Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2020

Programme Name: B.Tech ASE+AVE **Semester : VII**
Course Name : RADAR Technology **Time : 03 hrs**
Course Code : ECEG 4004 **Max. Marks : 100**
Nos. of page(s) : 03

Instructions:

SECTION A
[5x6=30]

Type the Answers

S. No.		Marks	CO
Q 1	Explain the principle of RADAR operation. Define all the sub systems connected to it.	**5**	**CO1**
Q 2	Deduce the term noise figure and write down the relation for noise figure and signal-to-noise ratio.	**5**	**CO2**
Q 3	Discuss RADAR cross-section of the target. Also, define its physical significance in defense applications.	**5**	**CO 3**
Q 4	Discuss the antenna impedance of an antenna used for the transmission and reception.	**5**	**CO 4**
Q 5	Define the field strength c_t and c_r	**5**	**CO1**
Q 6	Explain the fundamental principle of SAR	**5**	**CO4**

SECTION B
[10x5=50]

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Q 7	Define the term "Doppler's effect". Explain all the possible cases correlated to the Doppler's effect. Derive the relation for radial velocity obtained for the target. a) If the radar has a velocity of 300m/s towards an aircraft, which is moving towards the radar at a velocity of 200m/s, then find the Doppler frequency measured by the radar if the radar is operating at a frequency of 10 GHz.	**10**	**CO2**
Q 8	Search radar operates with the following parameters. Frequency = 6 GHz, pulse width = 1.2 μs, Duty cycle = 10^{-3}, Radar cross-section = 2 m^2 , Power gain of antenna = 400, maximum range = 60 km, Minimum detectable signal = 5 pW, Effective area = 1 m^2 . Calculate a) Operating wavelength, b) Pulse repetition time, c) Pulse repetition frequency, d) Peak power, e) Average power, f) Unambiguous range, g) Range resolution.	**10**	**CO 1**

<table>
<tr><td>Q 9</td><td>A low-power short-range radar is solid-state throughout, including a low-noise RF amplifier, which gives it an overall noise figure of 4.77dB. If the antenna diameter is 1m, IF BW is 500kHz, the operating frequency is 8GHz and the radar set is supposed to be capable of detecting targets of $5m^2$ cross sectional area at a maximum distance of 12km, what must be the peak-transmitted power?</td><td>10</td><td>CO 3</td></tr>
<tr><td>Q 10</td><td>a) For a parabolic reflector of diameter of 5m, illumination efficiency is 0.65. The frequency of operation is 9GHz. Find out its beam width, directivity and capture area.
b) A parabolic reflector operates at 5GHz. Its mouth diameter is 5m. It is required to measure far-field pattern of the paraboloid. Find out the minimum distance required between two antennas.</td><td>10</td><td>CO 4</td></tr>
<tr><td>Q 11</td><td>Derive the relationship for Monostatic and bi-static radar system with the schematic diagram.</td><td>10</td><td>CO 4</td></tr>
<tr><td colspan="4">SECTION-C
[1x20=20]
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<tr><td>Q 12</td><td>The radar parameters for the bistatic radar system is as shown in Table 1. The range parameters are defined in Table 2. Calculate SNR for the RADAR receiver.
Table 1 – Radar Parameters
<table><tr><th>RADAR PARAMETER</th><th>VALUE</th></tr><tr><td>Peak Transmit Power @ Power Tube, P_T</td><td>1 Mw</td></tr><tr><td>Transmit Losses, L_t</td><td>2 dB</td></tr><tr><td>Pulse Width, τ_p</td><td>0.4 μs</td></tr><tr><td>Antenna Gain, G_T, G_R</td><td>38 dB</td></tr><tr><td>Operating Frequency, f_c</td><td>8 GHz</td></tr><tr><td>Receive Losses, L_R</td><td>3 dB</td></tr><tr><td>Noise Figure F_n</td><td>8 dB</td></tr><tr><td>Other Losses, L_{other}</td><td>2 dB</td></tr></table>
Table 2 – Radar Range Equation Parameters
<table><tr><th>RADAR RANGE EQUATION PARAMETER</th><th>VALUE (MKS)</th><th>VALUE (dB)</th></tr><tr><td>P_T</td><td>10^6 w</td><td>60 dBw</td></tr><tr><td>G_T</td><td>6309.6 w/w</td><td>38 dB</td></tr><tr><td>G_R</td><td>6309.6 w/w</td><td>38 dB</td></tr><tr><td>$\lambda = c/f_c$</td><td>0.0375 m</td><td>-14.26 dB(m)</td></tr></table></td><td>20</td><td>CO2</td></tr>
</table>

σ	3.98 m^2	6 dBsm	
R	60×10^3 m	47.78 dB(m)	
kT_0	4×10^{-21} w-s	-204 dB(w-s)	
$B = 1/\tau_p$	2.5×10^6 Hz	64 dB(Hz)	
F_n	6.31 w/w	8 dB	
$L = L_t L_r L_{other}$	5.01 w/w	7 dB	