GATE ECE 2027 MASTER HANDBOOK

Complete Strategy, Concept Notes, Revision Formulae & Question Bank
Organizing Institute: IIT Madras (Official GATE 2027 Syllabus)

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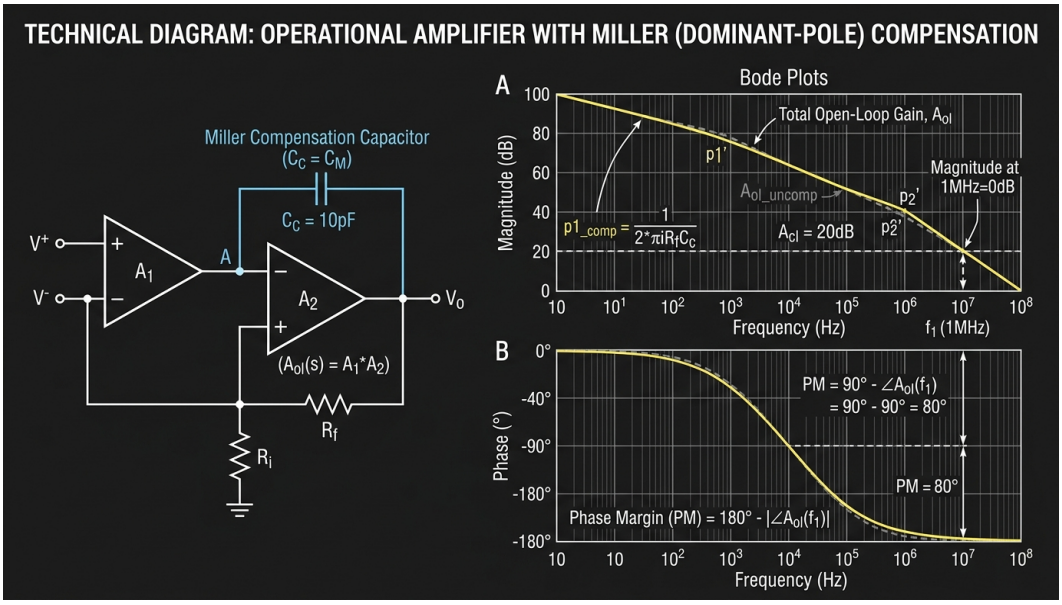
1. Executive Strategy & GATE 2027 Syllabus Analysis

This master handbook provides an exhaustive guide for candidates preparing for **GATE ECE 2027 organized by IIT Madras**. It combines high-yield concept derivations, shortcut formulas, visual circuit schematics, and solved previous-year questions.

Key Syllabus Additions for GATE 2027 (IIT Madras):

- **Signals & Systems:** FIR & IIR Filter Design (Window methods, Bilinear transformation, frequency pre-warping) and Signal Reconstruction.
- **Engineering Mathematics:** Correlation & Regression Analysis (Pearson's r, linear regression slopes b_yx, b_xy) and Euler-Cauchy ODEs.
- **Analog Circuits:** Dominant-pole Miller Compensation & Phase Margin stability criteria.
- **Control Systems:** PID Controllers (P, I, D action impact on rise time, overshoot, steady-state error) and Compensators.
- **Communications:** Source Coding Theorem (Shannon source coding, Huffman coding, efficiency) under Information Theory.



2. Section-Wise Concept Building Notes

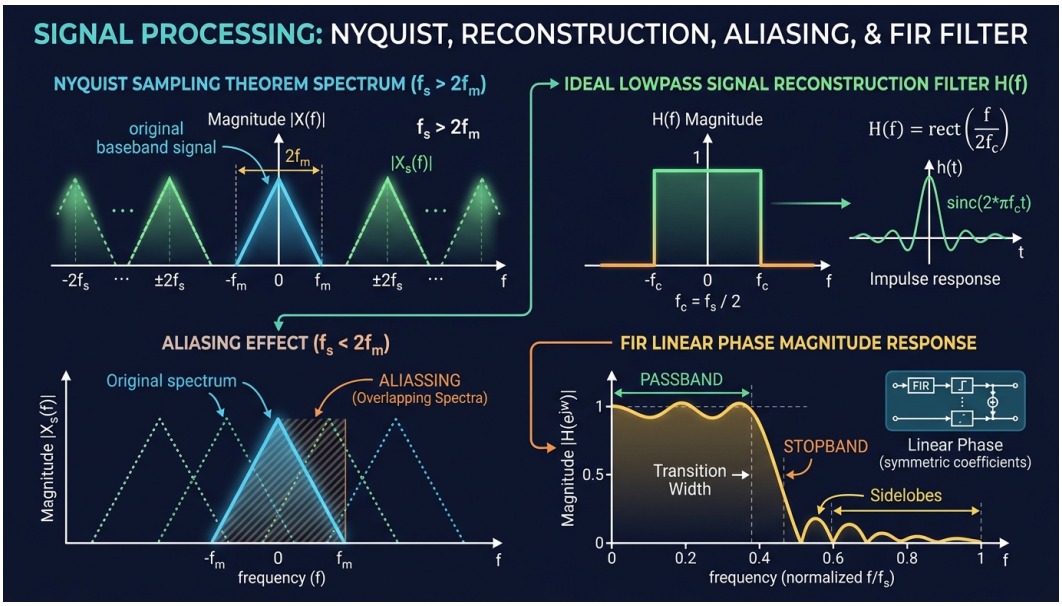
Engineering Mathematics (~13 Marks)

- **Linear Algebra:** Trace(A) = Sum of diagonal = Sum of eigenvalues; Det(A) = Product of eigenvalues.
- **Euler-Cauchy ODE:** x^2 y'' + a x y' + b y = f(x) -> Substitute x = e^z -> D(D-1)y + aDy + by = f(e^z).
- **Correlation & Regression:** r = Cov(X,Y)/(sigma_X * sigma_Y) = sqrt(b_yx * b_xy). Regression: Y - Y_bar = b_yx(X - X_bar).

Signals & Systems (~12 Marks)

• **Sampling & Reconstruction:** f_s >= 2 f_m. Reconstruction filter sinc interpolation: x(t) = sum x(n T_s) sinc((t - n T_s)/T_s).

• **Bilinear Transform:** s = (2/T_s) * (1 - z^-1)/(1 + z^-1). Pre-warping: Omega = (2/T_s) tan(omega/2).



Network Theory (~12 Marks)

• **Transient Response:** x(t) = x(infinity) + [x(0+) - x(infinity)] e^(-t/tau). tau = RC or L/R.

• **Max Power Transfer:** Complex load Z_L = Z_th^* -> P_max = |V_th|^2 / (4 R_th). Resistive load R_L = |Z_th|.

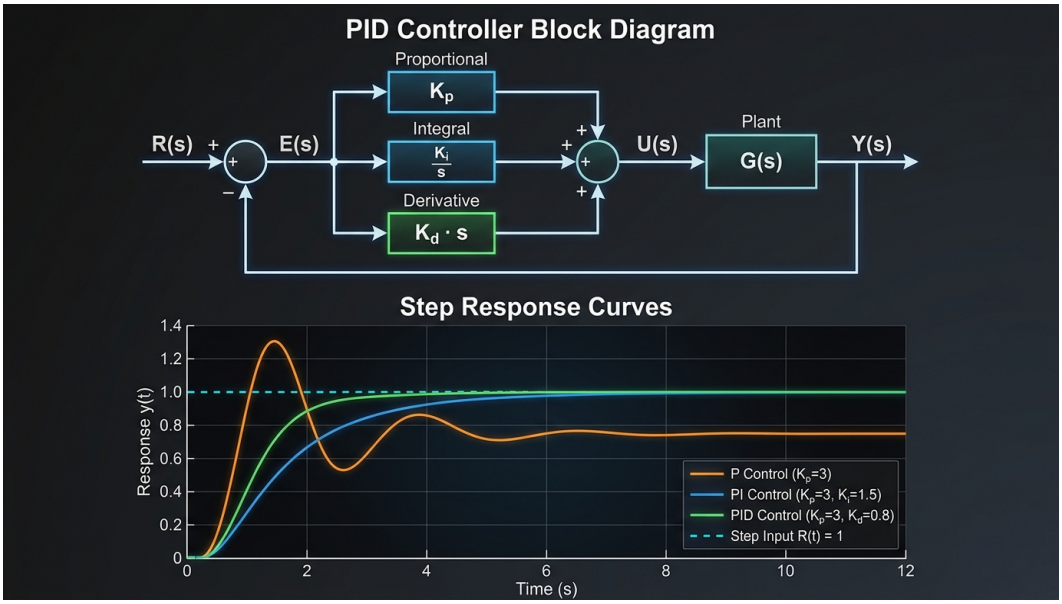
Analog Circuits (~10 Marks)

• **Miller Compensation:** Pole splitting causes dominant pole p1' = 1/(2*pi*R_in*A2*C_C). GBW = g_m1 / (2*pi*C_C).

• **Phase Margin:** PM = 180° + angle(T(j*omega_gc)). Target PM >= 60° for optimal stability.

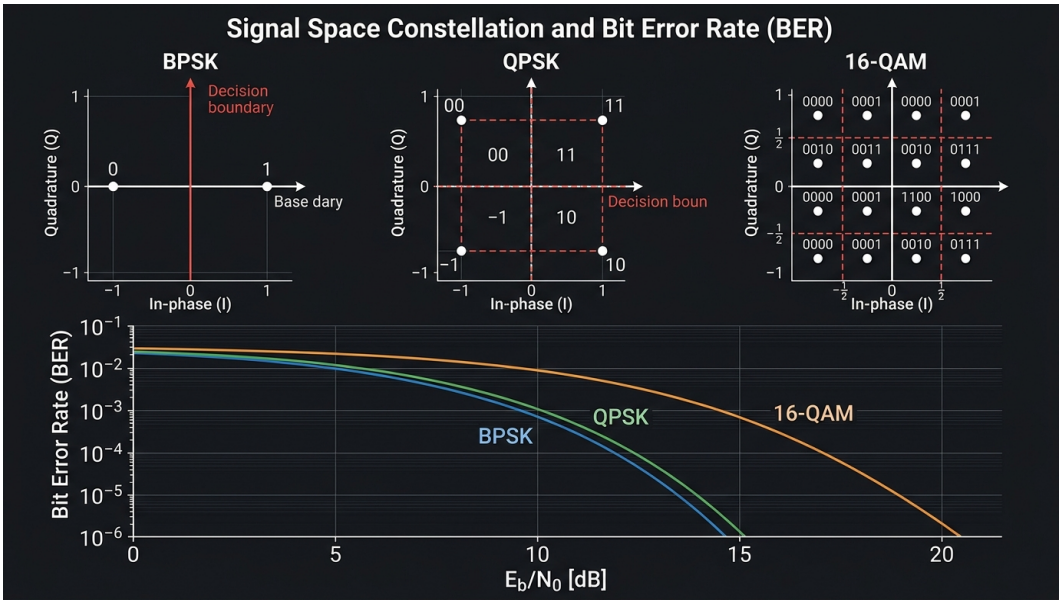
Control Systems (~9 Marks)

• **PID Controller:** G_c(s) = K_p + K_i/s + K_d s. Integral action eliminates e_ss (e_ss -> 0). Derivative action improves stability & reduces overshoot M_p.



Communication Systems (~13 Marks)

- **Information Theory:** H(X) = sum P_i log2(1/P_i). Source Efficiency eta = H(X) / L_bar.
- **Digital Modulation:** BPSK P_e = Q(sqrt(2 E_b / N_0)), QPSK P_e = Q(sqrt(2 E_b / N_0)).



3. Selected GATE Solved Numerical Examples

Example 1: Linear Regression Coefficient (Engineering Maths)

Problem: Given regression slopes b_yx = 0.8 and b_xy = 0.45, find correlation coefficient r.
Solution: r = sqrt(b_yx * b_xy) = sqrt(0.8 * 0.45) = sqrt(0.36) = **0.60**.

Example 2: Op-Amp Miller Bandwidth (Analog Circuits)

Problem: First stage g_m1 = 1 mA/V, Miller capacitor C_C = 10 pF. Find GBW in MHz.
Solution: GBW = g_m1 / (2*pi*C_C) = 10^-3 / (2*pi * 10^-11) = 10^8 / (2*pi) = **15.92 MHz**.

Example 3: PD Controller Parameters (Control Systems)

Problem: Plant G(s) = 1/s^2 controlled by G_c(s) = K_p + K_d s. Target poles s = -2 +/- j2.
Solution: Characteristic Eq: s^2 + K_d s + K_p = (s+2)^2 + 4 = s^2 + 4s + 8 = 0 -> **K_d = 4, K_p = 8**.