ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2021
EXAMINATION CATEGORY: <u>TECHNICAL</u>

PAPER III: SUBJECT SPECIALISATION PAPER FOR ELECTRONICS AND COMMUNICATION ENGINEERING

Date   : October 31, 2021
Total Marks   : 100
Writing Time   : 150 minutes (2.5 hours)
Reading Time   : 15 minutes (prior to writing time)

GENERAL INSTRUCTIONS:

1. Write your Registration Number clearly and correctly on the Answer Booklet.

2. The first 15 minutes is to check the number of pages of Question Paper, printing errors, clarify doubts and to read the instructions. You are NOT permitted to write during this time.

3. This paper consists of **TWO SECTIONS**, namely SECTION A & SECTION B:

    - **SECTION A** has two parts: Part I - 30 Multiple Choice Questions

                  Part II - 4 Short Answer Questions

        All questions under SECTION A are COMPULSORY.

    - **SECTION B** consists of two Case Studies. Choose only **ONE** case study and answer the questions of your choice.

4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.

5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating the Section, Part and Question Number will NOT be evaluated and no marks will be awarded.

6. Begin each Section and Part in a fresh page of the Answer Booklet.

7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.

8. Use of any other paper including paper for rough work is not permitted.

9. **You must hand over the Answer Booklet to the Invigilator before leaving the examination hall.**

10. This paper has **9 printed pages**, including this instruction page.

GOOD LUCK

SECTION A

PART I: Multiple Choice Questions [30 marks]

Choose the correct answer and write down the letter of your chosen answer in the Answer Booklet against the question number e.g. 31 (d). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. MATLAB stands for:
   a) Matrix library
   b) Matrix laboratory
   c) Matric library
   d) Math library

2. The process of adding impurity to an intrinsic semiconductor is known as
   a) Doping
   b) Recombination
   c) Ionization
   d) Annihilation

3. Which of the following is not a Quality of Service (QoS) parameter?
   a) Delay
   b) Checksum
   c) Throughput
   d) Reliability

4. A permanent joint formed between two different optical fibers in the field is known as
   a) Fiber Connector
   b) Fiber Splice
   c) Fiber Attenuator
   d) Fiber Dispersion

5. For the truth table in the given figure, Y=

A	B	C	Y
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	0
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	0

   a) $A+B+C$

   b) $\bar{A}+BC$

   c) $\bar{A}$

   d) $\bar{B}$

6. Which of the following is done to convert a continuous time signal into discrete time signal?
   a) Modulating
   b) Sampling
   c) Differentiating
   d) Integrating

7. The received power is attenuated by a factor called
   a) Path loss
   b) Free space loss
   c) Path & free space loss
   d) None of the above

8. A rectangular pulse of width 2, amplitude 3 and centred around -1 can be expressed as
   a) 3u(t+2) - u(t)
   b) 3u(t+2) -3u(t)
   c) 3u(t-2) - 3u(t)
   d) 3u(t-2) - u(t)

9. Which of the following standards committee specifies Bluetooth and other Personal Area Networks (PAN)?
   a) IEEE 802.11b
   b) IEEE 802.11g
   c) IEEE 802.15
   d) IEEE 802.16

10. How is BJT used as a faster switch?
    a) By operating it in the saturation and cut-off region
    b) By Operating it in the active and cut-off region
    c) By using it in strong saturation
    d) By decreasing its ON resistance

11. OP-amp can amplify
    a) AC signal only
    b) DC signal only
    c) Both AC and DC signals
    d) Neither AC nor DC signals

12. The circuit in the given figure is a _____.
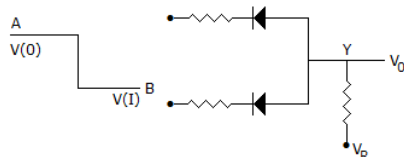
    a) positive logic OR gate
    b) negative logic OR gate
    c) positive logic AND gate
    d) None of the above

13. If a radio receiver amplifies all the signal frequencies equally well, it is said to have high
    a) Sensitivity
    b) Selectivity
    c) Distortion
    d) Fidelity

14. A counter type A/D converter contains a 4 bit binary ladder and a counter driven by a 2 MHz clock. Then conversion time is
    a) 8 μ sec
    b) 10 μ sec
    c) 2 μ sec
    d) 5 μ sec

15. The Earth area covered by a satellite radio beam is known as
    a) Beam width
    b) Band width
    c) Footprint
    d) Zone

16. Time division multiplexing is superior to Frequency division multiplexing because
    a) interchannel cross talk is avoided.
    b) circuitary required is digital.
    c) noise is absent.
    d) bandwidth requirement is reduced.

17. A system represented by its transfer function has some poles lying on the imaginary axis of the s-plane. The system is
    a) Absolutely stable
    b) Conditionally stable
    c) Marginally stable
    d) Unstable

18. When switch is closed, it has a total resistance of_____.
    a) Infinity
    b) zero
    c) 1000 Ohms at room temperature
    d) None of the above

19. The Nyquist Frequency of the signal $x(t) = 3\cos 50\pi t + 10 \sin 300\pi t - \cos 100\pi t$ is
    a) 50 Hz
    b) 100 Hz
    c) 200 Hz
    d) 300 Hz

20. Which of the following is the main advantage of microwave?
    a) Highly directive
    b) Moves at the speed of light
    c) Greater S/N ratio
    d) High penetration power

21. Term that is used for stationary or mobile wireless station and also have optional central base station is called
    a) Point to point
    b) Multi point
    c) Access Point
    d) Network Point

22. In microwave circuit, Wage Guide section will act as a
    a) Low Pass Filter
    b) Band Pass Filter
    c) High Pass Filter
    d) Band Reject Filter

23. Which of the following equation relates transmit power, antenna gains, distance and wavelength to received power?
    a) Shannon transmission equation
    b) Friis Transmission Equation
    c) Faraday's radiation Equation
    d) Polarization Equation

24. Find out the Transfer function for the closed loop control system given below:
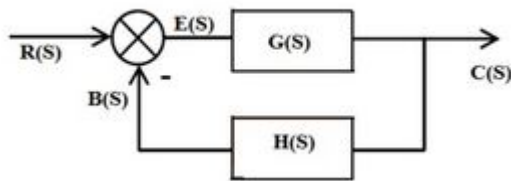
    a) G(s)/(1+G(s)*H(s))
    b) G(s)/(1-G(s)*H(s))
    c) G(s)+H(s)
    d) G(s)-H(s)

25. OP-amp have become very popular in industry mainly because
    a) they are dirt cheap.
    b) their external characteristics can be changed to suit any application.
    c) of their extremely small size.
    d) they are available in different packages.

26. Television transmission is an example of which type of transmission?
    a) Simplex
    b) Duplex
    c) Half duplex
    d) Half simplex

27. What does ALU which carries arithmetic and logic operations process?
    a) Binary coded decimal numbers
    b) Hexadecimal numbers
    c) Octal numbers
    d) Binary numbers

28. The current of an electric circuit is analogous to _____ parameter of a magnetic circuit.
    a) Flux density
    b) Flux
    c) Reluctivity
    d) Mmf

29. What type of diode is capable of both amplification and oscillation?
    a) Junction diode
    b) Tunnel diode
    c) Point contact diode
    d) Zener diode

30. Routers work at the _____ layer of the OSI model to connect networks of the same or different topologies.
    a) transport
    b) network
    c) datalink
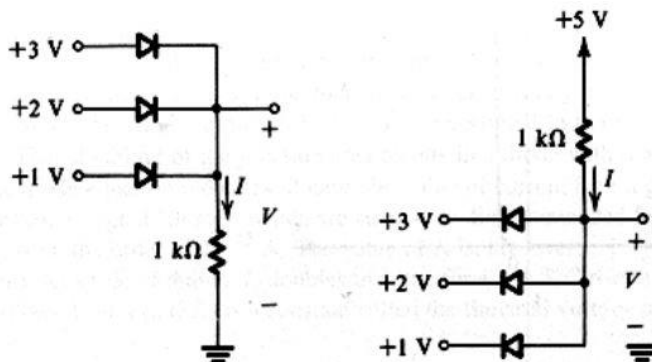   d) session

PART II – Short Answer Questions [20 marks]

This part has 4 Short Answer Questions. Answer ALL the questions. Each question carries 5 marks.

Question 1

What is CDMA and GSM? Explain the difference between CDMA and GSM. (5 marks)

Question 2

a) Find *V* and *I* for the circuits in the following figures. Assume that the diodes has a voltage of 0.7V
(3 marks)

b) State difference between Diode and transistor. (2 marks)

Question 3

a) There is a perception that wireless and radio technologies consume more power. Is this perception true? Explain your answer and state under what conditions the power requirements vary? (3 marks)

b) Define the followings in regard to the communication system. (2 marks)
   - Data throughput
   - Latency

Question 4

A compact disc (CD) records audio signals digitally by using PCM. Assume the audio signal bandwidth to be 15 KHz.

a) What is the Nyquist rate? (1 mark)

b) If the Nyquist samples are quantized into L=65,536 levels and then binary coded, determine the number of binary digits required to encode a sample. (1 mark)

c) Determine the number of binary digits per second (bits/s) required to encode the audio signal.

(1 mark)

d) For practical reasons, the signals are sampled at a rate well above the Nyquist rate. Practical CDs use 44,100 samples per second. If L= 65,536, determine the number of bits per second required to encode the signal, and the minimum bandwidth required to transmit the encoded signal. (2 marks)

SECTION B: **Case Study (50 marks)**

Choose either CASE I OR CASE II from this section. Each case study carries 50 marks.

CASE I

The VHF radio communication is used as primary means of communication between Pilots and Air Traffic Controllers (ATC) to exchange critical flight and weather information. For Lingshi Airport, the VHF radios are installed in the airport tower located in the valley surrounded by mountains. The radio range is found to be very poor especially while communicating with pilots in radius more than 15 Km.

Experts have recommended Airport Authority to extend the radio range beyond 15 Km for the safety of aircraft. The radio range can be extended only through establishment of remote radio stations located somewhere within 15 Km radius from airport. The separate VHF radio equipment using same frequency can be installed at remote station and the remote station can be connected to airport tower through microwave link.

You are working with airport as a Radio Communication Engineer. With regard to the aforementioned case, your manager has asked you to prepare a response to the following questions:

1. Why is the range of VHF radios installed at the airport tower poor when aircraft is flying outside 15 Km radius? (1 mark)

2. Explain VHF and LoS. How are they related? List down at least 2 differences between VHF and HF. (4 marks)

3. Microwave radio link technology is used for point to point connection between airport and remote station to improve the radio communication range. In this connection, please answer the following:

   a) What is microwave communication link? (1 mark)

   b) What are the major elements in the microwave communication link? Explain the working of microwave communication link with the help of a diagram. (7 marks)

   c) List down at least 6 factors to consider while designing and constructing microwave link?
   (3 marks)

   d) List down 4 applications of microwave link. (2 marks)

   e) Why is Microwave link considered as Line of Sight technology? (2 marks)

4. Amplitude Modulation or AM is used in the VHF radio communication technology. Answer the followings with regard to the AM.

   a) Define modulation? What is the need for modulation? (3 marks)

   b) What is AM? Explain AM with the help of sketches. What are different types of AM?
   (5 marks)

   c) How is AM different from FM or Frequency Modulation? List down three advantages and disadvantages of AM. (4 marks)

   d) Why carrier waves are of higher frequency compared to modulating signal? (1 mark)

   e) Why is the amplitude of the modulating signal kept less than the amplitude of the carrier wave?
   (1 mark)

   f) What is demodulation? Explain the detection of AM signals using Envelope Detector. List down 2 advantage and disadvantages of Envelope detector. (7 marks)

   g) What is modulation index? What happens if mu>1? (2 marks)

   h) If a modulating signal m(t)=10cos(2π×1,000t) is amplitude modulated with a carrier signal c(t)=50cos(2π×100,000t). calculate the following: (5 marks)
      i. the modulation index
      ii. frequencies of the modulated signal
      iii. bandwidth
      iv. the carrier power, assume value of R as 1 ohm.
      v. the power required for transmitting AM wave

5. Propose a redundancy for VHF radio communication for ATC-Pilot communication. Why did you propose this communication system or technology as a redundancy? (2 marks)

CASE II

Thimphu city is planning to introduce system called 'City Bus Information System' to provide bus information such as routes and travel time to passengers. The automatic bus information display will help passengers see where their respective buses are on its way from the display screens on designated bus stations and also by using smart phones on real-time basis. This system can potentially reduce the uncertainty associated with public transport trips and improve the overall level of city bus service in Thimphu.

If you are hired to develop comprehensive proposal to design "City Bus Information System", how would you do? Which technology would you use and why? Your proposal should include block diagram of the system with clear explanation of its working methodology, technical details of the proposed system, proposed display information format, use of GPS data and Google map, etc. You may include as many technical details as you can. (50 marks)

TASHI DELEK