

Assessed test 2

Open Book. One hour

Communications

1. A 1 GHz radio transmitter with a transmit power of 1 mW radiates from an antenna which has a gain of 3 dB. A receiver is positioned at a range of 500 m, with an antenna gain of 10 dB, pointing at the transmitter via a free-space path. What is the received power level ?

- (a)  $1 \times 10^{-10}$  W       (b)  $4.6 \times 10^{-11}$  W       (c)  $4.6 \times 10^{-6}$  W       (d)  $1.1 \times 10^{-11}$  W

2. The receiver has a bandwidth of 1 MHz and a Noise Figure of 6 dB. What is the noise power, referred to the receiver input ?

- (a)  $1.6 \times 10^{-14}$  W       (b)  $8 \times 10^{-12}$  W       (c)  $1.1 \times 10^{-6}$  W       (d)  $4 \times 10^{-14}$  W

3. Thermal noise is due to:

- (a) quantum effects       (b) the Earth's magnetic field       (c) cosmic radiation       (d) random vibration of electrons

4. An 802.11 WiFi link operates in the 2.4 GHz ISM band. The wavelength is approximately:

- (a) 12.5 mm       (b) 12.5 cm       (c) 2.5 cm       (d) 25 cm

5. The distortion of a radio signal due to multiple reflections from buildings is called

- (a) anomalous propagation       (b) superrefraction       (c) attenuation       (d) multipath

6. A communications link with a bandwidth of 100 kHz has a signal-to-noise ratio of 30 dB. What is the maximum theoretical channel capacity ?

- (a) 100 kbits/s       (b) 997 kbits/s       (c) 300 kbits/s       (d) 690 kbits/s

7. An amplitude modulated broadcast signal has a carrier frequency of 1 MHz and a maximum modulating signal frequency of 6 kHz. The bandwidth of the radiated signal is:

- (a) 1.006 MHz       (b) 6 kHz       (c) 12 kHz       (d) 3 kHz

8. In a digital communications link, increasing the signal-to-noise ratio at the receiver will cause the bit error rate (BER) to:

- (a) increase       (b) decrease       (c) stay the same       (d) drop to zero

9. Orthogonal Frequency Division Multiplexing (OFDM) is a way of:

- (a) avoiding the effects of multipath propagation       (b) increasing signal-to-noise ratio       (c) avoiding co-channel interference       (d) reducing antenna sidelobes

10. Which of the following is not a technique for measuring the direction of arrival of a radio signal ?

- (a) time difference of arrival       (b) interferometry       (c) time-division multiplexing       (d) amplitude comparison

### Sensing

11. A target is located at a range of 100 km from a radar. The two-way propagation delay of the radar pulse, from the radar to the target and back again, is

- (a) 670 ms       (b) 330  $\mu$ s       (c) 670  $\mu$ s       (d) 67 ms

12. If the transmit power of a radar transmitter is doubled, the maximum detection range for a given target will increase by a factor of

- (a)  $\sqrt[4]{2}$        (b) 2       (c)  $\sqrt{2}$        (d) 4

13. The most suitable radar band for a through-wall imaging radar would be

- (a) VHF/UHF  (b) S-band  (c) X-band  (d) mm-wave

14. A radar pulse of duration  $0.5 \mu\text{s}$  gives a range resolution of

- (a) 75 m  (b) 2.5 m  (c) 150 m  (d) 7.5 m

15. Which of the following would be likely to have the highest radar cross section ?

- (a) a stealthy aircraft  (b) a human  (c) a radar corner reflector  (d) a car

16. One of the designers of the Swedish naval corvette Visby stated in a BBC interview that: 'We are able to reduce the radar cross section by 99%. That doesn't mean that it's 99% invisible, it means that we have reduced its detection range'. By what factor is the detection range reduced ?

- (a) 100  (b) 3.2  (c) 10  (d) 32

17. A sideways-looking aircraft-borne Synthetic Aperture Radar has a frequency of 33 GHz. The aircraft flies at a velocity of 200 m/s and its antenna is 1.5 m long. The azimuth (cross-range) resolution in the image is

- (a) 10 m  (b) 5 m  (c) 1.5 m  (d) 0.75 m

18. A radar has a Pulse Repetition Frequency (PRF) of 2 kHz. The Pulse Repetition Interval is:

- (a)  $0.5 \mu\text{s}$   (b) 0.5 ms  (c) 0.25 ms  (d) 5 ms

19. A police Doppler radar operates at a frequency of 24 GHz. The Doppler shift of the echo from a car travelling at 55 mph towards the radar is approximately:

- (a) 195 Hz  (b) 45 kHz  (c) 2.25 kHz  (d) 3.9 kHz

20. In radar detection, raising the detection threshold will

(a) increase the probability of detection and increase the probability of false alarm

(b) increase the probability of detection and reduce the probability of false alarm

(c) reduce the probability of detection and increase the probability of false alarm

(d) reduce the probability of detection and reduce the probability of false alarm

### Satellites

21. The first artificial satellite was

(a) QUILL

(b) SKYLAB

(c) SPUTNIK

(d) SEASAT

22. A satellite orbit at a height of 700 km above the Earth's surface and an orbit period of 96 minutes would be described as

(a) LEO

(b) Geosynchronous

(c) Molniya

(d) MEO

23. A satellite orbit at a height of 36,000 km above the Earth's surface and an orbit period of 24 hours would be described as

(a) LEO

(b) Geosynchronous

(c) Molniya

(d) MEO

24. Spotlight-mode SAR is

(a) a way of achieving ultra-high resolution imaging

(b) a way of detecting moving targets

(c) a way of obtaining a 3-D image of a target scene

(d) a way of detecting targets hidden under foliage

25. Interferometric SAR is

- |  |   |  |   |
|--|---|--|---|
| (a) a way of achieving ultra-high resolution imaging<br><input type="checkbox"/> | (b) a way of detecting moving targets<br><input type="checkbox"/> | (c) a way of obtaining a 3-D image of a target scene<br><input type="checkbox"/> | (d) a way of detecting targets hidden under foliage<br><input type="checkbox"/> |
|--|---|--|---|

26. The Faraday Effect causes the polarisation of a 1 GHz satellite signal received at the Earth to be rotated by 60°. If the frequency were reduced to 500 MHz, the rotation would be:

- |                                      |                                     |                                      |                                     |
|--------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|
| (a) 120°<br><input type="checkbox"/> | (b) 30°<br><input type="checkbox"/> | (c) 240°<br><input type="checkbox"/> | (d) 15°<br><input type="checkbox"/> |
|--------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|

27. A solar array on the ISS has an area of 34 m x 12 m and generates 32 kW. How much power would a solar array of area 0.01 m<sup>2</sup> on a microsatellite generate ?

- |  |                                       |                                      |                                       |
|--|---------------------------------------|--------------------------------------|---------------------------------------|
| (a) 0.78 W<br><input type="checkbox"/> | (b) 7.8 W<br><input type="checkbox"/> | (c) 78 W<br><input type="checkbox"/> | (d) 780 W<br><input type="checkbox"/> |
|--|---------------------------------------|--------------------------------------|---------------------------------------|

28. The unfurlable dish antenna recently demonstrated by Oxford Space Systems has a diameter of 5 m and operates at Ku-band (12 GHz). Its gain is approximately

- |  |  |  |  |
|--|--|--|--|
| (a) 54 dBi<br><input type="checkbox"/> | (b) 56 dBi<br><input type="checkbox"/> | (c) 62 dBi<br><input type="checkbox"/> | (d) 48 dBi<br><input type="checkbox"/> |
|--|--|--|--|

29. An optical imaging system (assume  $\lambda = 500$  nm) on a satellite has a mirror diameter of 1.8 m and images the Earth's surface at a range of 200 km. The image resolution is approximately

- |                                     |                                       |                                      |                                      |
|-------------------------------------|---------------------------------------|--------------------------------------|--------------------------------------|
| (a) 5 m<br><input type="checkbox"/> | (b) 50 cm<br><input type="checkbox"/> | (c) 5 cm<br><input type="checkbox"/> | (d) 5 mm<br><input type="checkbox"/> |
|-------------------------------------|---------------------------------------|--------------------------------------|--------------------------------------|

30. Extreme Space Weather is caused by

- |  |  |  |   |
|--|--|--|---|
| (d) Solar flares<br><input type="checkbox"/> | (a) Polar wind<br><input type="checkbox"/> | (b) Space debris<br><input type="checkbox"/> | (c) Black holes<br><input type="checkbox"/> |
|--|--|--|---|

**Acoustic sensing**

31. The upper frequency limit of human hearing is approximately:

- (a) 1 kHz       (b) 3 kHz       (c) 6 kHz       (d) 20 kHz

32. The two-way propagation delay of an underwater sonar ping reflected from a target at a range of 5000 m is approximately

- (a) 29.1 s       (b) 6.7 s       (c)  $3.25 \times 10^{-5}$  s       (d) 3.3 s

33. Measurements of acoustic components and systems would be made in

- (a) a clean room       (b) a cloud chamber       (c) an anechoic chamber       (d) an ultrasonic bath

34. A fire engine with a siren emitting a signal at 2 kHz drives towards a stationary observer at a speed of 36 km/h. The frequency heard by the observer is approximately:

- (a) 2219 Hz       (b) 2120 Hz       (c) 2060 Hz       (d) 1880 Hz

35. An octave represents a frequency interval of a factor of

- (a) 16       (b) 10       (c) 8       (d) 2

36. An acoustic signal of 200 kHz has a wavelength in air of approximately

- (a) 1 m       (b) 7.5 mm       (c) 4.1 mm       (d) 1.7 mm

37. An acoustic signal of 200 kHz has a wavelength underwater of approximately

- (a) 1 m       (b) 7.5 mm       (c) 4.1 mm       (d) 1.7 mm

38. The propagation of sound underwater

(a) depends on the temperature of the water

(b) depends on the salinity of the water

(c) is such that attenuation increases strongly with frequency

(d) all of these

39. A plot of underwater acoustic signals as a function of frequency and of time is called a

(a) echogram

(b) frequency response

(c) stereogram

(d) lofargram

40. Underwater noise in the ocean is due to

(a) shipping

(b) sea surface noise

(c) whales, porpoises, shrimps

(d) all of these