📌 ENGINEERING MATHEMATICS – HIGH-YIELD CHEATSHEET (ECE GATE)

HOW TO USE THIS

- Don't memorize in one sitting
- Read → immediately see PYQs → recognition happens
- In exam: **spot pattern first, formula second**

1️⃣ LINEAR ALGEBRA (BIGGEST ROI)

🔹 Rank of a Matrix

Core facts

- Rank ≤ min(rows, columns)
- Rank = number of **linearly independent rows**
- If **det ≠ 0** → full rank

🔹 FAST OBSERVATION SHORTCUTS

- Two rows proportional → rank ↓
- One row = sum of others → dependent
- Zero row → ignore it

👉 **GATE pattern**

- "For what value of k rank reduces?"
  - First check **row dependency**
  - If not obvious → set determinant = 0

🔹 System of Linear Equations (Consistency)

Let A = coefficient matrix, (A|B) = augmented

Condition	Meaning
rank(A)=rank(A	B)=n
rank(A)=rank(A	B)<n
rank(A)≠rank(A	B)

👉 **Shortcut**:
If equations look similar → consistency question 90% chance.

🔹 Eigenvalues (VERY SCORABLE)

Golden rules

- Sum of eigenvalues = **Trace**
- Product = **Determinant**
- Triangular matrix → eigenvalues = diagonal

❌ Don't solve characteristic equation unless forced

👉 **Trap**: If matrix is triangular → GATE expects you to notice.

2️⃣ PROBABILITY (DIRECT MARKS)

🔹 Basic Formulae

- Mean:

$$E[X] = \sum xP(x)$$

- Variance:

$$Var(X) = E[X^2] - (E[X])^2$$

🔹 Conditional Probability

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

🔹 Bayes Theorem (ALMOST GUARANTEED)

$$P(A_i|B) = \frac{P(B|A_i)P(A_i)}{\sum P(B|A_j)P(A_j)}$$

🧠 BAYES SHORTCUT

- Always compute **numerator first**
- Denominator = sum of all numerators

👉 **Pattern**:

- Defective items
- Disease testing
- Communication errors

Probability answer must be **0–1** → eliminate crazy options.

3️⃣ RANDOM VARIABLES / PDF–CDF

🔹 PDF Validity

$$\int_{-\infty}^{\infty} f(x)\,dx = 1$$

👉 Often asked: "Find k such that PDF is valid"

🔹 Mean from PDF

$$E[X] = \int xf(x)\,dx$$

🔹 Variance

$$Var(X) = \int x^2 f(x)\,dx - (E[X])^2$$

👉 **Shortcut**

- PDF questions = **2 steps only**
  1. Find k
  2. Plug into mean/variance

4️⃣ LAPLACE TRANSFORM (REPEAT HEAVILY)

🔹 Standard Transforms

Function	Laplace
1	$1/s$
e^{at}	$1/(s-a)$
$\sin at$	$a/(s^2+a^2)$
$\cos at$	$s/(s^2+a^2)$

🔹 Properties (MOST IMPORTANT)

- **Time shift**

$$L\{e^{-at}f(t)\} = F(s+a)$$

- **Differentiation**

$$L\{tf(t)\} = -\frac{d}{ds}F(s)$$

👉 **Pattern**

- See exponential → shift s
- See t·f(t) → derivative

❌ Rarely requires integration

5️⃣ Z-TRANSFORM (LIGHT BUT EASY)

🔹 Basic

$$Z\{a^n u(n)\} = \frac{z}{z-a}$$

🔹 Initial Value Theorem

$$x(0) = \lim_{z\to\infty} X(z)$$

👉 Mostly **recognition based**

6️⃣ COMPLEX NUMBERS (FREE MARKS)

🔹 Polar Form

$$z = r(\cos\theta + j\sin\theta)$$

🔹 Roots of Unity

- n roots lie on a **circle**
- Angle gap = $360°/n$

👉 **Shortcut**

- Use geometry, not algebra

7️⃣ VECTOR CALCULUS (VERY LIGHT)

Only remember:

- Gradient → direction of max increase
- Divergence → source/sink
- Curl → rotation

👉 Mostly **conceptual MCQs**

🎯 MATHS-ONLY EXAM SHORTCUT STRATEGY

✅ Attempt Maths FIRST (first 30–40 mins)

Why?

- Direct questions
- Boosts confidence
- Reduces panic for core subjects

🎯 ELIMINATION RULES

- Probability ∈ [0,1]
- Rank is integer ≤ order
- Variance ≥ 0
- Eigenvalues of triangular = diagonal

🎯 WHEN STUCK

- Plug extreme values (k=0,1)
- Choose simplest expression
- Eliminate options with wrong **units / nature**

🚫 WHAT TO SKIP WITHOUT GUILT

- Long proofs
- PDEs
- Deep vector calculus
- Anything taking >2 minutes

Skipping smartly = scoring smartly.