Q.2 a. Write the block diagram, principle, range equation and applications of radar. (8)

Answer:

Radar range eqn (with names & diff. terms) 03

Block diagram of radar 02

Applications. 03

b. A typical waveform used in radar is shown below calculate: (8)
(i) average power (ii) duty cycle (iii) maximum range of radar

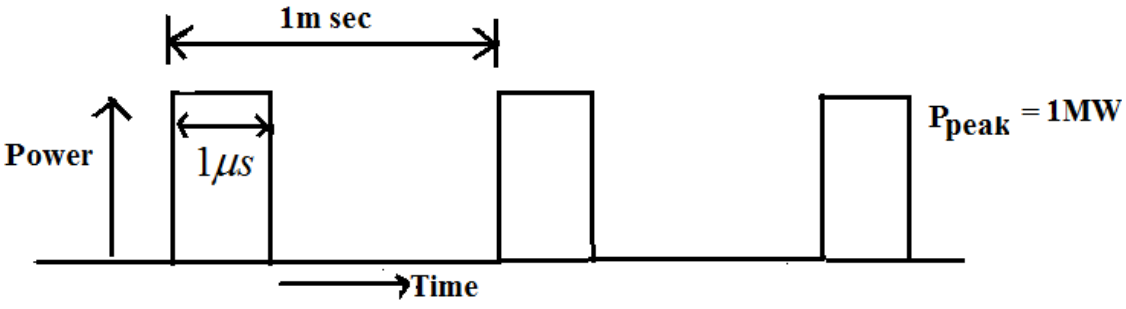

Fig.1

Answer:

From the fig,
Peak power, $P_t = 1\ MW$
Pulse width, $\tau = 1\ \mu s$
$PRF\ (f_r) = \frac{1}{1 \times 10^{-3}} = 1000\ Hz$ (01)

(i) $P_{av} = P_t \times \tau \times f_r = 10^6 \times 1 \times 10^{-6} \times 10^3$ (03)
$= 1\ KW$

(ii) Duty cycle $= \tau \times f_r = 10^{-6} \times 1000$
$= 0.001$ (02)

(ii) $R_{max} = \frac{c}{2f_r} = \frac{3\times10^8}{2\times1000} = 150\,Km$ (02)

Q.3 a. With respect to radar (8)
(i) Plumbing loss
(ii) Beam shape loss
(iii) Collapsing losses
(iv) Effect of noise on radar receiver performance

Answer:

Short notes on
Plumbing loss
Beam shape loss
Collapsing loss
Effect of noise
} 2.5×4

b. What is the peak power of a radar whose average power is 200W, pulse width of 1μsec and has PRF of 1000Hz? Also calculate the range of this ground based air surveillance radar if it has to detect a target with a RCS of $2m^2$ when it operates at a frequency of 2.9 GHz with a rectangular shaped antenna which is 5m wide, 2.7m height, antenna aperture efficiency of 0.6 and mds is 10^{-12} (8)

Answer:

Peak power, $P_t = \frac{P_{av}}{PW} \times PRF$

$= \frac{200}{(1\times10^{-6})} \times 1000$

$= 200\,Kw$ (02)

Effective antenna area,

$A_e = 0.6\times5\times2.7 = 13.5\,m^2\times0.6$

$= 8.1\,m^2$ (02)

$R = \sqrt{\frac{P_t A_e^2 \sigma}{4\pi x^2 S_{min}}} = 118\,Km$ (02)

Q.4 a. A pulse Doppler radar has a carrier frequency of 9 GHz and PRF of 400 GHz. Find its blind Doppler frequencies and the radial velocity of target which would be undetected by the radar. (8)

Answer:

Doppler frequencies,

$f_d = n \cdot PRF$

$= n(4000) = 1 \times 4000$

$= 4000\ Hz$

$= 2 \times 4000\ Hz = 8000\ Hz$

$= n \cdot 4000\ Hz$ (02)

Now Operating freq, $f = 9 \times 10^9\ Hz$

$\lambda = \frac{c}{f} = \frac{3 \times 10^8}{9 \times 10^9} = 0.03\ m$ (01)

V_r (blind speed) $= \frac{n \cdot PRF \cdot \lambda}{2} = \frac{n \times 4000 \times 0.03}{2}$

$= n \times 66.67\ m/s$ (01)

∴ Any integer multiple of 66.67 m/s is undetected by this radar system. (02)

b. A target is closing on a radial of radar with a velocity of 200 knots. The radar transmits a continuous wave at a wavelength of 5 cm. What will be the Doppler shift of the target? What will be the Doppler shift if the target alters it's course by 45°? Given 1 knots = 0.508m/sec. (8)

Answer:

$\lambda = 0.05\ m$

$V_r = 200\ Knots = 200 \times 0.508\ m/s$

$= 101.6\ m/s$ (01)

Doppler shift, $f_d = \frac{2V_r}{\lambda} = \frac{2 \times 101.6}{0.05}$

$= 4.06$ KHz (02)

Velocity component in the close direction

$V = V_r \cos\theta = 101.6 \times \cos 45°$

$= 101.6 \times 0.707 = 71.84$ m/s (03)

Freq. shift, $\Delta f_d = \frac{2 \times 71.84}{2.35}$

$= 12.87$ KHz. (02)

Q.5 a. Write note on various types of detector used in Radar. (8)

Answer:

Page No. 257

b. Describe matched filter receiver. List its important characteristics. (8)

Answer:

Page No. 261

Q.6 a. Explain variation of surface clutter with grazing angle, with the help of diagram. (8)

Answer:

Page No. 455

b. Describe clutter characteristics with respect to spectrum and amplitude. Explain how clutter reduction is achieved in radar systems. (8)

Answer:

Clutter Defn & Characteristics (04)

Clutter reduction in radar (04)

Q.7 a. How does a SAR differ from a physical linear array? Show that finer resolution is achievable using smaller physical apertures in SAR. (8)

Answer:

SAR v/s Physical linear Array (03)

Derivation (07)

b. Explain effective aperture and polarisation of antenna. (8)

Answer:

Page No. 543

Q.8 a. Draw and explain TR Duplexer. (8)

Answer:

Page No. 745

b. Write note on plan position Indicator. (8)

Answer:

Page No. 752

Q.9 a. Explain the errors encountered in direction finding. How are these removed? (8)

Answer:

Errors encountered in direction finding (04)

Removal of errors (04)

b. Write notes on - (4x2)

(i) Radar beacons

(ii) Sequential Lobing

Answer:

Short notes on:

(i) Radar Beacons (04)

(ii) Sequential Lobing (04)

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TEXT BOOK

I. Introduction to Radar Systems, Merrill I. Skolnik, 3e, TMH, 2001

II. Electronic and Radio Engineering, F.E. Terman, McGraw Hill Publications