonal | CO1 | Understand |
| 9. | Translate the Matrix A= $\begin{bmatrix} 1 & -1 & 2 & -3 \\ 4 & 1 & 0 & 2 \\ 0 & 3 & 0 & 4 \\ 0 & 1 & 0 & 2 \end{bmatrix}$ into Normal form by elementary row and column operations. | CO1 | Apply |
| 10. | Show that the only real value of $\lambda$ for which the following system of equations have non-zero solution is 6.<br>$x+2y+3z=\lambda x$, $3x+y+2z=\lambda y$, $2x+3y+z=\lambda z$. | CO1 | Apply |
| 11. | Solve the system of equations 3x+y-z = 3, 2x-8y+z = -5, x-2y+9z = 8 using Gauss elimination method. | CO1 | Apply |
| 12. | Solve the system of equations x+3y-2z = 0, 2x-y+4z = 0, x-11y+14z = 0 | CO1 | Design |
| 13. | Find the non-singular matrices P and Q such that the normal form of A is P A Q. Where A = $\begin{bmatrix} 1 & 3 & 6 & -1 \\ 1 & 4 & 5 & 1 \\ 1 & 5 & 4 & 3 \end{bmatrix}$. Hence find its rank. | CO1 | Understand |
| 14. | Show that the equations x+y+z=6, x+2y+3z=14, x+4y+7z=30 are consistent | CO1 | Apply |

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| | and solve them | | |
| 15. | Find whether the following equations are consistent, if so solve them. x+y+2z=4, 2x-y+3z=9, 3x-y-z=2 | CO1 | Understand |
| 16. | Show that the equations given below are consistent and hence solve them x-3y-8z = -10, 3x+y-4z =0, 2x+5y+6z =3 | CO1 | Apply |
| 17. | Solve the system of equations $4x+2y+z=11; -x+2y=3; 2x+y+4z=16$. using Gauss Seidel method | CO1 | Design |
| 18. | Solve the system of equations $2x+4y+z=14; 5x+y-z=10; x+y+8z=20$. using Gauss Seidel method. | CO1 | Design |
| 19. | Find for what values of $\lambda$ the system of equations $x+y+z=1, x+2y+4z=\lambda$ and $x+4y+10z=\lambda^2$ have a solution and solve them each case. | CO1 | Understand |
| 20. | Find the inverse of the matrix by Gauss-Jordon method A= $\begin{bmatrix} 0 & 1 & 2 & 2 \\ 1 & 1 & 2 & 3 \\ 2 & 2 & 2 & 3 \\ 2 & 3 & 3 & 3 \end{bmatrix}$ | CO1 | Understand |
| | **UNIT-II: EIGEN VALUES AND EIGEN VECTORS** | | |
| 1. | Utilize Cayley Hamilton theorem, find the inverse of the matrix $A=\begin{bmatrix} 7 & 2 & -2 \\ -6 & -1 & 2 \\ 6 & 2 & -1 \end{bmatrix}$ | CO2 | Apply |
| 2. | Find the model matrix P which transforms the matrix $A=\begin{bmatrix} 1 & 1 & 1 \\ 0 & 2 & 1 \\ -4 & 4 & 3 \end{bmatrix}$ into diagonal form. | CO2 | Understand |
| 3. | Utilize Cayley Hamilton theorem, find $A^4$ of the matrix $A=\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 5 \\ 3 & 5 & 6 \end{bmatrix}$ | CO2 | Apply |
| 4. | Find the Eigen values and Eigen vectors of the matrix $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$ | CO2 | Understand |
| 5. | Verify Cayley Hamilton theorem and express $2A^5-3A^4+A^2-4I$ as a | CO2 | |

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| | linear polynomial in A, where $A=\begin{bmatrix}3 & 1\\ -1 & 2\end{bmatrix}$ | | |
| 6. | Identify the nature of the quadratic form $x^2+4y^2+z^2-4xy+2xz-4yz$. by reducing into Canonical form. Also find rank, index and signature. | CO2 | Apply |
| 7. | Find the Eigen values and the corresponding Eigen vectors of the matrix $A=\begin{bmatrix}-2 & 2 & -3\\ 2 & 1 & -6\\ -1 & -2 & 0\end{bmatrix}$ | CO2 | Understand |
| 8. | Identify the nature of the quadratic form $2x^2+2y^2+2z^2+2yz$. by transforming into sum of squares form. | CO2 | Apply |
| 9. | Find the Eigen values and Eigen vectors of the matrix A and its inverse, where A = $\begin{bmatrix}1 & 3 & 4\\ 0 & 2 & 5\\ 0 & 0 & 3\end{bmatrix}$ | CO2 | Understand |
| 10. | *Find the Eigen values of* $3A^3+5A^2-6A+2I$ *where* $A=\begin{bmatrix}1 & 2 & -3\\ 0 & 3 & 2\\ 0 & 0 & -2\end{bmatrix}$ | CO2 | Understand |
| 11. | Find a matrix P which transform the matrix $\begin{bmatrix}1 & 0 & -1\\ 1 & 2 & 1\\ 2 & 2 & 3\end{bmatrix}$ *to diagonal form. Hence calculate* $A^4$ | CO2 | Understand |
| 12. | Determine the modal matrix P of = $\begin{bmatrix}-2 & 2 & -3\\ 2 & 1 & -6\\ -1 & -2 & 0\end{bmatrix}$. Verify that $P^{-1}AP$ is a diagonal matrix. | CO2 | Understand |
| 13. | Show that the matrix A = $\begin{bmatrix}1 & -2 & 1\\ 1 & -2 & 3\\ 0 & -1 & 2\end{bmatrix}$ satisfies its characteristic equation Hence find $A^{-1}$ | CO2 | Apply |
| 14. | Using Cayley - Hamilton Theorem find the inverse and $A^4$ of the matrix A = $\begin{bmatrix}7 & 2 & -2\\ -6 & -1 & 2\\ 6 & 2 & -1\end{bmatrix}$ | CO2 | Apply |
| 15. | Reduce the quadratic form $3x^2+5y^2+3z^2-2yz+2zx-2xy$ to the canonical form by orthogonal reduction. | CO2 | Apply |
| 16. | If A= $\begin{bmatrix}i & 0 & 0\\ 0 & 0 & i\\ 0 & i & 0\end{bmatrix}$ Find the Eigen values and corresponding Eigen vectors of A. | CO2 | Understand |
| 17. | Find the orthogonal transformation which transforms the quadratic form $x_1^2+3x_2^2+3x_3^2-2x_2x_3$ to canonical form | CO2 | Understand |

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| 18. | If $A=\begin{bmatrix}2 & 0\\ 0 & 1\end{bmatrix}$ then find $A^{100}$ using diagonalization. | CO2 | Understand |
| 19. | For a real symmetric matrix, the Eigen vectors corresponding to two distinct Eigen values are orthogonal. | CO2 | Design |
| 20. | The sum of the eigen values of a square matrix is equal to its trace and product of the eigen values is equal to its determinant. | CO2 | Design |
| **UNIT-III: CALCULUS OF SINGLE VARIABLE** | | | |
| 1. | Verify Rolle's theorem for the function f(x) = sinx/$e^x$ or $e^{-x}$ sinx in [0,π] | CO3 | Analyze |
| 2. | Verify Rolle's theorem for the functions $\log\left(\frac{x^2+ab}{x(a+b)}\right)$ in[a,b] , a>0, b>0 | CO3 | Analyze |
| 3. | Verify Rolle's theorem for the function f(x) = $(x-a)^m(x-b)^n$ where m,n are positive integers in [a,b]. | CO3 | Analyze |
| 4. | Using Rolle 's Theorem, show that g(x) = $8x^3-6x^2-2x+1$ has a zero between 0 and 1. | CO3 | Apply |
| 5. | Verify Rolle's theorem for f(x) = $x(x+3)e^{-x/2}$ in [-3,0]. | CO3 | Analyze |
| 6. | Verify Lagrange's Mean value theorem for f(x)= $x^3-x^2-5x+3$ in [0,4] | CO3 | Analyze |
| 7. | If a<b, P.T $\frac{b-a}{1+b^2}<Tan^{-1}b-Tan^{-1}a<\frac{b-a}{1+a^2}$ using Lagrange's Mean value theorem. Deduce the following.<br>i). $\frac{\pi}{4}+\frac{3}{25}<Tan^{-1}\frac{4}{3}<\frac{\pi}{4}+\frac{1}{6}$<br>ii). $\frac{5\pi+4}{20}<Tan^{-1}2<\frac{\pi+2}{4}$ | CO3 | Apply |
| 8. | Find c of Cauchy's mean value theorem for<br>$f(x)=\sqrt{x}$ & $g(x)=\frac{1}{\sqrt{x}}$ in [a,b] where 0<a<b | CO3 | Understand |
| 9. | Verify Cauchy's Mean value theorem for f(x) = $e^x$ & g(x) = $e^{-x}$ in [3,7] & find the value of c. | CO3 | Analyze |
| 10. | Verify Taylor's theorem for f(x) = $(1-x)^{5/2}$ with Lagrange's form of remainder up to 2 terms in the interval [0,1]. | CO3 | Analyze |
| 11. | Show that $\log(1+e^x)=\log 2+\frac{x}{2}+\frac{x^2}{8}+\frac{x^4}{192}+------$ and hence | CO3 | Apply |

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| | deduce that $\frac{e^x}{e^x+1}=\frac{1}{2}+\frac{x}{4}-\frac{x^3}{48}+---$ | | |
| 12. | Show that $\int_0^\infty \sqrt{x}e^{-x^3}dx=\frac{\sqrt{\pi}}{3}$ | CO3 | Apply |
| 13. | Evaluate $\int_0^1 \frac{x^4}{\sqrt{1-x^2}}dx$ | CO3 | Evaluate |
| 14. | Show that $\int_0^\infty x^4 e^{-x^2}dx=\frac{3\sqrt{\pi}}{8}$ | CO3 | Apply |
| 15. | Use $\beta-\Gamma$ functions to evaluate $\int_0^{\frac{\Pi}{2}} \sin^2\theta\cos^4\theta d\theta$ | CO3 | Apply |
| 16. | Evaluate $\int_0^\infty x^{1/2}e^{-x/5}dx$ | CO3 | Evaluate |
| 17. | Prove that $\beta(m,n)=\int_0^\infty \frac{x^{m-1}}{(1+x)^{m+n}}dx=\int_0^\infty \frac{x^{n-1}}{(1+x)^{m+n}}dx$ | CO3 | Understand |
| 18. | Prove that $\beta(m,n)=\frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$ | CO3 | Understand |
| 19. | Show that $\beta(m,\frac{1}{2})=2^{2m-1}\beta(m,m)$ | CO3 | Apply |
| 20. | Use $\beta-\Gamma$ functions to evaluate $\int_0^\infty \frac{x^2}{1+x^4}dx$ | CO3 | Evaluate |
| **UNIT-IV: MULTIVARIABLE CALCULUS** | | | |
| 1. | **If x+y+z=u , y+z=uv, z=uvw then evaluate** $\frac{\partial(x,y,z)}{\partial(u,v,w)}$ | CO4 | Apply |
| 2. | Prove that u=x+y+z, v=xy+yz+xz, w= $x^2+y^2+z^2$ are functional dependent and find the relation between them. | CO4 | Apply |
| 3. | find the minimum value of $x^2+y^2+z^2$ given $x+y+z=3a$ | CO4 | Understand |
| 4. | Examine for maximum and minimum values of $\mathbf{Sin\ x + sin y + sin(x+y)}$ | CO4 | Analyse |
| 5. | Examine for maximum and minimum values of $x^3+3xy^2-15x^2-15y^2+72xy.$ | CO4 | Analyse |
| 6. | Divide 24 into three parts such the continued product of first, square of second and cube of third is maximum | CO4 | Apply |
| 7. | if $u=\frac{yz}{x}, v=\frac{xz}{y}, w=\frac{xy}{z}$ find $\frac{\partial(u,v,w)}{\partial(x,y,z)}$ | CO4 | Understand |

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| 8. | Find the maximum and minimum values $x^4 + y^4 - 2x^2 - 2y^2 + 4xy$ | CO4 | Understand |
| 9. | find the minimum value &maximum value of $x + y + z$ given to $\frac{1}{x} + \frac{1}{y} + \frac{1}{z} = 1.$ | CO4 | Understand |
| 10. | Find the point on the plane x+2y+3z=4. Which is nearest to the origin | CO4 | Understand |
| 11. | Find the shortest distance between the functions $xyz^2=2$ | CO4 | Understand |
| 12. | If x = u(1-v), y = uv prove that JJ'=1. | CO4 | Apply |
| 13. | If the functions x=$e^r \sec\theta$ ,y=$e^r \tan\theta$ them prove that JJ'=1 | CO4 | Apply |
| 14. | Find the maximum and minimum values of the function f(x,y)= $x^3y^2(1 - x - y)$. | CO4 | Understand |
| 15. | If u=f(y-z,z-x,x-y) then Prove that $\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{\partial u}{\partial z} = 0$ | CO4 | Apply |
| 16. | Find the dimensions of the rectangular box open at the top of maximum capacity whosesurface area is 108 sq inches | CO4 | Understand |
| 17. | If u=$x^2 - y^2$, v=2xy,x=rcos$\theta$, y=rsin$\theta$ then find $\frac{\partial(u,v)}{\partial(r,\theta)}$ | CO4 | Understand |
| 18. | Find the volume of the greatest rectangular parallelepiped that can be inscribed in the ellipsoid. | CO4 | Understand |
| 19. | If $u = \tan^{-1}\left(\frac{x^2 + y^2}{x - y}\right)$ prove that $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = \frac{1}{2}\sin 2u$ | CO4 | Apply |
| 20. | If $u = \log\left(\frac{x^3 + y^3}{x^2 + y^2}\right)$ prove that $x\frac{\partial u}{\partial x} + y\frac{\partial u}{\partial y} = 1$ | CO4 | Apply |
| **UNIT-V: MULTIPLE INTEGRALS AND APPLICATIONS** | | | |
| 1. | Evaluate $\iint_R xy\,dx\,dy$ where R is the region bounded by x-axis and the ordinate x=2a and the curve $x^2=4ay$. | CO5 | Evaluate |
| 2. | Evaluate $\int_0^{\pi}\int_0^{a\sin\theta} r\,dr\,d\theta$ | CO5 | Evaluate |
| 3. | Evaluate $\iint(x^2 + y^2)dxdy$ in the positive quadrant for which $x + y \le 1$ | CO5 | Evaluate |
| 4. | Evaluate $\iint(x^2 + y^2)dx\,dy$ over the area bounded by the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$ | CO5 | Evaluate |
| 5. | Evaluate $\iint_R r^3 dr d\theta$ where R is the region included between the circles r=2sin$\theta$ and r=4sin$\theta$ | CO5 | Evaluate |
| 6. | Evaluate $\int_0^1\int_0^{\sqrt{1+x^2}} \frac{dydx}{1 + x^2 + y^2}$ | CO5 | Evaluate |

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| 7. | Evaluate $\int_0^{\frac{\Pi}{2}}\int_0^{\infty}\frac{r}{(r^2+a^2)^2}\,dr\,d\theta$ | CO5 | Evaluate |
| 8. | Evaluate $\iint_R y\,dx\,dy$ where R is the region bounded by the parabolas $y^2=4x$ and $x^2=4y$ | CO5 | Evaluate |
| 9. | Find the integral $\int_0^a\int_0^{\sqrt{a^2-y^2}}\sqrt{a^2-x^2-y^2}\,dx\,dy$ | CO5 | Understand |
| 10. | Evaluate $\iint xy(x+y)\,dx\,dy$ over the region R bounded by $y=x^2$ and y=x. | CO5 | Evaluate |
| 11. | Evaluate $\int_0^{\pi/4}\int_0^{a\sin\theta}\frac{r\,dr\,d\theta}{\sqrt{a^2-r^2}}$ | CO5 | Evaluate |
| 12. | Find the area between the parabolas $y^2=4ax$ and $x^2=4ay$. | CO5 | Understand |
| 13. | Find the area of the loop of the curve $r=a(1+\cos\theta)$. | CO5 | Understand |
| 14. | Using triple integrals, Find the volume of the sphere whose radius is' a' | CO5 | Apply |
| 15. | Using double integration, find the area lying between the parabola $y=4x-x^2$ and the line y=x. | CO5 | Apply |
| 16. | Determine the volume of the solid in the first octant bounded by the Paraboloid $z=9-x^2-4y^2$. | CO5 | Apply |
| 17. | Using double integration, find the volume common to the cylinders $x^2+y^2=a^2$ and $x^2+z^2=a^2$. | CO5 | Apply |
| 18. | Find the volume of the tetrahedron bounded by the coordinate planes ar $\frac{x}{a}+\frac{y}{b}+\frac{z}{c}=1$. | CO5 | Apply |
| 19. | Change the order of integration and evaluate $=\int_0^a\int_{x/a}^{\sqrt{x/a}}(x^2+y^2)\,dx\,dy$ | CO5 | Apply |
| 20. | Change the order of integration in $\int_0^1\int_{x^2}^{2-x} xy\,dx\,dy$ and hence evaluate the double integral. | CO5 | Apply |
| 21. | Change of the order of integration $\int_0^1\int_0^{\sqrt{1-Y^2}} y^2\sqrt{1-y^2}\,dx\,dy$ | CO5 | Apply |
| 22. | Evaluate the integral by changing to polar co-ordinates $\int_0^a\int_0^{\sqrt{a^2-y^2}}(x^2+y^2)\,dx\,dy$ | CO5 | Evaluate |
| 23. | Show that $\int_0^{4a}\int_{y^2/4a}^{y}\frac{x^2-y^2}{x^2+y^2}\,dx\,dy=8a^2\left(\frac{\pi}{2}-\frac{5}{3}\right)$ | CO5 | Apply |
| 24. | Evaluate $\int_0^1\int_0^{\sqrt{1-x^2}}\int_0^{\sqrt{1-x^2-y^2}} xyz\,dx\,dy\,dz$ | CO5 | Evaluate |

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| 25. | Evaluate $\int_{-1}^{1}\int_{0}^{z}\int_{x-z}^{x+z}(x+y+z)\,dx\,dy\,dz$ | CO5 | Evaluate |