MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF MIZORAM ENGINEERING SERVICE (M.E.S.) UNDER PUBLIC HEALTH DEPARTMENT, GOVERNMENT OF MIZORAM, MARCH, 2019.

ELECTRONICS & COMMUNICATION ENGINEERING
PAPER - III

Time Allowed : 3 hours   FM : 200

SECTION - A *(Multiple Choice questions)*

(100 Marks)

All questions carry equal mark of 2 each. Attempt all questions.

*This Section should be answered only on the **OMR Response Sheet** provided.*

1. The power in the signal $S(t) = 8Cos(20pt − p/2) + 4Sin(15pt)$ is
   - (a) 40
   - (b) 41
   - (c) 42
   - (d) 82

2. Quadrature multiplexing is
   - (a) Same as FDM
   - (b) Same as TDM
   - (c) A combination of FDM and TDM
   - (d) Quite different from FDM and TDM

3. Three analog signals having bandwidths 1200Hz, 600Hz and 600Hz are sampled at their respective Nyquist rates, encoded with 12-bit words and time-division multiplexed. The bit rate for the multiplexed signal is
   - (a) 115.2 kbps
   - (b) 28.8 kbps
   - (c) 57.6 kbps
   - (d) 38.4 kbps

4. Four messages band-limited to W, W, 2W and 3W respectively, are to be multiplexed using Time-Division Multiplexing (TDM). The minimum band-width required for transmission of this TDM signal is
   - (a) W
   - (b) 3W
   - (c) 6W
   - (d) 7W

5. Consider the AM signal $S(t) = 5[1+2Cos(2p×1000t)]\ Cos(2p×10^6t)$. The modulation index is
   - (a) 2
   - (b) 5/2
   - (c) 3/2
   - (d) 2/5

6. A 1 KHz sinusoidal signal is ideally sampled at 1500 samples/sec and the sampled signal is passed through an ideal low pass filter with cut off frequency 800Hz. The output signal has the frequency
   - (a) 0 Hz
   - (b) 0.75 KHz
   - (c) 0.5 KHz
   - (d) 0.25 KHz

7. Consider DMS with two symbols X_1 and X_2 are encoded as follows

X_i	$P(X_i)$	Code
X_1	0.9	0
X_2	0.1	1

The efficiency ç is

(a) 80%   (b) 24%

(c) 22.69%   (d) 46.9%

8. In amplitude modulation, the modulation envelope has a peak value which is double the unmodulated carrier value. What is the value of the modulation index.

(a) 25%   (b) 100%

(c) 75%   (d) 50%

9. If the bits 0 and 1 are transmitted using bipolar pulses, the minimum bandwidth required for the transmission is

(a) 64 KHz   (b) 32 KHz

(c) 8 KHz   (d) 4 KHz

10. In a delta modulation, the granular error distortion can be reduced by

(a) Decreasing the sampling rate.   (b) Increasing the sampling rate.

(c) Decreasing the step size.   (d) Increasing the step size.

11. The input to a coherent detector is DSB-SC signal plus noise. The noise at the detector output is

(a) The in-phase component   (b) The Quadrature component

(c) Zero   (d) The envelope

12. Which of the following schemes suffer(s) from the threshold effect?

(a) AM detection using envelope detection.   (b) AM detection using synchronous detection.

(c) FM detection using a discriminator.   (d) SSB detection with synchronous detection.

13. Two sinusoidal signals of same amplitude and frequency 10 KHz and 10.1 KHz are added together. The combined signal is given to an ideal frequency detector is

(a) 0.1 KHz sinusoid.   (b) 20.1 KHz sinusoid.

(c) A linear function of time.   (d) A constant.

14. A BPSK modulator has a carrier frequency of 70MHz and an input bit rate of 10Mbps. The maximum upper sideband frequency in MHz is

(a) 75   (b) 65

(c) 70   (d) 5

15. Let m(t) be a sinusoidal signal with a peak value A. The sinusoidal signal is fed to a uniform quantizer. The value of (SNR)q in dB for R-bit code word per sample is

(a) (6.02R+1.8)   (b) (6.02R+2.4)

(c) (6.02R+1.2)   (d) 6.02R

16. For a 8-PSK signal having a bandwidth of 5KHz, the baud rate and the bit rate, respectively are

(a) 5000 bauds, 8000 bps.   (b) 5000 bauds, 15000 bps.

(c) 4000 bauds, 40000 bps.   (d) 15000 bauds, 15000 bps.

17. In a PCM system with uniform quantization, increasing the number of bits from 8 to 9 will reduce the quantization noise power by a factor of

   (a) 9   (b) 8

   (c) 4   (d) 16

18. For a bit rate of 8 kbps, the best possible values of the transmitted frequencies in a coherent binary FSK system are

   (a) 14 KHz and 20 KHz   (b) 20 KHz and 32 KHz

   (c) 32 KHz and 40 KHz   (d) 45 KHz and 55 KHz

19. A sinusoidal signal peak-to-peak amplitude of 1.536V is quantized into 128 levels using a mid-rise uniform quantizer. The quantization noise power is

   (a) 0.768V   (b) 48×10^{-6} V^2

   (c) 12×10^{-6} V^2 (d) 3.072V

20. Diffraction of electromagnetic waves is caused by

   (a) The spherical wave fronts.   (b) The wave passing through a slot.

   (c) The edges of sharp obstacles.   (d) The reflection from the ground.

21. The critical frequency for ionospheric propagation is proportional to

   (a) The maximum electron density.

   (b) The square of maximum electron density.

   (c) The square root of maximum electron density.

   (d) The logarithm of the maximum electron density.

22. If "r" is the radius of the circular orbit of the satellite then the orbital period of a satellite is proportional to

   (a) $r^{3/2}$ (b) r^2

   (c) r   (d) $\sqrt{r}$

23. The satellite communication channels in a transponder are defined by the

   (a) Mixer   (b) LNA

   (c) Band pass filter   (d) Input signals

24. The TE$_{10}$ mode is to propagate through a rectangular waveguide of dimensions a=1.5cm and b=1cm. The signal frequency is 8 GHz. The waveguide is initially filled with air. In this case, TE$_{10}$ mode

   (a) Cannot propagate as the propagation wavelength is higher than the cut-off wavelength.

   (b) Will propagate as the propagating wavelength is lower than the cut-off wavelength.

   (c) Cannot propagate as the propagating wavelength is lower than the cut-off wavelength.

   (d) Will propagate as the propagating wavelength is higher than the cut-off wavelength.

25. A rectangular waveguide has dimensions 4cm × 2cm. Over what frequency range will such a guide support a single mode?

   (a) 3.5 to 5.5 GHz.   (b) 3.5 to 7 GHz.

   (c) 3.5 to 7.5 GHz.   (d) It will support a single mode only at 3.5 GHz.

26. The dominant mode in a circular waveguide is

   (a) TE$_{10}$ (b) TE$_{11}$

   (c) TM$_{10}$ (d) TM$_{11}$

27. The characteristic impedance of an air dielectric rectangular waveguide mode from a non-magnetic material mainly depends upon

   (a) Cut-off wavelength.   (b) Guide wavelength.

   (c) Dimensions (narrow & wide) of the waveguide (d) Propagating mode.

28. If Z_0 is the characteristics wave impedance of free space, then the characteristics wave impedance Z of a waveguide for TE_{mn} is given by

(a) $Z = Z_0 \sqrt{\left(1-(\lambda/\lambda_c)^2\right)}$

(b) $Z = \dfrac{Z_0}{\sqrt{\left(1-(\lambda/\lambda_c)^2\right)}}$

(c) $Z = \dfrac{Z_0}{\sqrt{\left(1-(\lambda_c/\lambda)^2\right)}}$

(d) $Z = Z_0 \sqrt{\left(1-(\lambda_c/\lambda)^2\right)}$

29. In a microwave test bench, why is the microwave signal amplitude modulated at 1 KHz?

(a) To increase the sensitivity of measurement.

(b) To transmit the signal to a far-off place.

(c) To study amplitude modulation.

(d) Because crystal detector fails at microwave frequencies.

30. An air-filled rectangular waveguide has inner dimensions of 3cm × 2cm. The wave impedance of the TE_{20} mode of propagation in the waveguide at a frequency of 30 GHz is (free space impedance h_0=377 W).

(a) 308 W

(b) 355 W

(c) 400 W

(d) 461 W

31. A rectangular waveguide with internal dimensions of a=4cm and b=3cm is to be operated in TE_{11} mode. The minimum operating frequency is

(a) 6.25 GHz

(b) 6.00 GHz

(c) 5.00 GHz

(d) 3.75 GHz

32. Operating wavelength and bandwidth of a certain antenna are 3 cm and 100 MHz respectively. The Q-factor is

(a) 100

(b) 200

(c) 300

(d) 1000

33. A tracking radar antenna with operational wave-length of 3cm produces a pencil-like beam with both azimuth and elevation beam width equal to 0.5^0 each. The approximate gain of the antenna is

(a) 48 dB

(b) 52 dB

(c) 60 dB

(d) 40dB

34. A 3m diameter circular reflector antenna operates at 10 GHz. Its length efficiency is 0.7 and its radiation efficiency is 0.9. The beam width is

(a) 0.41^0

(b) 0.61^0

(c) 0.80^0

(d) 0.50^0

35. A mast antenna consisting of a 50m long vertical conductor operates over a perfectly conducting ground plane. It is base-fed at a frequency of 600 KHz. The radiation resistance of the antenna is

(a) $\dfrac{2\pi^2}{5}\,\Omega$

(b) $\dfrac{\pi^2}{5}\,\Omega$

(c) $\dfrac{4\pi^2}{5}\,\Omega$

(d) $\dfrac{20\pi^2}{5}\,\Omega$

36. At 20GHz, the gain of a parabolic dish antenna of 1m diameter and 70% efficiency is

(a) 15dB

(b) 45dB

(c) 30dB

(d) 50dB

37. The radiation pattern of an antenna in spherical co-ordinates is given by $F(\theta) = Cos^4\theta, 0 \leq \theta \leq \pi/2$. The directivity of the antenna is

    (a) 10 dB   (b) 12.6 dB

    (c) 11.5 dB   (d) 18 dB

38. Which diode is not used as a microwave mixer or detector?

    (a) Schottky barrier   (b) PIN

    (c) Crystal   (d) Backward

39. An evanescent mode occurs when

    (a) A wave is attenuated rather than propagated.

    (b) The propagation constant is purely imaginary.

    (c) A wave is propagated rather than attenuated.

    (d) The wave frequency is same as the cut-off frequency.

40. Which of the following microwave diodes is suitable for very low power oscillator only?

    (a) IMPATT   (b) TUNNEL

    (c) LSA   (d) GUNN

41. Klystron operates on the

    (a) Principle of velocity modulation.   (b) Principle of pulse modulation.

    (c) Principle of phase modulation.   (d) Principle of amplitude modulation.

42. Ruby LASER differs from ruby MASER mainly in the fact that

    (a) It needs no resonator.   (b) It is as oscillator.

    (c) It produces much lower power.   (d) It does not require pumping.

43. The output of the two arms of an E-plane Tee are

    (a) In the same phase.   (b) 90^0 out of phase.

    (c) 180^0 out of phase.   (d) 45^0 out of phase.

44. 8085 microprocessor is a

    (a) Zero address microprocessor.   (b) One address microprocessor.

    (c) Two address microprocessor.   (d) Eight address microprocessor.

45. Setting contents of a microprocessor to zero can be efficiently done by

    (a) MOV immediate instruction using zero as immediate data.

    (b) AND immediate instruction using zero as immediate data.

    (c) XORing register with itself.

    (d) XOR immediate instruction using zero as immediate data.

46. The following signal is used when a peripheral device requests the microprocessor to have a DMA operation.

    (a) INTR and $\overline{INTR}$ (b) READY

    (c) HOLD and $\overline{HLDA}$ (d) $\overline{RD}$ and $\overline{WR}$

47. With reference to a 2K bit ROM organized as 256 x 8 array of memory cells, which one of the following statements is true?

   (a) It uses 256 rows of eight cells each.

   (b) It uses 2048 memory cells and 8-line to 256-line address decoder.

   (c) It uses 8 rows of 256 cells each.

   (d) It uses 2048 memory cells and 8-line to 256-line address encoder.

48. The number of memory cycles required to execute the following 8085 instructions

       I. LDA 3000H

      II. LXI D, FOF 1H

would be

   (a) 2 for (I) and 2 for (II).   (b) 4 for (I) and 3 for (II).

   (c) 3 for (I) and 3 for (II).   (d) 3 for (I) and 4 for (II).

49. The following program starts at location 0100H

      LXI SP, 00 FF

      LXI H, 0107

      MVI A, 20 H

      SUB M

The content of accumulator when the program counter reaches 0109 H is

   (a) 20 H   (b) 02 H

   (c) 00 H   (d) FF H

50. With reference to 8085 microprocessor, ANA R/M is

   (a) A logic instruction.   (b) An arithmetic instruction.

   (c) A Data transfer instruction.   (d) A control instruction.

SECTION - B *(Short answer type question)*
(100 Marks)

*All questions carry equal marks of **5** each.*

*This Section should be answered only on the **Answer Sheet** provided.*

1. Design an air-filled X-band rectangular waveguide such that the centre frequency of this is at least 25% higher than the cut-off frequency of the TE_{10} mode and at least 25% lower than the next higher order mode, so that the dominant mode of propagation is TE_{10}.

2. Why TEM mode can't propagate in a waveguide?

3. Explain with diagram the necessary arrangements for launching TE_{11}, TE_{01} and TM_{01} in a rectangular waveguide.

4. A directional coupler has coupling factor of 10dB and a directivity of 30dB. If the power in the isolated port is 40μW. Find the power in the input port and in the through port. Also find the insertion loss of the coupler.

5. The specifications of a three-port circulator are: Insertion loss=1dB, Isolation=25 dB and VSWR=1.4. Characterize the circulator by its S-parameters.

6. Explain the different modes of operation realizable with a Gunn diode.

7. A cosecant squared antenna is 16 ft wide and 4.8 ft high operating at 2.8GHz. Calculate its Azimuth beam width, Elevation beam width and directivity.

8. A waveguide is constructed so that the cross-section of the guide forms a triangle with sides of length a, a, $\sqrt{2a}$. The walls are perfectly conductors and the inside of the guide has air as the dielectric. Determine the allowed modes of propagation and the cut-off frequency.

9. Explain: - Microwave measurements with respect to a voltage minimum are more accurate than at voltage maxima.

10. The channel capacity is given by, $C = B log_2\left(1 + \dfrac{S}{N}\right)$. In the presence of white Gaussian noise; with a constant signal power the channel capacity reaches its upper limit with increase in the bandwidth B. Find the upper limit of the channel capacity.

11. Verify the following expression: $0 \le H(X) \le log_2 m$, where m is the size of the alphabet of X.

12. An analog signal is expressed by $x_a(t) = 10Cos 50\pi t + 16 Sin 100\pi t + 10 Cos 400\pi t Cos 300\pi t$. If the signal is sampled at its Nyquist rate find sampled signal expression and the analog signal $y_a(t)$ that can be reconstruct from the samples.

13. A signal $A Sin\omega_m t$ is input to a square-law device ($e_0 - e_{m2}$). The output of which is given to an FM modulator as the modulating signal. The frequency deviation characteristics of the FM modulator is f= f_c + Ke(t), where e(t) is the modulating signal and K is a constant. Determine the FM signal and frequency components in its spectrum.

14. The pulse rate in a DM system is 60,000 per sec. The input signal is 5 Cos (2p1000t) + 2 Cos (2p2000t) V, with t in sec. Find the minimum value of step size which will avoid slop overload error. What will happen if the step size is larger than the minimum step size?

15. A finite energy continuous time signal band limited to 3 MHz to 5 MHz is ideally sampled, encoded by a fixed length PCM coder and then transmitted over a digital channel of capacity 7 Mbps. The probability density function (PDF) at the output of the sampler is uniform over the range -2V to 2V.
    (a) Determine the minimum sampling rate necessary for perfect reconstruction.
    (b) Determine the maximum SNR (dB) that can be achieved.

16. What is the physical significance of numerical aperture of the optical fiber? Derive a suitable expression showing its dependence on refractive indices of core and cladding of the fiber.

17. Calculate the apogee and perigee heights for the orbital parameters given as Eccentricity (e) = 0.00155, semi- major axis = 7195 km and earth radius (R) = 6371Km.

18. Determine the power received by a satellite located at 40000Km from the surface of the earth. Satellite is operating at 11GHz with a gain of 50.5 dB and Effective Isotropic Radiated Power (EIRP) of 21dBW.

19. Draw the timing diagram for IN instruction of Intel 8085 microprocessor.

20. Explain the instructions SIM and RIM. Write an instruction to enable the RST 7.5, RST 6.5 and disable RST 5.5.

* * * * * * *