Engineering Mathematics Formulas For Gate

MATH142 Formula Sheet: Final Exam

Polar Coordinates:

$$r = \sqrt{x^2 + y^2}$$
$$\theta = \tan^{-1}\left(\frac{y}{x}\right) \quad \text{[chosen appropriately]}$$
$$x = r\cos\theta$$
$$y = r\sin\theta$$

Area in Polar Coordinates:

$$A = \frac{1}{2}\int_\alpha^\beta (f(\theta))^2 \mathrm{d}\theta = \frac{1}{2}\int_\alpha^\beta r^2 \mathrm{d}\theta$$

Arc Length:

Cartesians: $S = \int_a^b \sqrt{1 + \left(\frac{\mathrm{d}y}{\mathrm{d}x}\right)^2}\ \mathrm{d}x$

Parametric: $S = \int_\alpha^\beta \sqrt{\left(x'(t)\right)^2 + \left(y'(t)\right)^2}\ \mathrm{d}t$

Polar coordinates: $S = \int_{\theta_1}^{\theta_2} \sqrt{\left(\frac{\mathrm{d}r}{\mathrm{d}\theta}\right)^2 + r^2}\ \mathrm{d}\theta$

Volumes of solids of revolution:

Disc Method: $V = \pi\int_a^b \left[f(x)\right]^2 \mathrm{d}x$

Shell Method: $V = 2\pi\int_a^b x\ f(x)\ \mathrm{d}x$

Elementary rules for Numerical Integration:

Midpoint: $\int_a^b f(x)\ \mathrm{d}x \approx (b-a)f\left(\frac{a+b}{2}\right)$

Trapezoidal: $\int_a^b f(x)\ \mathrm{d}x \approx \frac{1}{2}(b-a)[f(a) + f(b)]$

Simpson's:

$$\int_a^b f(x)\ \mathrm{d}x \approx \frac{1}{3}\left(\frac{b-a}{2}\right)\left[f(a) + 4f\left(\frac{a+b}{2}\right) + f(b)\right]$$

Composite rules for Numerical Integration:

Trapezoidal rule: $\int_a^b f(x)\ \mathrm{d}x \approx \frac{1}{2}h\left\{f(a) + 2f(a+h) + 2f(a+2h) + \cdots + 2f(a+[N-1]h) + f(b)\right\},\ h = \frac{b-a}{n}$

Simpson's rule:

$$\int_a^b f(x)\ \mathrm{d}x \approx \frac{1}{3}h\left\{f(a) + 4f(a+h) + 2f(a+2h) + 4f(a+3h) + \cdots + 2f(a+[N-2]h) + 4f(a+[N-1]h) + f(b)\right\}$$

nth term test: If $\lim_{n\to\infty} u_n \neq 0$, $\sum_{n=1}^{\infty} u_n$ diverges.

Geometric series: $\sum_{n=0}^{\infty} ar^n$, convergent for $|r| < 1$. If convergent, sum $S = \frac{a}{1-r}$.

p-series: $\sum_{n=1}^{\infty} \frac{1}{n^p}$, convergent for $p > 1$.

"Telescoping" series: $\sum_{n=1}^{\infty} u_n$ where u_n can be written as a difference like $v_n - v_{n+1}$.

For $\sum_{n=1}^{\infty} u_n$, if $\sum_{n=1}^{\infty} c_n$ converges and $\sum_{n=1}^{\infty} d_n$ diverges,

CRT: $\lim_{n\to\infty} \frac{u_n}{c_n}$ finite gives convergence;
$\lim_{n\to\infty} \frac{u_n}{d_n} > 0$ and finite gives divergence.

CT: $u_n \leq c_n$ gives convergence; $u_n \geq d_n$ gives divergence.

RT: With $l = \lim_{n\to\infty}\left|\frac{u_{n+1}}{u_n}\right|$, $l < 1$ gives convergence, $l > 1$ gives divergence, $l = 1$ is inconclusive.

AST: $\sum_{n=1}^{\infty} u_n$ converges when (i) it's alternating, (ii) $\lim_{n\to\infty} |u_n| = 0$, and (iii) $|u_{n+1}| \leq |u_n|$.

Taylor Series: $f(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(a)(x-a)^n}{n!}$

Maclaurin Series: $f(x) = \sum_{n=0}^{\infty} \frac{f^{(n)}(0)x^n}{n!}$

Trigonometric Identities:

$$\sin(\theta \pm \phi) = \sin\theta\cos\phi \pm \cos\theta\sin\phi$$
$$\cos(\theta \pm \phi) = \cos\theta\cos\phi \mp \sin\theta\sin\phi$$
$$\sin 2\theta = 2\sin\theta\cos\theta$$
$$\cos 2\theta = \cos^2\theta - \sin^2\theta$$
$$1 = \cos^2\theta + \sin^2\theta$$
$$\sinh(x \pm y) = \sinh x\cosh y \pm \cosh x\sinh y$$
$$\cosh(x \pm y) = \cosh x\cosh y \pm \sinh x\sinh y$$
$$\cosh 2x = \cosh^2 x + \sinh^2 x$$
$$1 = \cosh^2 x - \sinh^2 x$$

Hyperbolic Functions:

$$\cosh x = \frac{e^x + e^{-x}}{2}$$
$$\sinh x = \frac{e^x - e^{-x}}{2}$$

To establish convergence or divergence of a series, suggested test to try first:

$u_n = \frac{\text{polynomial}}{\text{polynomial}}$ $\longrightarrow$ CRT

$u_n = \frac{\ln n}{\text{polynomial}}$ $\longrightarrow$ CRT or CT (using $\ln n < n$)

u_n contains $n!$ $\longrightarrow$ RT

u_n contains c^n $\longrightarrow$ RT (or CT)

$u_n = \frac{\text{trig function}}{\text{polynomial}}$ $\longrightarrow$ CT

$u_n = (-1)^n \frac{\text{polynomial}}{\text{polynomial}}$ $\longrightarrow$ CRT on $|u_n|$ then AST only if necessary

Engineering mathematics formulas for GATE are crucial for students preparing for the Graduate Aptitude Test in Engineering (GATE), a highly competitive examination in India. This test assesses the understanding of various undergraduate subjects in engineering and science. Among the subjects, mathematics plays a pivotal role, often determining the difference between success and failure. To excel in GATE, candidates must be well-versed in various mathematical concepts and their applications. This article delves into essential engineering mathematics formulas that are vital for GATE preparation, covering topics such as calculus, linear algebra, differential equations, and more.

Understanding the Importance of Engineering Mathematics in GATE

Engineering mathematics serves as the foundation for various engineering disciplines. It is essential for solving complex problems and analyzing engineering systems. In GATE, mathematics questions can range from basic concepts to advanced applications, making it imperative for candidates to master relevant formulas.

Key Topics in Engineering Mathematics for GATE

The syllabus for engineering mathematics in GATE includes several key topics. Here is a breakdown of these topics along with their important formulas:

1. Calculus

Calculus is a fundamental component of engineering mathematics, dealing with continuous change. The key areas include:

- Limits and Continuity
- Limit of a function:
\[
\lim_{{x \to c}} f(x) = L
\]

- Differentiation
- Derivative of a function:
\[
f'(x) = \frac{{df}}{{dx}}
\]
- Product rule:
\[
(uv)' = u'v + uv'
\]
- Quotient rule:
\[
\left(\frac{u}{v}\right)' = \frac{u'v - uv'}{v^2}
\]
- Chain rule:
\[
\frac{dy}{dx} = \frac{dy}{du} \cdot \frac{du}{dx}
\]

- Integration
- Indefinite integral:
\[

\int f(x) \, dx = F(x) + C
\]
- Definite integral:
\[
\int_{a}^{b} f(x) \, dx = F(b) - F(a)
\]
- Integration by parts:
\[
\int u \, dv = uv - \int v \, du
\]

2. Linear Algebra

Linear algebra is essential for understanding vector spaces and matrices. Important concepts include:

- Matrices and Determinants
- Matrix multiplication:
\[
C_{ij} = \sum_{k=1}^{n} A_{ik} B_{kj}
\]
- Determinant of a 2x2 matrix:
\[
\text{det}(A) = ad - bc \quad \text{for } A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}
\]

- Eigenvalues and Eigenvectors
- Characteristic equation:
\[
\text{det}(A - \lambda I) = 0
\]
- Eigenvalue equation:
\[
A\mathbf{v} = \lambda \mathbf{v}
\]

3. Differential Equations

Differential equations are pivotal in modeling real-world systems. The main types include:

- Ordinary Differential Equations (ODEs)
- First-order linear ODE:
\[
\frac{dy}{dx} + P(x)y = Q(x)
\]
- Second-order homogeneous linear ODE:
\[

$$
ay'' + by' + cy = 0
$$

- Partial Differential Equations (PDEs)
- General form:

$$
F(x, y, u, u_x, u_y, u_{xx}, u_{yy}, \ldots) = 0
$$

4. Probability and Statistics

Understanding probability and statistics is crucial for data analysis and interpretation. Key formulas include:

- Probability
- Conditional probability:

$$
P(A|B) = \frac{P(A \cap B)}{P(B)}
$$

- Descriptive Statistics
- Mean:

$$
\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i
$$

- Variance:

$$
\sigma^2 = \frac{1}{n} \sum_{i=1}^{n} (x_i - \bar{x})^2
$$

5. Numerical Methods

Numerical methods are essential for solving complex equations that may not have analytical solutions. Important techniques include:

- Numerical Integration
- Trapezoidal rule:

$$
\int_{a}^{b} f(x) \, dx \approx \frac{(b-a)}{2} (f(a) + f(b))
$$

- Root-Finding Methods
- Newton-Raphson method:

$$
x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}
$$

Preparing for GATE with Engineering Mathematics

To prepare for GATE effectively, students should follow these strategies:

1. **Understand the Concepts:** Rather than rote memorization, focus on understanding the underlying concepts behind each formula.
2. **Practice Regularly:** Solve a variety of problems to apply the formulas in different scenarios.
3. **Use Previous Year Papers:** Analyze past GATE papers to understand the types of questions asked and the application of formulas.
4. **Join Study Groups:** Collaborating with peers can enhance understanding and provide new insights into problem-solving.
5. **Online Resources:** Utilize online platforms and video tutorials to reinforce learning.

Conclusion

Mastering **engineering mathematics formulas for GATE** is not just about passing the exam; it is about building a strong foundation for your engineering career. By focusing on understanding and applying these formulas, candidates can enhance their problem-solving abilities and improve their chances of success in GATE. With consistent practice and a strategic approach to study, aspiring engineers can conquer the challenges of the GATE examination and pave the way for a bright future in their respective fields.

Frequently Asked Questions

What are the key engineering mathematics formulas required for GATE exam preparation?

Key formulas include differentiation and integration rules, matrix algebra, Laplace transforms, Fourier series, and probability distributions.

How can I effectively memorize engineering mathematics formulas for GATE?

Create flashcards, use mnemonic devices, practice regularly with past papers, and group similar formulas together for better retention.

Which calculus concepts are most important for GATE engineering mathematics?

Important concepts include limits, continuity, differentiation, integration, and applications of derivatives such as maxima and minima.

Are there any specific probability formulas I should focus on for GATE?

Yes, focus on Bayes' theorem, conditional probability, probability distributions (normal, binomial, Poisson), and expected value calculations.

What linear algebra formulas are critical for the GATE exam?

Critical formulas include determinant and inverse of matrices, eigenvalues and eigenvectors, and solving systems of linear equations.

How do Laplace transforms help in engineering mathematics for GATE?

Laplace transforms simplify the analysis of linear time-invariant systems, making it easier to solve differential equations and control problems.

What is the importance of numerical methods in GATE engineering mathematics?

Numerical methods are crucial for solving complex engineering problems that cannot be solved analytically, such as root finding and numerical integration.

Which differential equations are relevant for the GATE exam?

Focus on first-order differential equations, higher-order linear differential equations, and their applications in engineering contexts.

Can you provide an example of a Fourier series formula useful for GATE?

The Fourier series expansion of a periodic function f(x) is given by $f(x) = a0/2 + \Sigma(an \cos(nx) + bn \sin(nx))$, where $n = 1$ to ∞.

What role does statistics play in GATE engineering mathematics?

Statistics helps in analyzing data, understanding distributions, and making predictions, which are essential for engineering decision-making.

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