UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

SECOND SEMESTER EXAMINATIONS, MAY 2019

COURSE NO: EL 376
COURSE NAME: BASIC COMMUNICATION SYSTEMS
CLASS: EL III **TIME:** 3 HOURS

Name**:** _____Index Number: _____

Attempt ALL questions in Section A and any TWO from Section B.
Answer both Sections in the Answer Booklet

SECTION A

1. Two key barriers to human communication are
   a. cost
   b. ignorance
   c. distance
   d. language
2. Which of the following is not an example of a channel based on guided communication?
   a. Telephone channel
   b. Satellite channel
   c. Coaxial cable
   d. Optical fibre
3. The communications medium causes the signal to be
   a. attenuated
   b. amplified
   c. interfered with
   d. modulated
4. The original electrical information signal to be transmitted is called the
   a. modulating signal
   b. baseband signal
   c. modulated signal
   d. carrier
5. The function of the output transducer in a communication system is to
   a. transmit the message signal
   b. convert message signal into electrical signal
   c. modulate the message signal
   d. convert electrical signal into message signal
6. The bandwidth used in TV broadcast system is
   a. 5 kHz
   b. 10 kHz
   c. 200 kHz
   d. 6 MHz
7. A frequency of 5.40 GHz has a wavelength of approximately
   a. 5.6 m
   b. 5.4 m
   c. 0.56 m
   d. 0.056 m
8. A telephone is.
   a. Simplex
   b. Full duplex
   c. Half-duplex
   d. Multiplex

9. The energy of a photon that has a wavelength of 0.45 m is _____ J.
   a. 2.2×10^{-26}
   b. 4.4×10^{-26}
   c. 2.2×10^{-25}
   d. 4.4×10^{-25}
10. The wavelength of light (Å) that has a frequency of 3.22×10^{14} Hz is
   a. 932
   b. 9320
   c. 9.32×10^{-6}
   d. 9.32×10^{-7}
11. The energy of a photon that has a frequency of $5.59 \times 10^{15}\ Hz$ is …….. J
   a. 5.6×10^{-18}
   b. 3.7×10^{-18}
   c. 5.4×10^{-8}
   d. 1.86×10^{7}
12. The frequency range of infrared rays is approximately
   a. 3 to 30 GHz
   b. 30 to 300 GHz
   c. 300 GHz to 300 THz
   d. 300 THz to 3000 THz
13. A wavelength of 15 cm could be expected in:
   a. VHF
   b. SHF
   c. UHF
   d. EHF
14. The standard digital form of Pulse Modulation is known as
   a. PCM
   b. PDM
   c. PPM
   d. PAM
15. Which of the following is NOT a need for modulation?
   a. Need for bandwidth
   b. Need for required antenna height
   c. Need for Multiplexing
   d. Need for higher frequency
16. Modulation reduces the size of antenna for higher frequencies with _____ frequency
   a. greater
   b. middle
   c. lower
   d. none of these
17. Continuous voice or video signals are referred to as being
   a. baseband
   b. analog
   c. digital
   d. continuous waves
18. The bandwidth of an SSB signal with a carrier frequency of 5.0 MHz and a modulating signal with a frequency range of 320 Hz to 4.5 kHz is
   a. 4999.68 kHz
   b. 4995.50 kHz
   c. 9.00 kHz
   d. 4.18 kHz
19. In AM, the modulation envelope has a peak value that is double the unmodulated carrier level, when the modulation is
   a. 100%
   b. 66.7%
   c. 50%
   d. 33.3%

20. In AM, the power carried by both sidebands is

a. $\frac{m^2}{4}$ times carrier power
b. $\frac{m^2}{2}$ times carrier power
c. m^2 times carrier power
d. $\left(1+\frac{m^2}{2}\right)$ times carrier power

21. In AM, the amplitude of the modulated carrier signal, A, is given by

a. $A = A_c$
b. $A = A_m + v_m$
c. $A = A_m + A_c$
d. $A = A_c + v_m$

22. For over-modulation in AM, the value of modulation index m is

a. $m < 1$
b. $m = 1$
c. $m \leq 1$
d. $m > 1$

23. Information in an AM signal is conveyed in the

a. carrier
b. sidebands
c. both carrier and sidebands
d. none of them

24. For 100 percent modulation, the total sideband power is _____ of the carrier power.

a. 33.3 percent
b. 50 percent
c. 66.7 percent
d. 150 percent

25. Which of the following is the most correct?

a. V_m should be greater than V_c
b. V_c should be greater than V_m
c. V_m should be less than or equal to V_c
d. V_c must always equal V_m

26. Which of the following is NOT another name for modulation index?

a. Modulation reciprocal
b. Modulation factor
c. Depth of modulation
d. Modulation coefficient

27. If $V_{max}$and V_{min} are the maximum and minimum voltages respectively, displayed on an oscilloscope, then modulating amplitude, A_m is given by

a. $A_m = \frac{V_{max}-V_{min}}{2}$
b. $A_m = \frac{V_{max}+V_{min}}{V_{max}-V_{min}}$
c. $A_m = \frac{V_{max}+V_{min}}{2}$
d. $A_m = \frac{V_{max}-V_{min}}{V_{max}+V_{min}}$

28. The total bandwidth needed for an AM signal at 5.5 MHz with 0.07 MHz video modulation is

a. 0.14 MHz
b. 0.35 MHz
c. 1.4 MHz
d. 5.57 MHz

29. When m_1, m_2, m_3 etc. are the simultaneous modulation index, then the total modulating index, ${m_t}^2$ is

a. $= \sqrt{{m_1}^2 + {m_2}^2 + {m_3}^2 + \cdots}$
b. $= {m_1}^2 + {m_2}^2 + {m_3}^2 + \cdots$

c. $= \sqrt{m_1 + m_2 + m_3 + \cdots}$

d. $= m_1 + m_2 + m_3 + \cdots$

30. The ability of a receiver to pick up weak signals.

a. Sensitivity

c. Selectivity

b. S/N ratio

d. Gain

31. The ratio of the total power in amplitude modulated wave to the unmodulated carrier power is given by

a. $\frac{P_t}{P_c} = 1 + \frac{m}{2}$

c. $\frac{P_t}{P_c} = \sqrt{1 + \frac{m^2}{2}}$

b. $\frac{P_t}{P_c} = 1 + \frac{m^2}{2}$

d. $\frac{P_t}{P_c} = \sqrt{1 + m^2}$

32. All these represent the equation of the standard AM except

a. $V(t) = A_c[1 + m\sin\omega_m t]Sin\omega_c t$

c. $V(t) = A_c Sin\omega_c t + mA_c \sin\omega_m t Sin\omega_c t$

b. $V(t) = [A_c + A_m \sin\omega_m t]Sin\omega_c t$

d. $V(t) = A_c Sin\omega_c t + mA_m \sin\omega_m t Sin\omega_c t$

Preamble 1: *Use the following preamble to answer questions 33 to 36.*

A transmitter radiates 9 kW power with the carrier unmodulated and 10.125 kW when the carrier is sinusoidally modulated.

33. The modulation index will be

a. 40%

c. 50%

b. 44%

d. 66%

34. The power in one sideband is

a. 0.125 W

c. 0.250 W

b. 0.5625 W

d. 1.125W

35. If another sine wave, corresponding to 40% modulation is transmitted simultaneously, determine the total modulation index

a. 41%

c. 64%

b. 45%

d. 90%

36. Following from Q. 35 above, what is the total radiated power?

a. 9.4 kW

c. 10.42 kW

b. 10 kW

d. 10.84 kW

Preamble 2: Use the following preamble to answer questions 37 and 38.

In amplitude modulation, the carrier and the modulating voltages are given by $e_c = E_c \sin\omega_c t$

and $e_m = E_m \sin \omega_m t$ respectively.

37. The modulation index is

a. $\frac{e_m}{e_c}$

b. $\frac{E_m}{E_c}$

c. $\frac{E_c}{E_m}$

d. $\frac{e_c}{e_m}$

38. The amplitude of the AM voltage will be

a. $A = e_c(1 + m \sin \omega_m t)$

b. $A = E_c(1 + m \sin \omega_m t)$

c. $A = E_m(1 + m \sin \omega_m t)$

d. $A = E_m(1 + m \sin \omega_m t)$

39. Given an AM radio signal with a bandwidth of 40 kHz and the highest-frequency component at 600 kHz, what is the frequency of the carrier signal?

a. 560 kHz

b. 580 kHz

c. 620 kHz

d. 640 kHz

40. A carrier of 10 MHz is modulated by a 5 kHz sine wave. The LSB and USB are respectively

a. 5 kHz and 10.5 MHz

b. 9995 and 1005 kHz

c. 9995 and 10005 kHz

d. 9.95 MHz and 10.05 MHz

41. In AM, for frequency spectrum plot, the vertical axis is a measure of _____.

a. amplitude

b. frequency

c. phase

d. time

42. The circuit that recovers the original modulating information from an FM signal is known as

a. detector

b. mixer

c. modulator

d. antenna

43. In FM, the frequency deviation is

a. constant

b. proportional to modulating frequency

c. zero

d. proportional to amplitude of modulating signal

44. What is the bandwidth of a signal that ranges from 5 kHz to 5 MHz?

a. 495 kHz

b. 4500 kHz

c. 4.95 MHz

d. 4.995 MHz

45. In frequency modulation, amplitude of the modulating signal is

a. zero

b. one

c. constant

d. variable

46. In FM modulation, when the modulation index increases, transmitted power is

a. zero

b. constant

c. increased
d. decreased

47. If the amplitude of the modulating signal decreases, the carrier deviation
    a. increases
    c. remains constant
    b. decreases
    d. goes to zero

48. What is the relative amplitude of the fourth pair of sidebands of an FM signal with m = 4?
    a. – 0.4
    c. 0.28
    b. 0.36
    d. 0.39

49. In frequency modulation, frequency of the carrier signal is
    a. zero
    c. constant
    b. one
    d. variable

50. AM and FM are examples of _____ modulation
    a. analog-to-analog
    c. digital-to-analog
    b. analog-to-digital
    d. digital-to-digital

51. As FM sidebands get farther from the centre frequency their power _____.
    a. remains constant
    c. decreases
    b. increases
    d. Answer

52. In FM broadcast, the maximum modulation frequency is
    a. 5 kHz
    c. 15 kHz
    b. 10 kHz
    d. 20 kHz

53. In FM, the significant side bands converge with increased frequency.
    a. True
    b. False

54. In FM, if the frequency of the modulating voltage is doubled, the maximum frequency deviation
    a. doubles
    c. becomes four times
    b. becomes half
    d. remains unchanged

55. In FM, the modulation index is proportional to
    a. ω_m
    c. ${\omega_m}^2$
    b. $\frac{1}{\omega_m}$
    d. $\frac{1}{{\omega_m}^2}$

56. In FM, if the amplitude of the modulated voltage is doubled, the rate of deviation of carrier frequency
    a. doubles
    c. becomes four times
    b. becomes half
    d. remains unchanged

57. In FM, noise

a. decrease by increasing deviation
b. decrease by decreasing deviation
c. decrease with constant deviation
d. is not affected by deviation

Preamble 3: Use the following preamble to answer questions 58 to 61.

In FM system when the audio frequency, (AF) is 3000 Hz and the voltage of the AF is 3.5 V, the deviation is 21 kHz.

58. If a change in AF voltage causes the deviation to increase to 33 kHz, the new AF voltage is
    a. 3.5 V
    b. 5.5 V
    c. 6 V
    d. 198 V
59. The modulation index (in reference to Q58) will be
    a. 3
    b. 7
    c. 11
    d. 1.6
60. If AF voltage is raised to 7.5 V while the AF is dropped to 2500 Hz, the deviation will be
    a. 3 kHz
    b. 30 kHz
    c. 45 kHz
    d. 75 kHz
61. The modulation index in this case is
    a. 18
    b. 15
    c. 11
    d. 7
62. For an FM wave, the modulating frequency is 10 kHz and bandwidth is 2 MHz. If the modulating signal amplitude is doubled, the bandwidth will be
    a. 0.5 MHz
    b. 1 MHz
    c. 2 MHz
    d. 4 MHz
63. FM broadcast band lies in
    a. UHF
    b. VHF
    c. HF
    d. MF
64. Digital systems
    a. do not provide a continuous set of values
    b. represent values as discrete steps
    c. can utilise decimal or binary systems
    d. all of them
65. In _____, the frequency of the carrier signal is varied to create signal elements. Both amplitude and phase remain constant.
    a. OOK
    b. MSK
    c. PRK
    d. QAM
66. Which modulation technique involves tribits and two amplitudes?

a. 4-PSK
c. 8-PSK
b. 4-QAM
d. 8-QAM

67. The constellation diagram of BPSK has _____ dots.

a. 2
c. 8
b. 4
d. 16

68. Which of these is a baseband signal?

a. AFSK
c. ASK
b. FSK
d. MSK

69. In a hexabit modulation the number of points in the constellation is_____.

a. 6
c. 32
b. 16
d. 64

70. If the bit rate for a PRK signal is 2400 bps, the baud rate is _____.

a. 600
c. 2400
b. 1200
d. 4800

71. If the baud rate is 1400 for a 128-QAM signal, the bit rate is _____ bps.

a. 200
c. 9800
b. 1400
d. 179200

72. PRK is an example of _____.

a. ASK
c. FSK
b. PSK
d. Digital-to-digital modulation

73. Which of the following is most affected by noise?

a. ASK
c. OOK
b. AM
d. FSK

74. In 16-QAM, the angles are usually out of phase by_____ degrees.

a. 22.5
c. 90
b. 45
d. 180

75. The _____ is the number of signal units sent in one second.

a. Bit rate
c. Baud rate
b. Signal time
d. Bit time

76. A digital signal has a bit rate of 400 bps. The bit interval is _____ seconds.

a. 0.0025
c. 200
b. 0.005
d. 400

77. How many carrier frequencies are used in QPSK?

a. 0
b. 1
c. 2
d. 4

78. In QAM, _____ of a carrier signal is/are varied.

a. both frequency and amplitude
b. both frequency and phase
c. both amplitude and phase
d. only phase

79. The kind of filter that can be used to select a signal of one particular radio station is

a. low-pass
b. band-pass
c. high-pass
d. band-stop

80. The figure-of-merit of a band-pass filter depends on

a. only the centre frequency
b. centre frequency and bandwidth
c. only the bandwidth
d. the critical frequencies

SECTION B

Question 1

(a) Explain with the aid of a diagram a Bandstop filter **(3 marks)**

(b) The standard FM broadcast band has frequency range of 88 to 108 MHz. Stations are spaced every 200 kHz. The maximum permitted deviation is 75 kHz, with modulating frequencies up to 15 kHz. Compute the bandwidth of an FM station using the two methods and then discuss how that bandwidth compares with the channel spacing. (**9 marks)**

(c) The antenna current of an AM broadcast transmitter modulated to a depth of 60% by an audio sine wave is 12 A. It increases to 13.5 A as a result of simultaneous modulation by another audio sine wave. What is the modulation index due to this second wave?

(**7 marks)**

(d) Sketch the QPSK waveform for the sequence 110 0 1 1 1 0 0 0 0 1, assuming the carrier frequency to be equal to the bit rate. **(6 marks)**

Question 2

(a) What is noise? Give any two examples of noise **(3 marks)**

(b) Give three (3) reasons why there is the need for modulation in communication system. **(3 marks)**

(c) A carrier of frequency 10^6 Hz and amplitude 3 V is frequency modulated by a sinusoidal modulating signal of frequency 500 Hz and peak amplitude 1 V. As a result, the frequency deviation is 1 kHz.

(i) Write the equation for the FM signal.

(ii) Determine the bandwidth for the signal using both methods **(10 marks)**

(d) A 1–MHz carrier is simultaneously modulated with $75\ Hz, 900\ Hz\ and\ 1.25\ kHz$ audio waves. Determine the frequencies present in the output. **(9 marks)**

Question 3

(a) What is a constellation diagram? Draw the constellation diagram of 32 – PSK. **(4 marks)**

(b) What is frequency modulation? If $v = V_c \sin\theta$ and $M_f = \frac{\Delta f}{f_m}$, derive an expression for the instantaneous voltage of the FM signal. **(7 marks)**

(c) A 400 – W carrier is modulated on a depth of 75 percent; calculate the total power in the modulated wave in the following forms of AM:

(i) DSB-AM
(ii) DSBSC
(iii) SSBSC
(iv) SSBTC **8 marks**

(d) A photon has energy of 4.08×10^{-16} J.
Determine:

i. the frequency of the photon.
ii. its wavelength (in nm)
iii. the energy in eV **6 marks**

***Examiners: S. Ofori**/ Dr S. Nunoo*