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Bengaluru

Mid Term Examinations - October 2026

Date: 05/10/2026 **Time:** 11:45 AM - 01:15 PM

Course Code: ECE3057 **Course Name:** Radar Engineering

Semester: Seventh Semester **Max. Marks:** 50 **Weightage:** 50%

CO - Levels	CO1	CO2	CO3	CO4
Marks	24	22	22	22

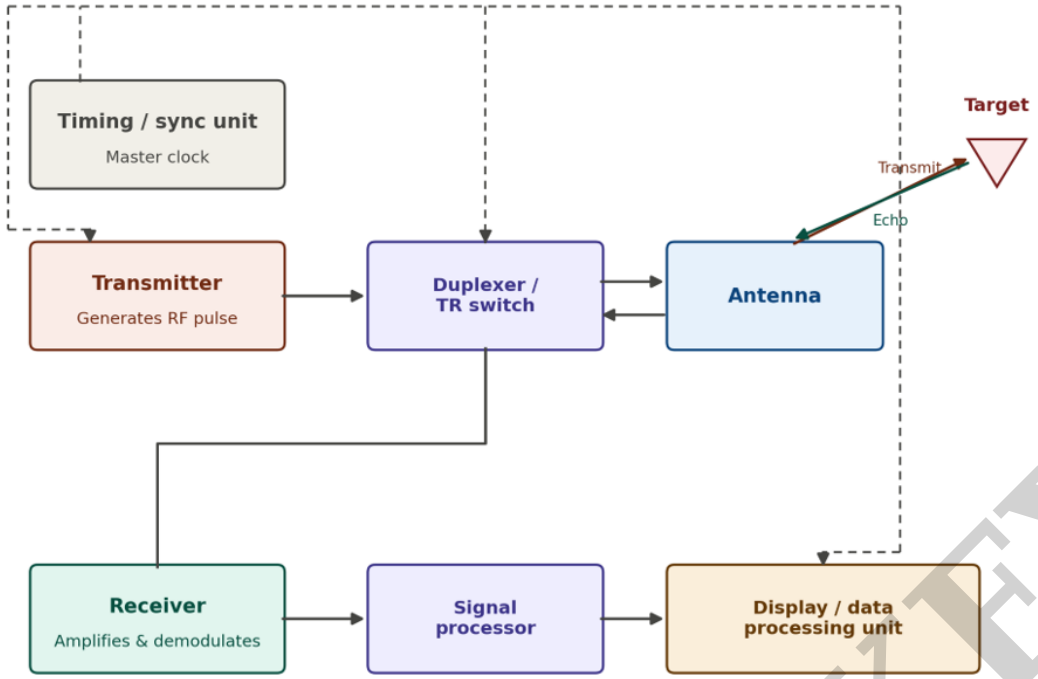
PART A: Answer Following Questions. 10 M

Q.N.	Questions	M	CO	BT
1	Radar operates on the principle of **transmission and reflection (echo) of electromagnetic waves**: it emits radio-frequency signals which, upon striking a target, are reflected back and received, allowing detection of the target's range and position based on the time delay of the echo.	2	CO1	BT2
2	Allow the same antenna to be used for both transmission and reception.	2	CO1	BT2
3	75 km [$R_{un} = c/(2\times PRF) = (3\times10^8)/(2\times2000) = 75{,}000$ m]	2	CO2	BT2
4	Including losses reduces the effective maximum detection range, since the received echo power is decreased due to energy dissipated in the atmosphere, antenna, transmission lines, and signal processing circuitry.	2	CO3	BT2
5	Albersheim's equation provides an empirical approximation to estimate the required signal-to-noise ratio (SNR) for a given probability of detection and probability of false alarm, without needing complex statistical detection theory calculations.	2	CO4	BT3

PART B : Answer Any 1 Following Questions. 10 M

Q.N.	Questions	M	CO	BT

ANSWER KEY

6		10	CO1	BT2
7	<table><tr><th>Band</th><th>Frequency range</th><th>Typical application</th></tr><tr><td>L</td><td>1 – 2 GHz</td><td>Long-range air-surveillance, en-route ATC radar</td></tr><tr><td>S</td><td>2 – 4 GHz</td><td>Terminal air-traffic control, weather surveillance, some naval radar</td></tr><tr><td>C</td><td>4 – 8 GHz</td><td>Weather radar, satellite tracking, some fire-control radar</td></tr><tr><td>X</td><td>8 – 12 GHz</td><td>Fire-control, airborne intercept, marine navigation, weather</td></tr><tr><td>Ku / K / Ka</td><td>12 – 40 GHz</td><td>High-resolution mapping, short-range fire-control, automotive radar</td></tr></table>	10	CO1	BT2

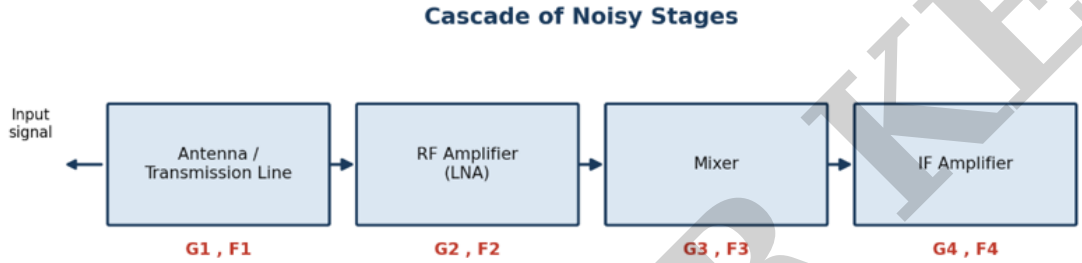
ANSWER KEY

ANSWER KEY

PTO (Please Turn Over)

ANSWER KEY

PART D: Answer Any 1 Following Questions. 10 M				
Q.N.	**Questions**	**M**	**CO**	**BT**

10	<table><tr><th>Loss Type</th><th>Physical Origin</th><th>Typical Symbol</th><th>Typical Value (dB)</th></tr><tr><td>Atmospheric attenuation loss</td><td>Absorption/scattering by oxygen, water vapour, rain along the two-way path</td><td>La</td><td>0.5 - 6 (rain dependent)</td></tr><tr><td>Transmission-line / waveguide loss</td><td>Resistive loss in feeder cable, rotary joint, duplexer between transmitter/receiver and antenna</td><td>Lt</td><td>1 - 3</td></tr><tr><td>Antenna loss</td><td>Ohmic and aperture-efficiency loss in the radiating structure</td><td>Lant</td><td>0.5 - 1</td></tr><tr><td>Beam-shape (scanning) loss</td><td>Target illuminated by less than peak gain as beam scans past it</td><td>Lp</td><td>1.6 - 3.3</td></tr><tr><td>Collapsing loss</td><td>Loss when integrating noise-only range/angle cells with signal-bearing cells in the processor</td><td>Lc</td><td>1 - 3</td></tr><tr><td>Signal-processing / matched-filter mismatch loss</td><td>Non-ideal matched filter, quantisation, window functions</td><td>Lsp</td><td>1 - 3</td></tr><tr><td>Field degradation (operational) loss</td><td>Ageing components, poor maintenance, weather radome effects</td><td>Lop</td><td>1 - 2</td></tr></table>	10	CO3	BT2
11		10	CO3	BT2

PART E: Answer Any 1 Following Questions. 10 M				
Q.N.	**Questions**	**M**	**CO**	**BT**
12	**Radar Range Equation (with losses):** *R_max = [(Pt × G² × λ² × σ) / ((4π)³ × Pmin × L)] ^ (1/4)* **Step 1 — Ideal (loss-free) range** Antenna gain in linear form: G = 10^(35/10) = 3162 (approx.) Numerator: Pt × G² × λ² × σ = $(1.5\times10^{6})(3162)^{2}(0.032)^{2}(5) = 7.68 \times 10^{10}$ Denominator: $(4\pi)^{3} \times$ Pmin = $(1984.4)(2\times10^{-13}) = 3.97 \times 10^{-10}$ $R_{max}^{4} = 7.68\times10^{10} / 3.97\times10^{-10} = 1.935 \times 10^{20}$ **R_max (no loss) = (1.935×10^{20})^(1/4) ≈ 1.179×10^{5} m = 117.9 km** **Step 2 — Total System Loss** Losses add directly in dB (two-way propagation loss + hardware loss): L_total (dB) = L_atm + L_rain + L_ant = 2.0 + 3.0 + 1.5 = 6.5 dB **Converting to linear scale: L = 10^(6.5/10) = 4.467** **Step 3 — Corrected (Actual) Range** Since R_max is proportional to (received power)^(1/4), and loss divides the received power by L: R_max (with loss) = R_max (no loss) / L^(1/4) L^(1/4) = (4.467)^0.25 = 1.454 **R_max (with loss) = 117.9 km / 1.454 ≈ 81.1 km**	10	CO4	BT3
13	Convert all quantities to linear units: G = 10^(3.4) = 2511.9, F = 10^(0.5) = 3.162, $(S/N)_{min} = 10^{(1.3)} = 19.95$. With k = 1.38×10^{-23} J/K and T_0 = 290 K, substitute into the range–SNR equation above: $R_{max}^{4} = [P_t\ G^2\ \lambda^2\ \sigma] / [(4\pi)^3\ k\ T_0\ B\ F\ (S/N)_{min}] = 4.62 \times 10^{19}\ m^4 \Longrightarrow R_{max} \approx 8.68 \times 10^{4}$ m ≈ 86.8 km.	10	CO4	BT3

ANSWER KEY