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Engineering Mathematics 1 Important Questions PDF

Engineering Mathematics 1 usually has five units: matrices, differential calculus I, differential calculus II, multiple integration and vector calculus. Most marks come from standard numericals such as rank and eigenvalues, Leibnitz theorem, maxima and minima, change of order of integration and Gauss or Stokes theorem. Practise these question types unit by unit and write every step.

Key takeaways

- Matrices: rank, consistency of equations, eigenvalues and Cayley-Hamilton are the most repeated question types.
- Differential calculus: Leibnitz theorem, Euler's theorem, Taylor series, maxima-minima and Lagrange multipliers.
- Multiple integrals: change of order, polar substitution, beta and gamma functions, area and volume.
- Vector calculus: gradient, divergence, curl, directional derivative and the three integral theorems.
- These are practice questions based on common syllabus topics, not verified past papers.

About these important questions

These are **practice questions** built from topics that appear in most Indian B.Tech syllabi for Engineering Mathematics 1, including AKTU and universities that follow the AICTE model curriculum. They are **not verified past papers**, and we do not claim that any question will appear in your exam. Unit numbers and topic order differ between universities, so first match each unit below with your own university syllabus. For real previous papers, use your university's official archive. AKTU students can download them from the AKTU old question paper page.

Each unit lists key definitions, derivations or theory questions, numericals with short answer outlines, and long-answer questions. Use the outlines to check your method, then write full solutions yourself.

Unit 1: Matrices

Key definitions: rank of a matrix, echelon form, normal form, linear dependence of vectors, eigenvalues and eigenvectors, characteristic equation, orthogonal and unitary matrices, diagonalisation.

Derivations and theorems:

- State and verify the Cayley-Hamilton theorem for a 2 x 2 or 3 x 3 matrix, then use it to find the inverse.
- Prove that the eigenvalues of a real symmetric matrix are real.
- Show that the sum of eigenvalues equals the trace and their product equals the determinant.

Numericals (answer outline):

- Find the rank of A = [[1, 2, 3], [2, 4, 6], [1, 1, 1]]. Outline: R2 - 2R1 gives a zero row, the other two rows are independent, so rank = 2.
- Find the eigenvalues of [[2, 1], [1, 2]]. Outline: characteristic equation $\lambda^2 - 4\lambda + 3 = 0$, so $\lambda = 1$ and 3. Eigenvectors are (1, -1) and (1, 1).
- For A = [[1, 2], [2, 1]], the characteristic equation is $\lambda^2 - 2\lambda - 3 = 0$. By Cayley-Hamilton, $A^2 - 2A - 3I = 0$, so $A^{-1} = (A - 2I)/3$.
- Test the consistency of a system of three linear equations and solve it if consistent (compare rank of A and of the augmented matrix).

Long-answer questions: Diagonalise a 3 x 3 matrix and find the modal matrix. Discuss for what values of λ and μ a system has no solution, a unique solution or infinitely many solutions.

Unit 2: Differential Calculus I

Key definitions: successive differentiation, nth derivative, partial derivative, homogeneous function, total derivative, curve tracing.

Derivations and theorems:

- State and prove Leibnitz theorem for the nth derivative of a product.
- State and prove Euler's theorem on homogeneous functions, and its corollary for second-order derivatives.

Numericals (answer outline):

- If $y = \sin(m \sin^{-1}x)$, prove $(1 - x^2)y_{(n+2)} - (2n + 1)x\, y_{(n+1)} + (m^2 - n^2)y_{(n)} = 0$. Outline: differentiate twice to get $(1 - x^2)y_2 - x\, y_1 + m^2 y = 0$, then apply Leibnitz n times.
- If $u = \sin^{-1}[(x^2 + y^2)/(x + y)]$, show that $x\, \partial u/\partial x + y\, \partial u/\partial y = \tan u$. Outline: sin u is homogeneous of degree 1, apply Euler's theorem to sin u.
- Find the nth derivative of $1/(x^2 - 5x + 6)$ using partial fractions.
- Trace a standard curve such as the cissoid or the cardioid $r = a(1 + \cos\theta)$: check symmetry, origin, asymptotes and region.

Long-answer questions: Prove Euler's theorem and use it on a function of degree n. Total derivative problems where u = f(x, y) and x, y depend on t.

Unit 3: Differential Calculus II

Key definitions: Taylor and Maclaurin series for two variables, Jacobian, functional dependence, stationary point, saddle point, Lagrange multiplier.

Numericals (answer outline):

- Find the extreme values of $f = x^3 + y^3 - 3axy$. Outline: stationary points $(0, 0)$ and (a, a). At $(0, 0)$, $rt - s^2 < 0$, so it is a saddle point. At (a, a), $r = 6a$ and $rt - s^2 = 27a^2 > 0$, so it is a minimum for $a > 0$ with value $-a^3$.
- Minimise $x^2 + y^2 + z^2$ subject to $x + y + z = 3a$. Outline: Lagrange's method gives $x = y = z = a$ and the minimum value $3a^2$.
- Find the Jacobian $\partial(x, y)/\partial(r, \theta)$ for $x = r \cos \theta$, $y = r \sin \theta$. Answer: r.
- Expand e^x sin y in powers of x and y up to second-degree terms.
- Error and approximation questions: find the percentage error in the area of a rectangle when its sides have small errors.

Long-answer questions: Prove that $JJ' = 1$ for two Jacobians. Show that given functions are functionally dependent and find the relation between them.

Unit 4: Multiple Integration

Key definitions: double and triple integrals, region of integration, change of order, change of variables, beta and gamma functions, Dirichlet's integral.

Derivations and theorems:

- Prove the relation $B(m, n) = \Gamma(m)\Gamma(n)/\Gamma(m + n)$.
- Show that $\Gamma(1/2) = \sqrt{\pi}$, and hence that the integral of e^(-x^2) from 0 to infinity is $\sqrt{\pi}/2$.

Numericals (answer outline):

- Change the order of integration and evaluate a standard double integral; always draw the region first and mark the new limits.
- Evaluate a double integral by changing to polar coordinates, using $dx\,dy = r\,dr\,d\theta$.
- Find the area enclosed by a cardioid or the volume of a solid bounded by given surfaces.
- Use Dirichlet's integral to find the volume or mass of a region bounded by the coordinate planes and a plane.

Long-answer questions: A full change-of-order question with a sketch, plus one beta-gamma evaluation, is a common 10-mark combination.

Unit 5: Vector Calculus

Key definitions: gradient, divergence, curl, directional derivative, solenoidal and irrotational fields, line, surface and volume integrals.

Theorems to state and verify: Green's theorem in the plane, Stokes' theorem and Gauss divergence theorem.

Numericals (answer outline):

- Find grad φ for $\varphi = x^2y + yz$ at $(1, 1, 1)$. Answer: $(2xy, x^2 + z, y) = (2, 2, 1)$. Then find the directional derivative along a given vector by dotting with the unit vector.
- Show that div $r = 3$ and curl $r = 0$ for the position vector r.
- Find the angle between two surfaces at a point using their normals (gradients).

- Verify Green's theorem for a given vector field over a square or triangle, and verify Gauss divergence theorem over a unit cube.

Long-answer questions: Verify Stokes' theorem over a rectangle or hemisphere. Show that a field is irrotational and find its scalar potential.

How to score well in Engineering Mathematics 1

- Learn formulas unit by unit and write them on one revision sheet per unit.
- Draw the region for every double integral and every change-of-order question. Examiners often give marks for a correct sketch.
- State the theorem before using it, for example "By Cayley-Hamilton theorem" or "By Euler's theorem".
- Practise at least ten full numericals per unit with a timer. Speed matters in a three-hour paper.
- Keep a list of standard results: eigenvalue properties, $\Gamma(1/2)$, standard Taylor series and vector identities.

Short-answer (2-mark) questions for Engineering Mathematics 1

Short questions test definitions and one-line results. Practise answering each in two to four lines:

1. Define the rank of a matrix and state one method to find it.
2. State the Cayley-Hamilton theorem.
3. If the eigenvalues of A are 2 and 3, find the eigenvalues of A^2 and A^{-1}. (Answer: 4, 9 and 1/2, 1/3.)
4. When is a system of linear equations consistent?
5. State Euler's theorem for a homogeneous function of degree n.
6. Write the Maclaurin series of e^x up to the x^3 term.
7. What is a saddle point?
8. Define the Jacobian and give its value for polar coordinates.
9. Write the value of $\Gamma(1/2)$ and $\Gamma(n + 1)$ for a positive integer n.
10. Define solenoidal and irrotational vector fields.
11. State Gauss divergence theorem.
12. Find the unit normal to the surface $x^2 + y^2 + z^2 = 9$ at (1, 2, 2). (Answer: (1, 2, 2)/3.)

A 7-day revision plan for Engineering Mathematics 1

Use this plan in the last week before the exam. Adjust it to the units and weightage in your own syllabus.

- **Day 1 (Unit 1, Matrices):** revise the definitions, then solve the numericals and one long answer from this unit without notes.
- **Day 2 (Unit 2, Differential Calculus I):** revise the definitions, then solve the numericals and one long answer from this unit without notes.
- **Day 3 (Unit 3, Differential Calculus II):** revise the definitions, then solve the numericals and one long answer from this unit without notes.

- **Day 4 (Unit 4, Multiple Integration):** revise the definitions, then solve the numericals and one long answer from this unit without notes.
- **Day 5 (Unit 5, Vector Calculus):** revise the definitions, then solve the numericals and one long answer from this unit without notes.
- **Day 6:** attempt one full three-hour practice paper made from these questions, or an official previous paper from your university archive.
- **Day 7:** go through your formula sheet, the short-answer list and every question you got wrong in the practice paper.

Frequently asked questions

Which units of Engineering Mathematics 1 carry the most numericals?

Matrices, differential calculus and multiple integration usually have the most numericals. Vector calculus questions often ask you to verify Green's, Stokes' or Gauss theorem, which takes longer, so practise those with a timer.

Is Cayley-Hamilton theorem important for the exam?

Yes, it is one of the most common topics in the matrices unit. Practise verifying it for a 3 x 3 matrix and using it to find the inverse or a higher power of the matrix.

How should I prepare for change of order of integration?

Always draw the region first, mark the curves and the strip direction, and then write the new limits. Most mistakes come from wrong limits, not from the integration itself.

Are these questions from real past papers?

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