

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- 2024

B.Tech-VIII Semester (ECE)

COURSE CODE (CREDITS): 18B1WEC839 (3)

MAX. MARKS: 35

COURSE NAME: Radar Principles and Applications

COURSE INSTRUCTORS: Dr. Vikas Baghel

MAX. TIME: 2 Hours

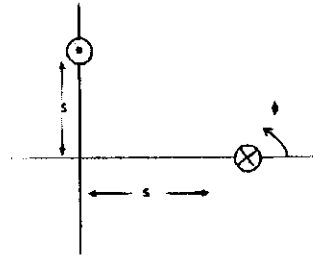
Note: (a) All questions are compulsory.

(b) Marks are indicated against each question in square brackets.

(c) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

- Q1. a) What are the primary differences between CW, FM, and MTI radar systems? [CO2] [2]
b) A transmitting antenna radiates $251W$ isotropically. A receiving antenna, located $100m$ away from the transmitting antenna, has an effective aperture of $500cm^2$. Calculate the total received power by the antenna. [2]
c) A person with a receiver is $5km$ away from the transmitter. What is the distance that this person must move further to detect a $3dB$ decrease in signal strength? [2]
- Q2. a) How does a matched filter maximize the SNR of a received signal? Explain it with derivation. [CO3] [4]
b) Explain the concept of ambiguity function in the context of matched filtering. [2]
- Q3. a) What is antenna directivity? How is antenna directivity measured? [CO1] [2]
b) The radiation pattern of an antenna in spherical coordinates is given by [3]
$$F(\theta) = \cos^4(\theta), \quad 0 \leq \theta \leq \pi/2$$

Find the directivity of the antenna?
c) In a uniform linear array, four isotropic radiating elements are spaced $\lambda/4$ apart. Find the progressive phase shift between the elements required for forming the main beam at 30° off the end-fire. [2]
d) Two identical antennas are placed in the $\theta = \pi/2$ plane as shown in figure. The elements have equal amplitude excitation with 180° polarity difference, operating at wavelength λ . What is the correct value of the magnitude of the far-zone resultant electric field strength normalized with that of a single element? Both computed for $\phi = 0$. [2]



- Q4.** a) What is the relationship between noise figure and signal-to-noise ratio (SNR)? If a radar receiver improves the signal-to-noise ratio (SNR) from 10 dB at the input to 5 dB at the output, determine the noise figure of the receiver. [CO5] [2]
- b) A radar receiver has an input signal power of -100 dBm and an output signal power of -80 dBm. If the input and output noise powers are 120 dBm and -100 dBm, respectively, calculate the noise figure of the radar receiver. [2]
- c) A radar system has two amplifiers in cascade. The first amplifier has a gain of 20 dB and a noise figure of 3 dB. The second amplifier has a gain of 10 dB and a noise figure of 4 dB. Calculate the overall noise figure of the cascaded system. [2]
- d) A radar system operating at a frequency of 10 GHz has a noise figure of 10 dB. If the system's noise figure is improved to 3 dB, by what factor does the maximum detectable range increase, assuming all other parameters remain constant? [2]
- Q5.** a) What is sonar and how does it work? [CO4] [2]
- b) At 10 GHz, calculate the gain of a parabolic dish antenna of 1 meter diameter with 80% efficiency. [2]
- c) A 1km long microwave link uses two antennas each having 40dB gain. What is the approximate power received by the other antenna, if the power transmitted by one antenna is 1W at 3GHz? [2]