

Modified

# CBCS SCHEME

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17EC833

## Eighth Semester B.E. Degree Examination, July/August 2021 Radar Engineering

Time: 3 hrs.

Max. Marks: 100

Note: Answer any FIVE full questions.

- 1 a. Explain basic principle of radar with suitable diagrams. (10 Marks)  
b. Explain maximum unambiguous range of a radar with equation and graph. (10 Marks)
- 2 a. A 10GHz radar has the following characteristics  $P_t = 250\text{KW}$ ,  $\text{PRF} = 1500\text{PPS}$ , pulse width =  $0.8\mu\text{s}$ , Power gain of antenna = 2500,  $S_{\text{min}} = 10^{-14}\text{W}$ ,  $A_e = 10\text{m}^2$ ,  $\sigma = 2\text{m}^2$ . Find : i) Runamb ii) Maximum possible range iii) Duty cycle iv) Average power. (10 Marks)  
b. Briefly describe the major areas of radar applications. (10 Marks)
- 3 a. Derive the modified radar equation in terms of signal to noise ratio. (10 Marks)  
b. Explain the radar cross section of sphere and cone sphere targets. (10 Marks)
- 4 a. Discuss with equation and graphs the probability of false alarm and the probability of detection using an envelope detector. (10 Marks)  
b. Discuss briefly the following types of system losses in radar  
i) Microwave plumbing losses  
ii) Antenna losses  
iii) Signal processing losses. (10 Marks)
- 5 a. Explain the working of digital Moving Target Indicator (MTI) doppler signal processor with neat diagram. (10 Marks)  
b. List the limitations of single delay line cancellers and derive its associated equations. (10 Marks)
- 6 a. With neat block diagram, explain the original Moving Target Detector (MTD) signal processor. (10 Marks)  
b. Derive the equations for clutter attenuation and MTI improvement factor. (10 Marks)
- 7 a. Define monopulse tracker. Using block diagram explain amplitude comparison monopulse tracking radar for a single angular coordinate. (10 Marks)  
b. With neat block diagram, explain conical scan tracking radar. (10 Marks)
- 8 a. What are the different types of tracking radar systems? Explain with diagrams, how angle tracking is done. (10 Marks)  
b. Discuss on tracking in range of a tracking radar with suitable waveforms and equations. (10 Marks)
- 9 a. List the different functions served by radar antenna. (10 Marks)  
b. Explain different types of radar display system. (10 Marks)
- 10 a. List the advantages and limitations of electronically steered phase array antenna. (10 Marks)  
b. What is the role of duplexers in radar system? Illustrate the transmit condition and receive condition in case of balanced duplexer. (10 Marks)

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Important Note : 1. On completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages.  
2. Any revealing of identification, appeal to evaluator and/or equations written eg.  $42+8=50$ , will be treated as malpractice.

Date: 05-08-2021

The Scheme and Solutions of following subjects are verified and found that they are very much in line with the question paper.

Sl no.	Sub code	Subject Name	Remarks
1.	17EC831	Micro Electro Mechanical Systems	No Modifications.
2.	17EC833	Radar Engineering	No Modifications.
3.	17EC834	Machine Learning	No Modifications.
4.	17EC835	Network and cyber Security	No Modifications.

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Scheme & Solutions

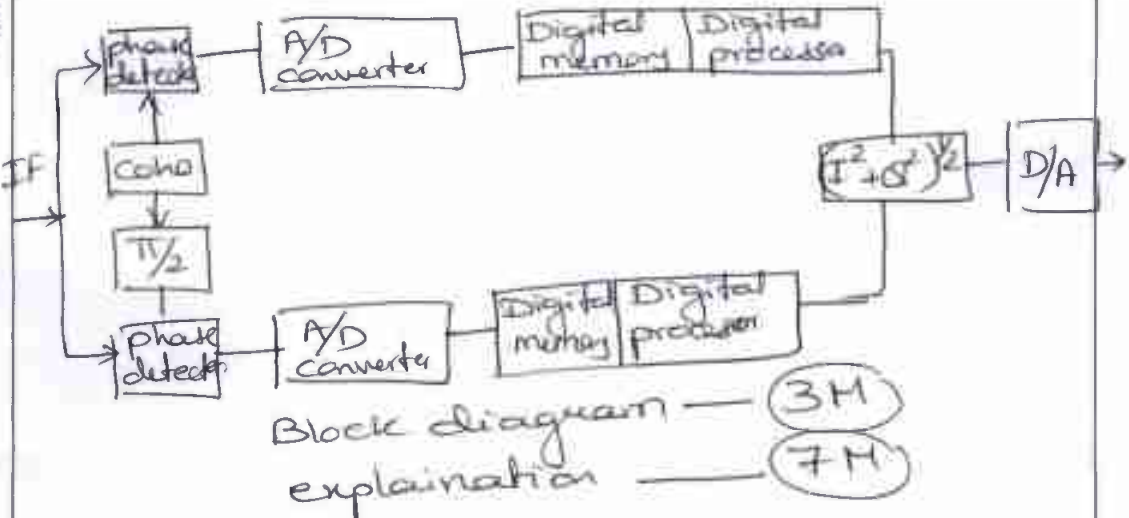
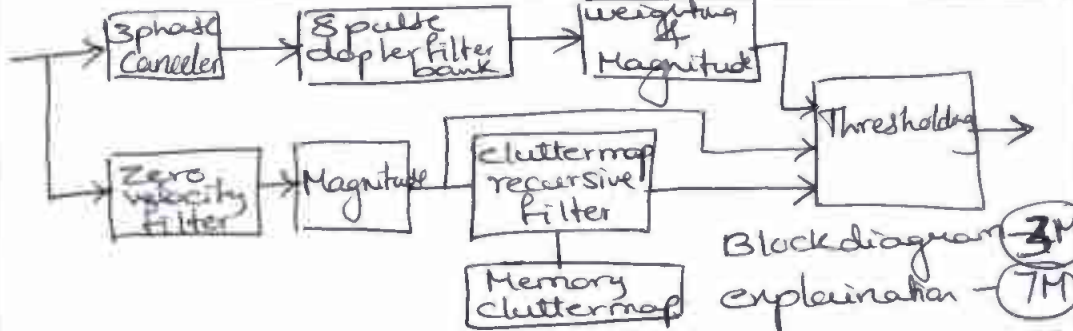
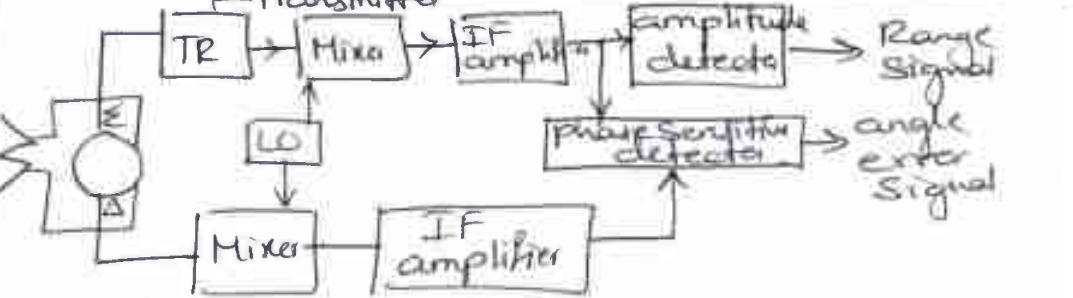
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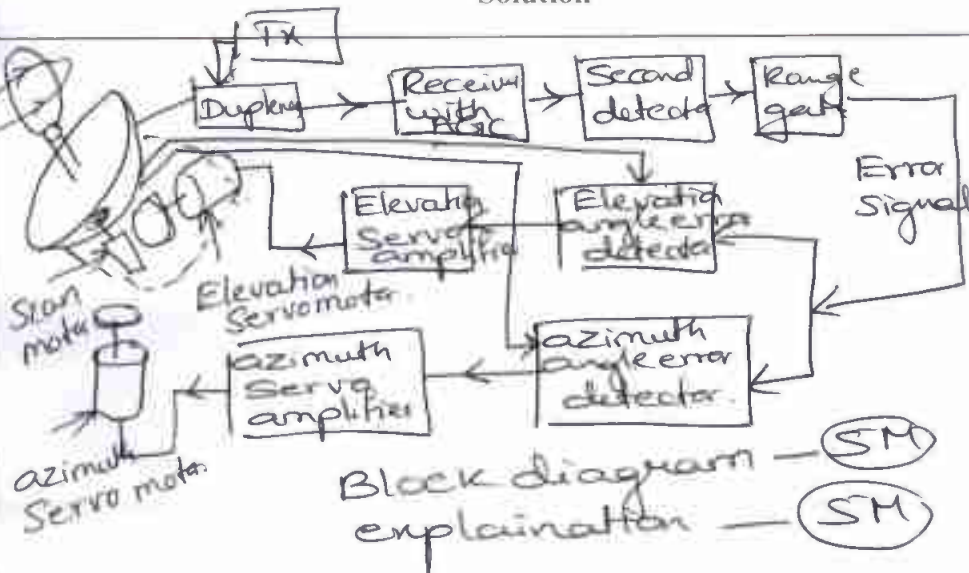
Subject Title : Radar Engineering

Subject Code : 17EC833

Question Number	Solution	Marks Allocated
1a)	<p>Target detection &amp; information extraction</p> <p>diagrams with specifications — (4M)</p> <p>Explanation — (6M)</p>	10M
1b)	$R_{un} = \frac{CT_p}{2} = \frac{C}{2f_p}$ <p><math>T_p</math> - pulse repetition period = <math>\frac{1}{f_p}</math></p> <p><math>f_p</math> - pulse repetition frequency (PRF) in Hz or PPS</p> <p>Graph — (2M)</p> <p>Explanation — (5M)</p> <p>(3M)</p>	10M
2a)	$R_{un} = \frac{C}{2f_p} = 100\text{km} \quad \text{--- (2 1/2 M)}$ $R_{max} = \left[ \frac{P_t G A_e \sigma}{(4\pi)^2 S_{min}} \right]^{1/4} = 298\text{km} \quad \text{--- (2 1/2 M)}$ $\text{Duty cycle} = \frac{T}{T_p} = T f_p = 0.12\% \quad \text{--- (2 1/2 M)}$ $\text{Average power} = P_{av} = \frac{T}{T_p} \times P_t = T f_p P_t = 300\text{W} \quad \text{--- (2 1/2 M)}$	10M

Question Number	Solution	Marks Allocated
2b	1> Military 2> Remote Sensing 3> Air traffic control 4> Law enforcement & Highway Safety 5> Aircraft safety & navigation 6> ship safety 7> space. Any 5 applications explanation <del>2x5</del> (S x 2M)	10M
3a.	$R_{max} = \left[ \frac{P_t G A_e \sigma}{(4\pi)^2 S_{min}} \right]^{1/4}$ Thermal noise power = $kTB_n$ $B_n = \frac{\int_{-\infty}^{\infty}  H(f) ^2 df}{ H(f_0) ^2}$ $F_n = \frac{N_{out}}{kT_0 B G_a}$ $F_n = \frac{S_{in}/N_{in}}{S_{out}/N_{out}}$ $S_{in} = \frac{kT_0 B F_n S_{out}}{N_{out}}$ $S_{min} = kT_0 B F_n \left( \frac{S_{out}}{N_{out}} \right)_{min}$ $R_{max} = \frac{P_t G A_e \sigma}{(4\pi)^2 kT_0 B F_n (S/N)_{min}}$ 1 step x 1M. 10 steps = 10M For this derivation 10 steps	10M.
3b	Cross section of sphere plots — (3M) explanation — (3M) cross section of cone sphere plot — (1M) explanation — (3M)	10M
4a>	Probability of false alarm $\left\{ \begin{array}{l} \text{equations} - (2M) \\ \text{graph} - (1M) \\ \text{explanation} - (2M) \end{array} \right.$ probability of detection $\left\{ \begin{array}{l} \text{equations} - (2\frac{1}{2}M) \\ \text{explanation} - (2\frac{1}{2}M) \end{array} \right.$	10M
4b>	Microwave plumbing losses explanation — (4M) explanation on Antenna losses — (3M) explanation on Signal processing losses — (3M)	10M

Question Number	Solution	Marks Allocated
5a)	 <p>Block diagram — (3M)            explanation — (7M)</p>	10M
5b)	<p>Limitations — 3M.            equation derivation — 7M</p>	10M
6a)	 <p>Block diagram — (3M)            explanation — (7M)</p>	10M
6b)	<p>Equations for clutter attenuation } Derivation (5M)  <math display="block">CA = \frac{f_p^4}{48\pi^4 \sigma_c^4} = \frac{f_p^4 \lambda^4}{768\pi^4 \sigma_v^4}</math></p> <p>Derive the equation for MTI improved factor } Derivation (5M)  <math display="block">I_f = \frac{1}{2\pi^2 (\sigma_v/f_p)^2} = \frac{\lambda^2}{8\pi^2 (\sigma_v/f_p)^2}</math></p>	10M
7a)	 <p>Definition — (2M)            Block diagram — (3M)            explanation — (5M)</p>	10M

Question Number	Solution	Marks Allocated
7b)	 <p>Block diagram — (5M)            explanation — (5M)</p>	10M
8a)	<p>Single target tracker.            Automatic detection and track } (3M)            Phased array radar tracking            Track while scan.            Diagrams — (2M)            explanation on angle tracking — (5M)</p>	10M
8b)	<p>Split gate tracker &lt; waveforms — (2M)            &lt; explanation — (3M)            Range glint &lt; equations — (2M)            &lt; explanation — (3M)</p>	10M
9a)	<p>each function carries — 1M            so 10 functions — (10M).</p> <p>(i) acts as transducer.            (ii) concentrates or radiated energy.            (iii) collects the echo energy            (iv) Measures angle of arrival            (v) Acts as spatial filter            (vi) provides desired volumetric coverage            (vii) estimates time.            e.t.c.</p>	10M.

Question Number	Solution	Marks Allocated
9b)	A Scope, B Scope, C-Scope, E-Scope, PPI display, RHI display, CRT display, Stroke and Raster display, flat panel display. Any 5 displays explanation. $5 \times 2M$	10M
10a)	Any 5 advantages — 5M Any 5 limitations — 5M	10M
10b)	Role of duplexer — (2M) Transmit condition $\left\{ \begin{array}{l} \text{diagram} - (1M) \\ \text{explanation} - (3M) \end{array} \right.$ Receive condition $\left\{ \begin{array}{l} \text{diagram} - (1M) \\ \text{explanation} - (3M) \end{array} \right.$	10M
	<p><b>"APPROVED"</b></p> <p><i>Ray</i> — TE</p> <p><b>Registrar (Evaluation)</b></p> <p>Visveswara Technological University                      BELAGAVI - 590018</p>	