ECE 514E – RADAR & SATELLITE ENGINEERING

PULSE RADAR – TEST YOUR KNOWLEDGE

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1. What does "pulse radar" primarily use to determine target range?

◯ a) Frequency shift

◯ b) Phase difference

◯ c) **Time delay of reflected pulses**

◯ d) Amplitude attenuation

Answer: c) Time delay of reflected pulses
Explanation: Pulse radar measures the time taken for a transmitted pulse to reflect off a target and return. Range is calculated as R=$C\Delta t/2$ where C is the speed of light and Δt is the round-trip time.

2. The Pulse Repetition Interval (PRI) is:

◯ a) The duration of one pulse

◯ b) **The time between consecutive pulses**

◯ c) The number of pulses per second

◯ d) The time taken to scan 360 degrees

Answer: b) The time between consecutive pulses

Explanation: PRI is the interval from the start of one pulse to the start of the next. It is the inverse of Pulse Repetition Frequency (PRF).

3. A radar with a Pulse Repetition Frequency (PRF) of 1,000 Hz has a PRI of:

◯ a) 1 μs
◯ b) 10 ms
◯ c) **1 ms**
◯ d) 100 ms

Answer: c) 1 ms

Explanation: PRI = $\frac{1}{PRF}$=11000 Hz=0.001s=1 ms

4. The maximum unambiguous range (R_{max}) of a pulse radar is determined by:

◯ a) Transmitter power

◯ b) **Pulse Repetition Frequency (PRF)**

◯ c) Antenna gain

◯ d) Pulse width

Answer: b) Pulse Repetition Frequency (PRF)

Explanation: Rmax=$\frac{C.PRI}{2}$. = $\frac{C}{2PRF}$. Higher PRF reduces R_{max} due to sho rter intervals between pulses.

5. Range resolution in pulse radar depends primarily on:

◯ a) PRF

◯ b) **Pulse width (τ)**

◯ c) Carrier frequency

◯ d) Antenna beamwidth

Answer: b) Pulse width (τ)

Explanation: Shorter pulses allow better distinction between closely spaced targets. Range resolution $\approx \frac{c\tau}{2}$.

6. Which component protects the receiver from high-power transmitter pulses?

◯ a) Mixer

◯ b) **Duplexer**

◯ c) Modulator

◯ d) Local oscillator

Answer: b) Duplexer

Explanation: The duplexer (e.g., circulator or TR switch) routes transmitted pulses to the antenna and received echoes to the receiver, isolating the sensitive receiver from high-power transmission.

7. The Doppler effect in pulse radar is used to measure:

◯ a) Target size

◯ b) **Radial velocity**

◯ c) Altitude

◯ d) Material composition

Answer: b) Radial velocity

Explanation: Doppler shift ($\frac{2v_r}{\lambda}$) occurs due to relative motion between radar and target, altering the received frequency.

8. In Moving Target Indication (MTI) radar, clutter is suppressed by:

◯ a) Increasing pulse width

◯ b) **Cancelling successive pulses**

◯ c) Using higher frequencies

◯ d) Reducing PRF

Answer: b) Cancelling successive pulses
Explanation: MTI uses a delay-line canceller to subtract consecutive pulses. Stationary clutter (with zero Doppler) cancels out, while moving targets produce residue.

9. A radar with a pulse width of 2 μs has a range resolution of:

◯ a) 150 m

◯ b) **300 m**

◯ c) 600 m

◯ d) 1.2 km

Answer: b) 300 m

Explanation: Range resolution = $\frac{C\tau}{2}$ =3×10^8 m/s×2×10^{-6} =300m.

10. Duty cycle of a pulse radar is defined as:.

◯ a) $\frac{PRF}{Pulse\ Width}$

◯ b) $\frac{Peak\ Power}{Average\ Power}$

◯ c) $\frac{Pulse\ Width}{PRI}$

◯ d) $\frac{Average\ Power}{Peak\ Power}$

Answer: c) $\frac{Pulse\ Width}{PRI}$

Explanation: Duty cycle = $\frac{\tau}{PRI}$

11. Higher PRF improves maximum unambiguous range.

◯ True

◯ False

Answer: False
Explanation: Higher PRF reduces PRI, decreasing R_{max}

Low PRF is used for long-range detection.

12. The primary role of the modulator in pulse radar is to:

◯ a) Amplify received signals

◯ b) **Generate high-voltage pulses for the transmitter**

◯ c) Convert RF to IF

◯ d) Filter clutter

◯ **Answer:** b) Generate high-voltage pulses for the transmitter

◯ **Explanation:** The modulator triggers the transmitter (e.g., magnetron) to produce high-power RF pulses.

13. Which radar type uses coherent processing to detect moving targets?

◯ a) **Pulse Doppler radar**

◯ b) Frequency-modulated radar

◯ c) Non-coherent pulse radar

◯ d) Continuous-wave radar

Answer: a) Pulse Doppler radar
Explanation: Pulse Doppler radar preserves phase coherence between pulses, enabling precise Doppler measurement and high clutter rejection.

14. Blind speeds in MTI radar occur when:

◯ a) Targets are too close

◯ b) **Doppler shift equals multiples of PRF**

◯ c) Pulse width is too short

◯ d) Clutter is dominant

Answer: b) Doppler shift equals multiples of PRF

Explanation: Blind speeds occur when fd=n, causing moving targets to appear stationary and be cancelled by MTI filters.

15. The minimum detectable range is limited by:

◯ a) PRF

◯ b) **Pulse width (τ)**

◯ c) Antenna height

◯ d) Receiver bandwidth

Answer: b) Pulse width (τ)

Explanation: The radar cannot receive while transmitting. Minimum range ≈ c·τ.

16. A superheterodyne receiver in radar converts:

◯ a) RF to baseband

◯ b) **RF to intermediate frequency (IF)**

◯ c) IF to Doppler frequency

◯ d) Digital to analogue signals

Answer: b) RF to intermediate frequency (IF)

Explanation: The mixer combines RF signals with a local oscillator to produce a lower, fixed IF for easier amplification and filtering.

17. Pulse compression allows long pulses to achieve the range resolution of short pulses.

◯ **True**

◯ False

Answer: True

Explanation: Pulse compression (e.g., using chirp modulation) spreads frequency during transmission. Matched filtering compresses the echo, combining long-pulse energy with short-pulse resolution.

18. Ground clutter appears in radar displays as:

◯ a) Moving targets

◯ b) **Stationary echoes near the radar**

◯ c) High-altitude targets

◯ d) Noise

Answer: b) Stationary echoes near the radar

Explanation: Ground clutter refers to strong, stationary reflections from terrain/buildings, concentrated at short ranges.

19. The radar equation states that received power Pr is proportional to:

◯ a) R^2

◯ b) R^3

◯ c) **R^{-4}**

◯ d) R^{-2}

Answer: c) R^{-4}

Explanation

$$P_r \propto \frac{P_t G^2 \sigma \lambda^2}{(4\pi)^3 R^4 L}.$$

Received power decreases with the fourth power of range.

20. Which factor does NOT affect radar cross-section (RCS)?

◯ a) Target material

◯ b) Target shape

◯ c) **Radar PRF**

◯ d) Aspect angle

Answer: c) Radar PRF

Explanation: RCS (σ) depends on target properties (size, shape, material) and aspect angle, not radar parameters like PRF.

21. A monostatic radar:

◯ a) Uses two antennas

◯ b) **Shares transmitter/receiver at one location**

◯ c) Operates at multiple frequencies

◯ d) Measures only velocity

Answer: b) Shares transmitter/receiver at one location

Explanation: Monostatic radar uses a single antenna or co-located antennas for transmission and reception.

22. True or False: MTI radar requires coherent oscillator (COHO) and stable local oscillator (STALO).

Answer: True

Explanation: COHO and STALO maintain phase coherence between pulses, essential for Doppler processing in MTI.

23. The main advantage of higher carrier frequencies is:

◯ a) **Better Doppler resolution**

◯ b) Longer maximum range

◯ c) Lower atmospheric attenuation

◯ d) Reduced clutter

Answer: a) Better Doppler resolution

Explanation: Doppler shift $f_d = \frac{2v_r}{2}$. Shorter wavelengths (higher frequencies) increase f_d for a given velocity, improving velocity resolution.

24. Sea clutter typically has:

◯ a) High Doppler shift

◯ b) **Time-varying amplitude**

◯ c) Zero RCS

◯ d) Constant phase

Answer: b) Time-varying amplitude
Explanation: Sea clutter amplitude fluctuates due to wave motion, modelled by distributions like Rayleigh or log-normal.

25. Pulse integration improves SNR by:

◯ a) Increasing pulse width

◯ b) **Averaging multiple pulses**

◯ c) Reducing PRF

◯ d) Using wider beams

Answer: b) Averaging multiple pulses

Explanation: Coherent/non-coherent integration of N*N* pulses reduces noise, improving SNR by up to N (non-coherent) or N (coherent).

26. A radar with 1 kW peak power and 10% duty cycle has an average power of:

◯ a) 10 W

◯ b) **100 W**

◯ c) 1,000 W

◯ d) 10 kW

Answer: b) 100 W

Explanation: Average power = Peak power × Duty cycle = 1000 W×0.1=100 W

27. Which display shows range vs. amplitude?

◯ a) PPI

◯ b) B-scope

◯ c) **A-scope**

◯ d) RHI

Answer: c) A-scope
Explanation: A-scope is a Cartesian display with range on the x-axis and echo amplitude on the y-axis.

28. Pulse radar can measure range and radial velocity simultaneously without ambiguity.

◯ True

◯ **False**

Answer: False

Explanation: Trade-offs exist: Low PRF avoids range ambiguities but causes Doppler ambiguities, while high PRF has the opposite problem. Medium PRF is a compromise.

29. Clutter rejection in Doppler processing uses:

◯ a) **High-pass filters**

◯ b) Low-pass filters

◯ c) Band-pass filters

◯ d) Matched filters

Answer: a) High-pass filters
Explanation: Clutter has low Doppler frequencies. High-pass filters (e.g., in MTI) attenuate low-frequency clutter while passing high-frequency moving targets.

30. The function of a quadrature demodulator is to:

◯ a) Amplify signals

◯ b) **Extract I/Q (in-phase/quadrature) components**

◯ c) Generate PRF

◯ d) Compress pulses

Answer: b) Extract I/Q (in-phase/quadrature) components

Explanation: I/Q demodulation preserves magnitude and phase of received signals, enabling Doppler processing and clutter rejection.