🔌 NETWORK THEORY — GATE CHEATSHEET & SHORTCUTS

(Target: **8–10 marks** with minimal effort)

1️⃣ BASIC LAWS (Free Marks Zone)

🔹 KCL

Sum of currents at a node = 0

Shortcut

- Choose node with **maximum connections**
- Use **conductances (1/R)** → faster equations

Trap

- Forgetting current direction sign

🔹 KVL

Sum of voltages in a loop = 0

Shortcut

- Use **mesh analysis** when loops < nodes
- Assign mesh current clockwise always

2️⃣ NODAL vs MESH — WHICH TO USE?

Condition	Use
More current sources	**Nodal**
More voltage sources	**Mesh**
Supernode present	**Nodal**
Supermesh present	**Mesh**

3️⃣ THEVENIN & NORTON (VERY HIGH YIELD)

🔹 Thevenin

- V_{th} = Open-circuit voltage
- R_{th} = Resistance seen with sources killed

🔹 Norton

- $I_n = \frac{V_{th}}{R_{th}}$
- $R_n = R_{th}$

Source Killing Rules

- Voltage source → **short**
- Current source → **open**

⚠️ **Dependent sources are NEVER killed**

4️⃣ MAXIMUM POWER TRANSFER (Guaranteed Question)

🔹 DC

$$R_L = R_{th}$$

🔹 AC

$$Z_L = Z_{th}^*$$

(conjugate)

🔹 Maximum Power

$$P_{max} = \frac{V_{th}^2}{4R_{th}}$$

Shortcut

- If asked **condition only**, don't calculate anything

5️⃣ SERIES & PARALLEL (Fast Recognition)

🔹 Series

- Same current
- Voltages add
- $R_{eq} = R_1 + R_2$

🔹 Parallel

- Same voltage
- Currents add
- $R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$

⚡ Current Divider

$$I_1 = I \cdot \frac{R_2}{R_1 + R_2}$$

⚡ Voltage Divider

$$V_1 = V \cdot \frac{R_1}{R_1 + R_2}$$

6️⃣ STAR–DELTA (Only If Needed)

🔹 Delta → Star

$$R_A = \frac{R_{AB}R_{CA}}{R_{AB} + R_{BC} + R_{CA}}$$

Shortcut

- Only use if **no direct series/parallel possible**

7️⃣ FIRST-ORDER CIRCUITS (EXTREMELY IMPORTANT)

🔹 Time Constant

- RC: $\tau = RC$
- RL: $\tau = \frac{L}{R}$

🔹 Key Rules

- Capacitor → open circuit at steady DC
- Inductor → short circuit at steady DC

🔹 Initial Conditions

- Capacitor voltage **cannot change instantly**
- Inductor current **cannot change instantly**

🔹 Standard Response

$$x(t) = x(\infty) + [x(0^+) - x(\infty)]e^{-t/\tau}$$

Shortcut

- At $t = \tau$: ~63% change
- At 5τ: steady state

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8 RLC & RESONANCE (SCORABLE)

Resonant Frequency

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

At Resonance

- Inductive reactance = Capacitive reactance
- Impedance purely resistive
- Current maximum (series RLC)

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9 TWO-PORT NETWORKS (Recognition Based)

Z-Parameters

- Open-circuit conditions
- Units: Ohms

Y-Parameters

- Short-circuit conditions
- Units: Siemens

ABCD Parameters

- Used for **cascade**
- Very common 1-mark questions

Shortcut

- If cascade → ABCD
- If open terminals → Z
- If short terminals → Y

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10 SINUSOIDAL STEADY STATE (FAST ELIMINATION)

Impedances

- Resistor: R
- Inductor: $j\omega L$
- Capacitor: $\frac{1}{j\omega C}$

Power

- Real power: $P = VI\cos\phi$
- Reactive: $Q = VI\sin\phi$

🧠 EXAM HALL SHORTCUTS

- If calculation looks **long**, it's the wrong method
- GATE loves **conditions**, not values
- Eliminate options with **wrong units**
- Check **DC steady state behavior** quickly

🚫 COMMON MISTAKES TO AVOID

- Killing dependent sources ❌
- Forgetting capacitor/inductor behavior at DC ❌
- Mixing RMS and peak values ❌
- Wrong sign convention ❌

🔁 HOW TO USE THIS CHEATSHEET

- Morning: read once (10 min)
- Night: glance again (5 min)
- Before exam: this + formulas only