CBCS SCHEME

USN | | | | | | | | | |

BEC714D/BTE714D

Seventh Semester B.E./B.Tech. Degree Examination, Dec.2025/Jan.2026
Radar Communication

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	Derive Radar equation. Discuss the effects of each parameter on the maximum detection range of the radar.	10	L3	CO1
	b.	Draw the block diagram of pulse radar with super heterodyne receiver and explain the function of each block and its operation.	10	L2	CO1
		OR			
Q.2	a.	Define Radar cross section of targets and explain its significance for various types of targets.	10	L2	CO1
	b.	Explain the following : (i) Pulse Repetition Frequency (PRF) (ii) Range Ambiguities (iii) Minimum detectable signal	10	L2	CO1
		Module – 2			
Q.3	a.	With a neat block diagram, explain simple CW Doppler radar. Also mention the advantages and disadvantages.	10	L2	CO2
	b.	Discuss the block diagram of MTI radar that uses a power amplifier as the transmitter.	10	L2	CO2
		OR			
Q.4	a.	Explain one angle co-ordinate amplitude comparison mono-pulse tracking with neat diagram.	10	L2	CO2
	b.	What are the different types of tracking radar systems? Explain with diagrams, how angle tracking is done.	10	L2	CO2
		Module – 3			
Q.5	a.	Explain the parameters required for measurement of a point target.	10	L2	CO3
	b.	Explain how the formula for time delay accuracy in radar measurement is simplified.	10	L2	CO3
		OR			
Q.6	a.	Derive surface clutter radar equation.	10	L3	CO3
	b.	Explain the detection of radar signals in high resolution sea clutter.	10	L2	CO3

Module – 4					
Q.7	**a.**	Explain Klystron with a neat diagram.	**10**	**L2**	**CO4**
	b.	Explain the working principle of a traveling wave tube with the help of a diagram.	**10**	**L2**	**CO4**
OR					
Q.8	**a.**	List and explain different types of mixers used in radar receiver.	**10**	**L2**	**CO4**
	b.	With diagram, explain the operation of balanced duplexer.	**10**	**L2**	**CO4**
Module – 5					
Q.9	**a.**	Derive Radar equation for synthetic Aperture Radar system.	**10**	**L3**	**CO4**
	b.	Explain the classification of OTHR systems. Explain ionosphere effect on OTHR systems.	**10**	**L2**	**CO4**
OR					
Q.10	**a.**	Explain principles of secondary Surveillance Radar.	**10**	**L2**	**CO4**
	b.	With related formula, explain range performance in secondary Surveillance Radar.	**10**	**L2**	**CO4**

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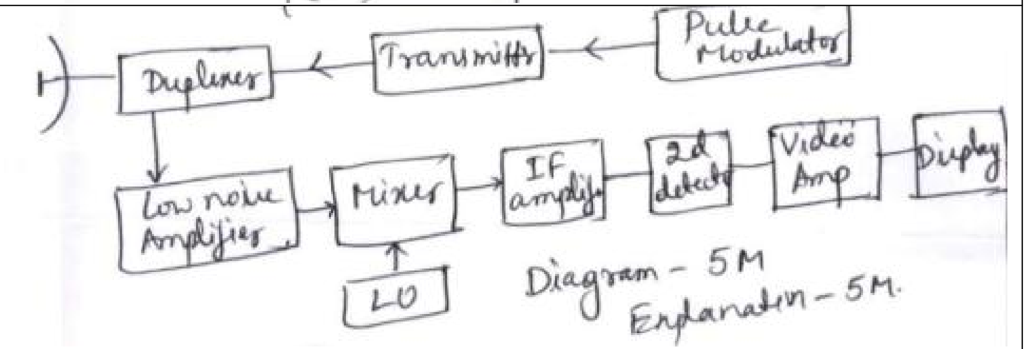
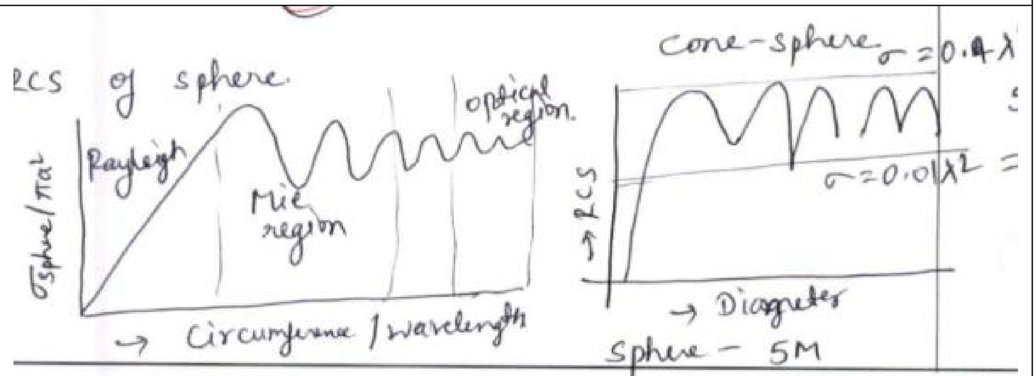
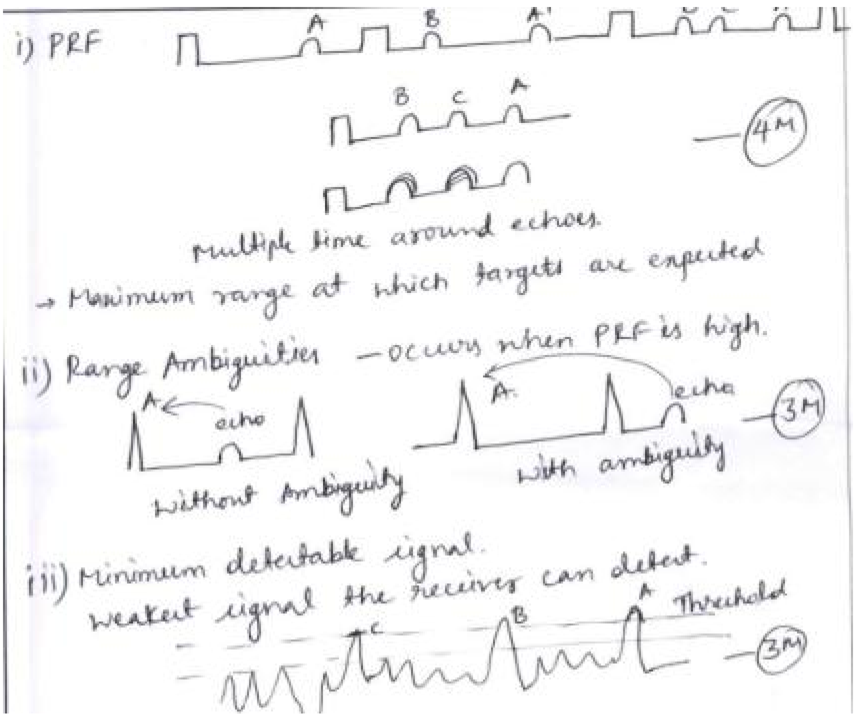
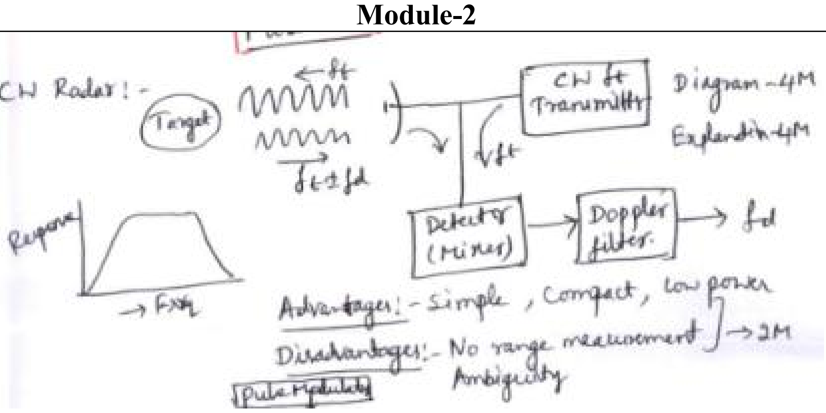
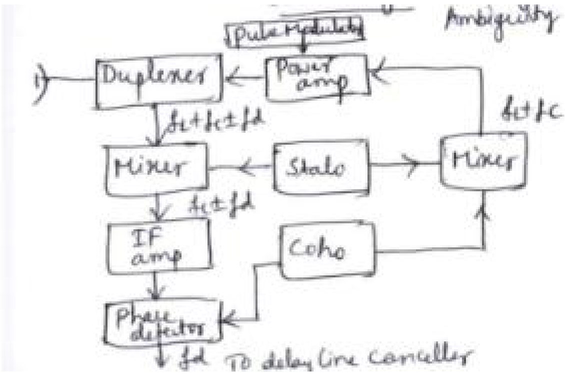
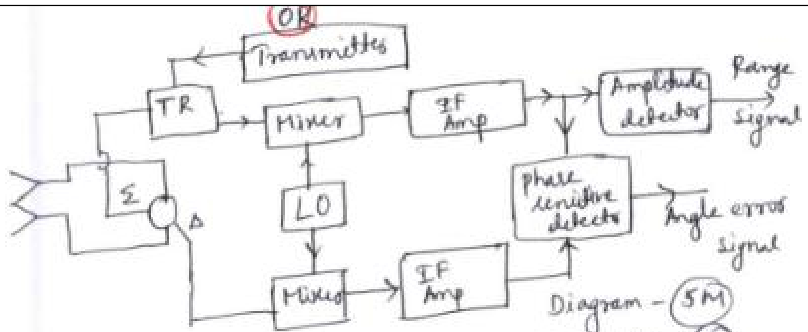
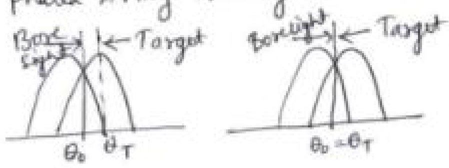
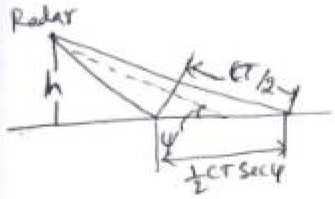
Module-1		
Q.1	**a**	Power density from an isotropic antenna $= \frac{P_t}{4\pi R^2}$ — ① P.d from directive antenna $= \frac{P_t G}{4\pi R^2}$ — ② — (4M) P.d of echo signal $= \frac{P_t G}{4\pi R^2} \times \frac{\sigma}{4\pi R^2}$ — ③ Power received $P_r = \frac{P_t G A_e \sigma}{(4\pi)^2 R^4}$ — ④ — (3M) $P_r = S_{min}$ $\therefore R_{max} = \left[\frac{P_t G A_e \sigma}{(4\pi)^2 S_{min}}\right]^{1/4}$ — ⑤ — (3M)
	b	 Diagram - 5M Explanation - 5M.
OR		
Q.2	**a**	 Sphere - 5M Cone sphere - 5M

	b	

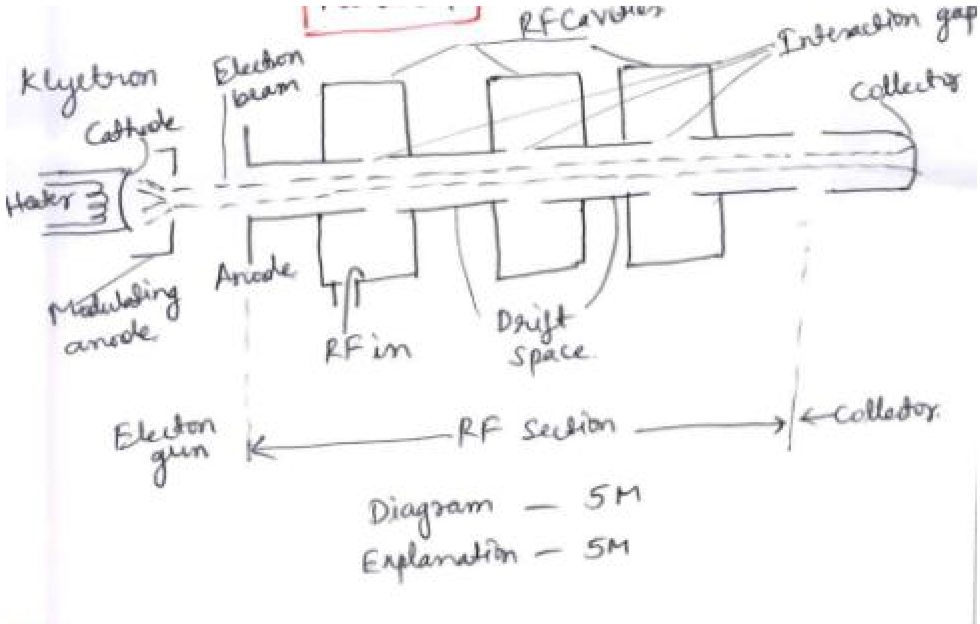
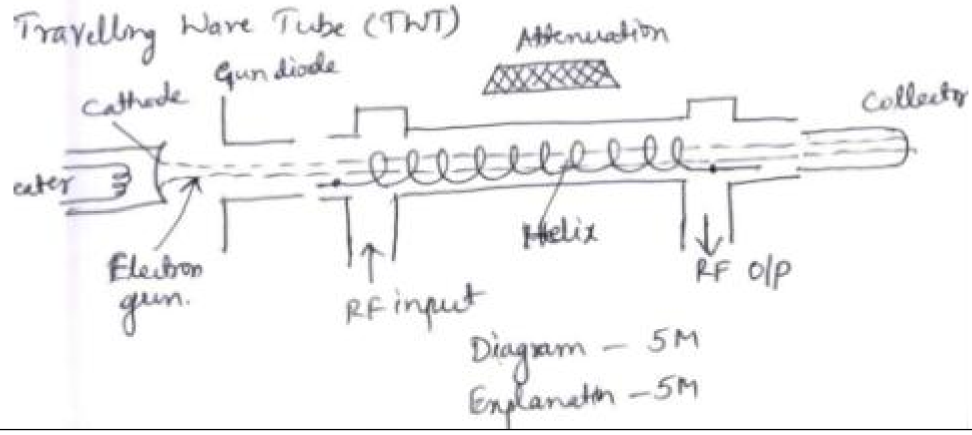
Module-2		
Q.3	**a**	

	b	 Diagram – 5M Explanation – 5M
	OR	
Q.4	**a**	 Diagram – (5M) Explanation – (5M)
	b	Types of Tracking: STT Radar, ADT Radar, TWS Radar, phased Array Tracking radar — Explain any 3, 3×2 = (6M) Angle Tracking → (4M) 

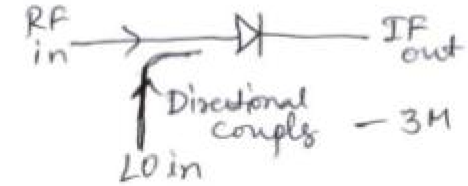
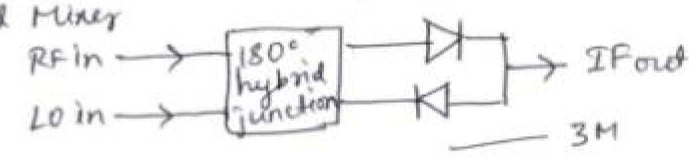
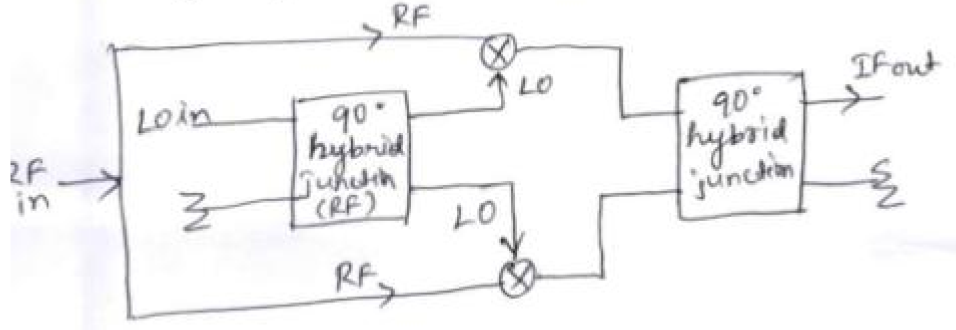
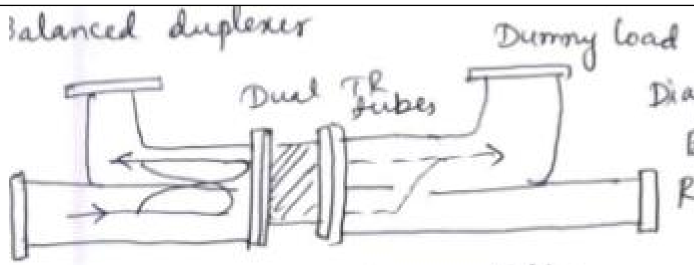
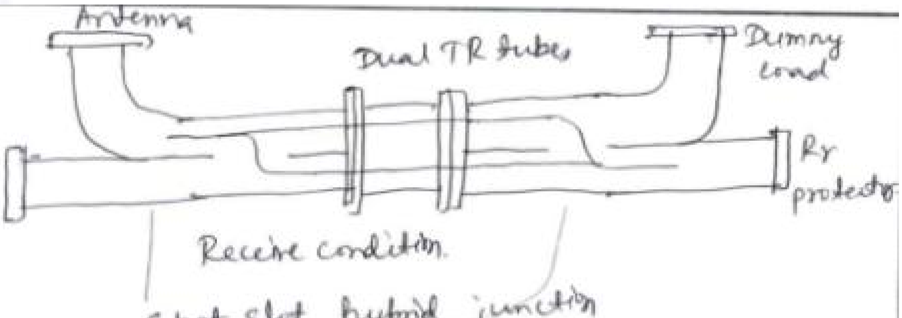
Module-3		
Q.5	**a**	Measurement of point Target → 2M parameters :- Range, Angle Measurement, Radial velocity, Tangential velocity — Each parameter carries – 2M

	b	Time-delay Accuracy simplified. $\delta R = \frac{c}{2}\delta T_R$ Slope $= \frac{A}{t_r}$ $\frac{A}{t_r} = \frac{n(t)}{\Delta T_R}$ $(\overline{\Delta T_R^2})^{1/2} = \delta T_R = \frac{t_r}{(A^2/N^2)^{1/2}} = \frac{t_r}{(2S/N)^{1/2}}$ $\delta T_R = \left(\frac{\tau}{2BE/N_0}\right)^{1/2}$ Formula → 5M Explanation - 5M $\delta T_R = \left(\frac{\tau}{4BE/N_0}\right)^{1/2}$
OR		
Q.6	**a**	(OR) Surface clutter Radar Equation. Low Grazing Angle $P_r = \frac{P_t G A_e \sigma}{(4\pi)^2 R^4}$ → $P_r = S$, $\sigma = \sigma_t$  $S = \frac{P_t G A_e \sigma_t}{(4\pi)^2 R^4}$ $A_c = R\theta_B (c\tau/2)\sec\psi$ $C = \frac{P_t G A_e \sigma^0 \theta_B (c\tau/2)\sec\psi}{(4\pi)^2 R^3}$ $\frac{S}{C} = \frac{\sigma_t}{\sigma^0 R\theta_B (c\tau/2)\sec\psi}$ $R_{max} = \frac{\sigma_t}{(S/C)_{min}\sigma^0\theta_B(c\tau/2)\sec\psi}$ Equation — 5M Explanation — 5M
	b	Detection of Signals in high resolution Sea clutter Sea spike suppression methods → Recognizing char amp modulation & removing sea spike echoes. → Using log-log receiver — 5M Sea clutter at very low grazing angles — 5M

Module-4

Q.7	a	 RF Cavities Interaction gap Klystron Electron beam Collector Cathode Heater Modulating anode Anode RF in Drift space Electron gun RF Section Collector Diagram — 5M Explanation — 5M
	b	 Travelling Wave Tube (TWT) Attenuation Gun diode Cathode Collector eater Helix Electron gun. RF input RF o/p Diagram – 5M Explanation –5M

OR

Q.8	**a**	Different types of Mixers 1) Single ended Mixer.  — 3M 2) Balanced Mixer  — 3M 3) Image-rejection mixer — 4M 
	b	Balanced duplexer  Diagram 5M Explanation – 5M Transmit condition.  Receive condition. Short slot hybrid junction

Module-5

Q.9	**a**	Radar equation for synthetic Aperture Radar $P_r = \frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 R^4}$, $SNR = \frac{S}{N} = \frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 R^4 FKT_0 B}$ $SNR = \frac{P_t G^2 \lambda^2 \sigma n}{(4\pi)^3 R^4 FKT_0 B}$ $n = Tf_r$ — (3M) $T = \frac{L}{V} = \frac{\lambda R}{2 V d_x \sin\theta_0}$, $n = \frac{f_r \lambda R}{2 V d_x \sin\theta_0}$ — (3M) $SNR = \frac{P_{av} G^2 \lambda^3 \sigma}{2(4\pi)^3 R^3 F K T_0 V d_x \sin\theta_0}$, $\sigma = \sigma^0 d_R d_x \sec\theta_0$ $P_t = \frac{P_{av}}{\tau f_r} = \frac{P_{av} B}{f_r}$ $SNR = \frac{P_{av} G^2 \lambda^3 \sigma^0 d_R}{2(4\pi)^3 R^3 F K T_0 V \sin\theta_0}$ $P_{av} = \left(\frac{(4\pi)^3 R^3 F K T_0}{G^2 \lambda^2 \sigma^0 d_R}\right)\left(\frac{2V}{\lambda}\right)(SNR)$ — (4M)
	b	classification of OTHR → Skywave OTHR systems — 2M → Surfacewave OTHR systems — 2M → Ionospheric effect on OTHR system - 6M 
OR		
Q.10	**a**	Principles of SSR  → 2M. SSR interrogation pulses SSR Modes of operation A 8 Identify B 17 Identify C 21 Altitude D 25 Undefined S 3.5 Multipurpose Mode $P_1 - P_3$ purpose → 2M Explanation 6M

	b	Range Performance in SSR The Up Link Range → (5M) $\hat{P}_i = \frac{P_i G_i}{4\pi R^2}$ $P_i = \left(\frac{P_i G_i}{4\pi R^2}\right)\left(\frac{\lambda_i^2 G_t}{4\pi}\right)$ $P_t = \frac{P_i G_i \lambda_i^2 G_t}{(4\pi)^2 R^2 L_{si} L_p L_g}$ $\frac{S_t}{N_t} = \frac{P_t G_i G_t \lambda_i^2}{(4\pi)^2 R^2 K T_0 B_i F_t L_{si} L_p L_g}$ $R_{imax} = \left[\frac{P_i G_i G_t \lambda_i^2}{(4\pi)^2 R^2 K T_0 B_i F_t L_{si} L_p L_g (S_t/N_t)_{min}}\right]^{\frac{1}{2}}$ The down-link Range → (5M) $P_i = \frac{P_t G_t \lambda_t^2 G_i}{(4\pi)^2 R^2 L_{st} L_p L_g}$ $\frac{S_i}{N_i} = \frac{P_t G_i G_t \lambda_t^2}{(4\pi)^2 R^2 K T_0 B_t F_i L_{st} L_p L_g}$ $R_{t(max)} = \left[\frac{P_t G_i G_t \lambda_t^2}{(4\pi)^2 K T_0 B_t F_i L_{st} L_p L_g (S_i/N_i)_{min}}\right]^{\frac{1}{2}}$