# KHULNA UNIVERSITY OF ENGINEERING &TECHNOLOGY

B.Sc. Engineering 3rd Year 2nd Term Examination, 2018

Department of Electronics and Communication Engineering

ECE 3201

(Information Theory)

TIME: 3 hours FULL MARKS: 210

N.B. i) Answer **ANY THREE** questions from each section in separate scripts.

ii) Figures in the right margin indicate full marks.

## SECTION A

(Answer **ANY THREE** questions from this section in Script A)

1. a) Write down two key factors for transmission of information. What is the relationship between them? Why they are important for a modern communication system? (4+2+4)

   b) "The greater the uncertainty of a message, the more of information it carries"-Justify the statements. (10)

   c) Consider a two-hop satellite channel as shown in Fig 1(c) along with transition probabilities. Find its channel capacity. (15)

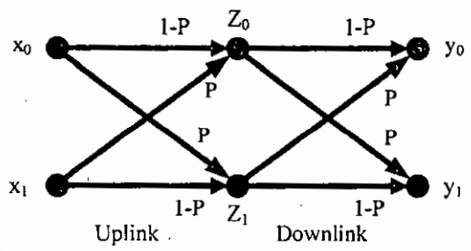


Fig. 1(c) Tow hop satellite channel.

2. a) Show that the entropy is maximum when all the symbols are equiprobable. (06)

   b) Why diversity is important for transmission and reception of information. Explain three diversity techniques for a modern communication system. (04+06)

   c) Prove that the mutual information of a channel is symmetric. (10)

   d) An analog signal is bandlimited to BHZ, sampled at a Nyquist rate, and the samples are quantized into 4 levels. The quantization levels $Q_1, Q_2, Q_3$, and $Q_4$ (messages) are assumed independent and occur with probabilities $P_1 = P_4 = {}^1/_8$ and $P_2 = P_3 = {}^3/_8$. Find the entropy and information rate of the source. (04+05)

3. a) How can you optimize power allocation for parallel Gaussian channels? Interpret the result from the communication engineering point of view. (06+06)

   b) "Feedback cannot increase the capacity of the discrete memoryless channel"-Justify the statement. (11)

   c) Assume that a sender X is sending to two fixed base stations. Assume that the sender sends a signal X that is constrained to have average power P and the receive signals $Y_1$ and $Y_2$ are given by: (12)

$$Y_1 = \alpha_1 X + Z_1$$
$$Y_2 = \alpha_2 X + Z_2$$

   where $Z_1 \sim N(0, N_1)$, $Z_2 \sim N(0, N_2)$ and $Z_1$ and $Z_2$ are independent, $\alpha_i$ is the constant over transmitted block.

4. a) From the modern communication system block diagram, find the instantaneous received SNR and capacity of the band-limited Gaussian channel. (6+4+4)

   b) Explain water-filling algorithm from the communication engineering point of view. (09)

   c) Consider the Markov Chain shown in Fig. 4(c); (i) Is this chain irreducible? (ii) Is this chain aperiodic? and, (iii) Find the stationary distribution for this chain. (12)

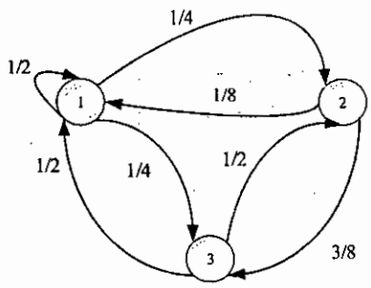


Fig. 4(c)

## SECTION B

(Answer **ANY THREE** questions from this section in Script B)

5. a) What are the key differences between channel and source coding? (06)

   b) Define the following terms: (09)

   (i) Leaf entropy, (ii) Path length lemma, (iii) Branching entropy.

   c) What is coding efficiency? Show that the coding efficiency is maximum when $P(0) = P(1)$. (10)

   d) Design binary Huffman code for the random message U with the probabilities $P_1 = 0.4$, $P_2 = 0.1$, $P_3 = 0.1$, $P_4 = 0.1$, $P_5 = 0.1$, $P_6 = 0.1$, $P_7 = 0.1$, and also compute their performance. (10)

6. a) Define Block-to-variable length and variable length-to-Block coding of a DMS. What are the disadvantages of Block-to-variable length coding. (06+04)

   b) Construct the first and second Elias codes for the positive integers extend from 1 to 10. (12)

   c) Consider a ternary DMS that emits an independent and identically distributed (IID) sequence of ternary random messages with the following probabilities: (13)

   $$P(a) = 0.5,\ P(b) = 0.3 \text{ and },\ P(c) = 0.2$$

   The encoded source symbols are based on an arithmetic code of block length $M = 3$. Determine the decoded source sequence if the first couple of digits of the received sequence are as follows: 10001110100....

7. a) Why LDPC is called the low-density parity check code? Why LDPC is widely used for modern communication systems? (10)

   b) Assume a binary source ($r = 2$) and a parser producing block message of length $M = 2$. Then we have $2^2 = 4$ messages {00, 01, 10, 11} at the input of the recency rank calculator. Suppose that the sequence of past messages before time K is: (13)

   $$\ldots|V_{k-4}|V_{k-3}|V_{k-2}|V_{k-2}|Now = \cdots|11|00|11|10|01|11|01|01|Now$$

   Compute the recency rank list in the tabular form. Also express the rank values in second Elias code.

   c) Consider a binary source $U_k \in \{A, B\}$, the window size $w = 4$, $l_{max} = 8$, $D = 2$. Design LZ-77 codes for the source that produces the following sequences: (12)

   ABBABBABBBAABABA

8. a) Draw and explain a typical block diagram of a turbo decoder. (10)

   b) Does Viterbi algorithm avoid exhaustive search in convolutional codes? Explain. (05)

   c) Consider a binary linear convolution code described by the following generator matrix (20)

   $$G = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

   i. Draw the state transition diagram for this code.

   ii. Assume that 3 information bits followed by 2 zero bits are transmitted. Suppose that the received signals are given by $(0.1, -0.4, -0.2,\ 0.3, 0.2, -0.4,\ 0.1, 0.4, -0.2,\ 0.1, -0.1, 0.3,\ 0.2, -0.1, -0.3)$. Use the Viterbi algorithm to perform soft decision decoding of this received sequences. Identify the 3 information bits.

# KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B.Sc. Engineering 3rd Year 2nd Term Examination, 2018
Department of Electronics and Communication Engineering
ECE 3203
(Digital Signal Processing)

TIME: 3 hours FULL MARKS: 210

N.B. i) Answer **ANY THREE** questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.

## SECTION A

(Answer **ANY THREE** questions from this section in Script A)

1. a) What are meant by correlation & convolution? Determine the circular correlation & linear convolution values of the two sequences, $x(n) = \{2, 2, 4, 4\}$ & $h(n) = \{1, 1, 2, 2\}$ (08)

   b) What are the 'twiddle factors' of DFT? What properties of them are exploited to reduce computational complexity of DFT? Briefly explain the computational efficiency of FFT over DFT. (10)

   c) State Parseval's theorem. Determine the DFT of the sequence: (10)

$$x(n) = \begin{cases} 1/5, & for -1 \le n \le 1 \\ 0, & otherwise \end{cases}$$

   d) What are the differences between FIR and IIR filters? What are the advantages of FIR over IIR filters? (07)

2. a) Determine the DFT (8-point) for a continuous time signal, $x(t) = \sin(2\pi ft)$ with $f = 100Hz$. Using DIF-FFT algorithm. (13)

   b) What is "Gibb's phenomenon"? Which technique can be applied to reduces the undesirable effect from "Gibb's phenomenon"? Explain with necessary diagram. (10)

   c) What are the problems involved in implementing Fourier series method of FIR filter design? Use Fourier series method to design a high-pass filter to approximate the ideal specification given by (12)

$$H_d(e^{j\omega}) = \begin{cases} 0, & for\ |f| \le f_p \\ 1, & for\ f_p \le |f| \le F/2 \end{cases}$$

3. a) What is window technique of FIR filtering? Obtain the frequency-domain characteristic of rectangular window and compare the frequency domain characteristics among the different windows. (12)

   b) A low-pass filter with passband gain of unity, cut-off frequency of 850Hz and at a sampling frequency of F=5000Hz, the length of the impulse response should be 5. Use Hanning window to design this FIR digital filter. (08)

   c) In what way Kaiser window is superior to other window functions? Explain the design procedures of an FIR high-pass filter using Kaiser window. (10)

   d) What are meant by equiripple & extra-ripple filters? Which method is applied for designing such filters? (05)

4. a) What are meant by quality factor and variability of any estimator? (04)

   b) Suppose we have N=1000 samples from a sample sequence of a random process. Determine the frequency resolution of Welch (50% overlap) method and Blackman-Tuckey method. (06)

c) What are the basics of AR, MA and ARMA models for power spectrum estimation? (07)

d) What is frequency resolution? In terms of frequency resolution, which non-parametric method is the most efficient? Explain the bias, consistency & quality factor of that method. (10)

e) Compute the autocorrelation and power spectral density of the signal: $x(t) = K\cos(2\pi f_c t + \varphi)$. (08)

## SECTION B

(Answer **ANY THREE** questions from this section in Script B)

5. a) What is digital signal processing (DSP)? Why do we need DSP? Write down the advantages and disadvantages of DSP. (12)

b) State sampling theorem. Classify practical DSP methods and also mention some of their name. (07)

c) A prototype low-pass filter has the system's response: $H(s) = \frac{1}{s^2+2s+1}$. Obtain a band pass filter with $\Omega_0 = 2\frac{rad}{s}, Q = 10, \Omega_0^2 = \Omega_1.\Omega_2$ and $Q = \frac{\Omega_0}{\Omega_2 - \Omega_1}$. (11)

d) Draw the block diagram of a typical DSP chip. (05)

6. a) What are recursive & non-recursive filter? (08)

b) Define canonic and non-canonic digital filters. What are the advantages of representing systems in block diagram. (08)

c) A filter has transfer function as follows: (15)

$$H(z) = \frac{1 + \frac{1}{4}z^{-1}}{\left(1 + \frac{1}{2}z^{-1}\right)\left(1 + \frac{1}{2}z^{-1} + \frac{1}{4}z^{-2}\right)}$$

i. Draw the canonic realization form of H(z).
ii. Draw the parallel form realization of H(z).

d) What are rounding and truncation errors in DSP? (04)

7. a) What is STFT? What are the drawbacks of STFT? (05)

b) The output of an A/D converter is applied to a digital filter with the system function, $H(z) = \frac{0.5z}{z-0.5}$. Find the output noise from the digital filter when the input signal quantized to have eight bits. (10)

c) For the analog transfer function $H(s) = \frac{1}{(s+1)(s+2)}$, determine H(z) using impulse invariant technique. Assume T = 1s. (10)

d) What is MRA? How can it be use to solve resolution problem? Explain with necessary diagrams. (10)

8. a) Design a Band-pass filter using pole-zero placement method with (10)

i. Center frequency at $\Omega_0 = \frac{\pi}{2}$;
ii. A bandwidth of $\Omega_{BW} = \frac{\pi}{8}$;
iii. Complete attenuation at $\Omega_{r_1} = 0$ and $\Omega_{r_2} = \pi$ ;
iv. Double pass-band gain.

b) Define DWT & CWT. Also write the procedural steps to compute CWT. (10)

c) Design a digital Butterworth filter that satisfies the following constraint using bilinear transformations. Assume T = 1s. (15)

$$0.9 \le \left|H(e^{j\omega})\right| \le 1, \qquad 0 \le \omega \le \pi/2$$

$$\left|H(e^{j\omega})\right| \le 0.2, \qquad 3\pi/4 \le \omega \le \pi$$

# KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B.Sc. Engineering 3rd Year 2nd Term Examination, 2018

Department of Electronics and Communication Engineering

ECE 3205

(Digital Communications)

TIME: 3 hours FULL MARKS: 210

N.B. i) Answer **ANY THREE** questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.

## SECTION A

(Answer **ANY THREE** questions from this section in Script A)

1. a) Briefly illustrate a digital communication system with aid of its fundamental block diagram. List the advantages and disadvantages of digital communication over analog counterpart. (09)

   b) State and prove the sampling theorem. What are the practical difficulties in sampling process and how to overcome the problems? (11)

   c) Why and how does the channel bandwidth limit the data rate? Why does bandwidth affect the shape of a digital signal? Explain clearly. (06)

   d) A band limited signal is express as $10 + 5\sin 10 \times 10^6 \pi t$ , (i) What will be the required channel bandwidth to transmit this signal considering noise free? (ii) Estimate thermal noise level of this channel when operated at $30°C$. (iii) What signal power is required to achieve the capacity of 50Mbps in this channel at $30°C$. (09)

2. a) What are the sources of noise in PCM system? Show that the output signal to noise ratio in a system can be expresses as $\frac{S_0}{N_0} = \frac{3(2^{2n})}{1+4P_e(2^{2n}-1)}\left(\frac{\tilde{m}^2}{m_p^2}\right)$, where the symbols have their usual meanings. (12)

   b) Explain the function of a compandar to improve the performance of PCM systems. (05)

   c) What is an eye pattern? With an ideal eye pattern, illustrate what useful information's you can extract from the eye pattern? (08)

   d) In PCM system, the bit error rate is $10^{-4}$. Assume that the peak signal to noise ratio on the recovered analog signals needs to be at least 30dB. (i) Find the minimum number of quantizing steps that can be used to encode the analog signal into a PCM signal. (ii) If the original analog signal had an absolute bandwidth of 2.7KHz, what is the null bandwidth of PCM signal for polar NRZ signaling case. (10)

3. a) Briefly illustrate the DPCM process with the aid of block diagram. Also explain the technique of signal prediction in this process. (10)

   b) With appropriate block diagram, discuss about the principle of Delta modulation. State the advantages of DM, and then compare the performance of DM with PCM. (10)

   c) What is line coding? What are the properties of a line coding? (05)

   d) In a single-integration DM system, the voice signal is sampled at a rate of 64 kHz. The maximum signal amplitude $A_{max} = 1$. (i) Determine the minimum value of the step size to avoid slope overload, (ii) Determine the granular noise power if the voice signal bandwidth is 3.5KHz, (iii) Assume the voice signal is sinusoidal, determine the SNR and (iv) Determine the minimum transmission bandwidth. (10)

4. a) Briefly describe the synchronous and asynchronous transmission with their frame formats. (10)

b) Explain the Manchester and B8ZS coding formats with their advantages and disadvantages. (08)

c) Write a short note on CCITT recommended digital TDM hierarchy. What is pulse stuffing? (07)

d) What are the importance of frame synchronization at TDM system? Explain the two channel bit-interleaved TDM with pulse stuffing technique. (10)

## SECTION B

(Answer **ANY THREE** questions from this section in Script B)

5. a) Describe the phase shift keying modulation scheme. With proper diagram explain the operation of a balanced ring modulator. What are the advantages and disadvantages of Differential Binary Phase Shift Keying compared to BPSK. (3+4 +3= 10)

b) For an 8-PSK modulator with an input data equal to 10Mbps and a carrier frequency of 70MHz, (i) determine the minimum double-sided Nyquist bandwidth and the band rate. (ii) calculate the Nyquist bandwidth for BPSK and QPSK also, and (iii) there analyze how multilevel signaling effects the bandwidth requirements. (4+4 +3= 11)

c) Suppose the input bit sequence: 110110010101, for an 8-PSK modulator. (i) Draw the I bit. Q bit and C bit, (ii) Determine the number of distinct symbols generated, (iii) Determine the output phase sequence of the reference carrier $\sin \omega_c t$, and (iv) Draw the corresponding constellation diagram. (14)

6. a) How Quadrature Amplitude Modulation (QAM) reduces the likelihood of errors? For a quadbit input of $I = 1$, $I' = 0$, $Q = 1$,and $Q' = 0$, determine the output amplitude and phase for the 16-QAM modulator. (2+4 =6)

b) With proper mathematical modeling explain the multicarrier modulated (MCM) system. Why orthogonality of sub-carriers is important in MCM system? (5+3 =8)

c) Show the schematic representation of FFT/ IFFT based orthogonal frequency division multiplexing (OFDM). What is cyclic prefix and why adding cyclic prefix is necessary in OFDM? (6+4 =10)

d) Explain mathematically how phase change of $90^o$ is maintained in minimum shift keying (MSK) for each bit transition? What modifications of MSK leads to Gaussian-MSK (GMSK)? (8+3 =11)

7. a) Derive the expression of impulse response for a matched filter. Show that for maximization of output signal to noise ratio, the impulse is delayed and time reversed version of the input signal. (15)

b) Explain the coherent and non-coherent detection techniques. For a coherent QPSK receiver in the presence of additive white Gaussian noise, calculate the binary error probability ($P_b$). (10)

c) What is s spread spectrum system (SSS)? What can be gained from the apparent waste of spectrum in SSS? (10)

8. a) For an optimum binary receiver, show that the probability of bit error $P_b = Q\left(\sqrt{(E_p + E_q - 2E_{pq})/2N}\right)$, and the optimum threshold $a_0 = \frac{1}{2}(E_p - E_q)$, where the symbols have their usual meaning. (13)

b) For an optimum binary receiver, show that the probability of bit error for polar signaling is given by $P_b = \left(\frac{1}{2\sqrt{\pi E_b/N}}\right) e^{-E_b/N}$; $E_b/N \gg 1$. Hence, prove that On-OFF signaling requires twice as much energy per bit to achieve the same performance as polar signaling. (12)

c) Consider the input data sequences: 101100, and the spreading code corresponding to input data is 110 010 111 011 000 100. Draw the direct sequence spread spectrum signal using BPSK. (10)

# KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B. Sc. Engineering 3rd Year 2nd Term Examination, 2018

Department of Electronics and Communication Engineering

ECE-3207

(Antenna Engineering)

TIME: 3 hours FULL MARKS: 210

N.B. i) Figures in the right margin indicate full marks.
ii) Answer **ANY THREE** questions from each section in separate scripts.

## SECTION A

(Answer **ANY THREE** questions from this section in Script A)

1. a) Define antenna. Explain the principle on how antenna works as an electromagnetic radiator. 12
   b) The power radiated by a lossless antenna is 10 Watts. The directional characteristics of the antenna are represented by the radiation intensity of $U = B_0 \cos^3\theta$ (W/unit solid angle), $0 \le \theta \le \pi/2, 0 \le \phi \le 2\pi$. Find the i) maximum power density (Watts/m$^2$) at a distance of 1000 m, ii) directivity of the antenna, iii) gain of the antenna. 09
   c) An antenna has a field pattern given by $E(\theta) = \cos^2\theta$ for $0 \le \theta \le 90°$. Find the solid angle of this pattern. 06
   d) What do you mean by antenna efficiency and aperture efficiency of an antenna? 08

2. a) A $\lambda/2$ dipole, with a total loss resistance of 1 Ohm, is connected to a generator whose internal impedance is 50 + $j$25 Ohms. Assuming that the peak voltage of the generator is 2 V and the impedance of the dipole, excluding the loss resistance, is 73 + $j$42.5 Ohms. Find the power i) supplied by the source (real), ii) radiated by the antenna, and iii) dissipated by the antenna. 09
   b) Deduce the general expression of the effective area of an antenna. Reduce the expression under following conditions: 14
      i) The antenna is being polarization matched and
      ii) The antenna under test is matched to the load.
   c) Two spacecraft are separated by $10^8$ m. Each has an antenna with D = 1000 operating at 2.5 GHz. If craft A's receiver requires 20 dB over 1 pW, what transmitted power is required on craft B to achieve this signal level? 06
   d) What is meant by scattering area and capture area of an antenna. 06

3. a) Derive the expression of effective system noise temperature of antenna and receiver system. 10
   b) State and explain duality theorems in antenna engineering. 07
   c) State and explain the reciprocity in case of electromagnetic theory. 08
   d) Prove that the total radiation resistance of an infinitesimal dipole is $R_r = 80\pi^2(l/\lambda)^2$, where the symbols have their usual meanings. 10

4. a) Derive the expression of total radiated power of half wavelength dipole antenna. 10
   b) "A small electric loop can be replaced by a small linear magnetic dipole of constant current" – justify the statement. 08
   c) How can we increase the radiation resistance of a loop antenna. 07
   d) Find the radiation resistance of a single turn and a 6-turns small circular loop. The radius of the loop is $\lambda/25$ and the medium is free space. Also draw the equivalent circuit of loop antenna in transmitting mode. 10

## SECTION B

(Answer **ANY THREE** questions from this section in Script B)

5. a) What is meant by broadside array and end fire array ? 06
   b) What is minor lobe? Write down the disadvantages of minor lobe. 06
   c) Draw the radiation pattern for the following conditions of an antenna. 10
      i) Major lobe $\theta_{max} = 0°$ and 180°.
      ii) $(\theta_{mx})_{minor} = \pm 41.4°$ and $\pm 138.6°$, $\theta_{HPP} = \pm 60°$ and $\pm 120°$.
      iii) $(\theta_{min})_{minor} = \pm 60°$ and $\pm 120°$, $(\theta_{mx})_{minor} = \pm 75.5°$ and $\pm 104.5°$, when major lobe $\theta_{mx} = 90°$ and 270°.
      iv) Define which are satisfied for both cases.
   d) "Array of two point sources with equal amplitude and same phase satisfy the broadside array" – justify the statement. 13

6. a) "Unidirectional radiation pattern can be converted into bidirectional of Rhombic antenna" – justify the statement. 08
   b) Show that the input impedance at the terminals of a folded dipole antenna is equal to the square of number of conductors. 09
   c) Write down the equation of electromagnetic field of travelling wave antenna and draw its radiation pattern for different angles and amplitudes. Also write down its applications. 08
   d) Find out the value of flare angle and axial length of Horn antenna. Write down the applications of such antenna. 10

7. a) Describe the physical structure of Ferrite-Rod antenna and show that the value of maximum emf (V) = $\frac{2\pi}{\lambda} EANF\mu_r$, where the symbols have their usual meanings. 7+8
   b) What are the limitations of microstrip antenna? How can we overcome these limitations? 10
   c) Calculate the voltage induced in a loop antenna of 1 $m^2$ of 10 turns with its plane at 45° off the line of bearing of a distant station due to an incident magnetic field of strength of $10^{-7}$ $Wb/m^2$ at a wavelength of 100 m. 10

8. a) "Helical antenna sometimes acts as a loop antenna and sometimes acts as a short dipole antenna" – justify the statement. 08
   b) Show that the focal length $f = D/4 \cot \theta/2$ of parabolic reflector antenna, where the symbols have their usual meanings. 12
   c) Describe balance to unbalance transformation system for antenna. 07
   d) Calculate the effective length of a ferrite rod receiving antenna which has 120 turns wound on a 1.40 cm diameter ferrite rod with relative permeability of 160. Assume the length factor to be 0.75 and the frequency to be 1 MHz. 08

# KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B. Sc. Engineering 3rd Year 2nd Term Examination, 2018

Department of Electronics and Communication Engineering

CSE-3209

(Database System)

TIME: 3 hours FULL MARKS: 210

N.B. i) Figures in the right margin indicate full marks.
ii) Answer **ANY THREE** questions from each section in separate scripts.

## SECTION A

(Answer **ANY THREE** questions from this section in Script A)

1. a) Explain Instance and Schema in database management systems. 05
   b) Demonstrate the concept of participation of an entity set in a relationship set with proper diagram. 10
   c) How can you represent the entity set and relationship set? Explain with proper diagram. 08
   d) A university wants to set up a database to record details about its staff and the departments they belong to. They intend to record the following information. 12

   - For each member of staff, their staff identity number, name, job title and salary.
   - For each department, its name and address.
   - For each member of staff, all departments they belong to. It is required that every member of staff belongs to at least one department.
   - For each department, the head of the department. It is required that each department has exactly one head of department.

   Draw an ER diagram that expresses the requirements for the database. Make sure that you capture all the constraints on the data mentioned above.

2. a) Define query processing. Explain the basic steps of query processing with proper diagram. 12
   b) Demonstrate the concept of aggregation with an example. 05
   c) Explain the distinction between disjoint and overlapping constraints. 06
   d) Apply external sort-merge algorithm on the following data and compute total number of block transfers and seeks. (Consider, the number of blocks in the main memory buffer available for sorting = 3 and one block of data is read at a time from each run). 12

   5, 2, 1, 7, 12, 3, 8, 21, 19, 11, 22

3. a) Explain division operation in relational algebra. Write down an expression using division operation to find the names of students from the following tables who failed in all subjects. What will be the output of the expression? 10

Table: Students

| Name | Sub-Failed |
|---|---|
| Jacob | Politics |
| Jacob | Statistics |
| Lucas | Politics |
| Ryan | Statistics |

Table: Subjects

| Sub |
|---|
| Politics |
| Statistics |

   b) "Denormalization can be used to improve performance for specific applications" Justify the statement. 05
   c) Explain Functional Dependencies with example. 08
   d) Consider the following schema and answer the following queries using the concept of relational algebra operations. (12)

Student (SID, surname, firstname; email, cgpa)
Course (dept, cNum, cName)
Offering (oID, dept, cNum, term, instructor)
Took (SID, oID, marks, grade)

where, offering [dept, cNum] ⊆ Course [dept, cNum], Took [SID] ⊆ Student [SID], Took [oID] ⊆ offering [oID].

(i) SID number of all students who have taken CSE-3209.
(ii) SID number of all students who have taken CSE-3209 and earned an A+ in it.
(iii) SID number of all students who have earned some marks over 80 and some marks below 50.
(iv) Terms when CSE-3209 was not offered.
(v) Department and course number of courses that have never been offered.

4. a) Explain extraneous attributes with an example. 05
b) "BCNF decomposition is not always dependency preserving" - justify the statement. 08
c) Explain canonical cover. Consider the following set F of functional dependencies on schema (V, W, X, Y, Z): 12

$$V \rightarrow W, VW \rightarrow X, Y \rightarrow VXZ.$$

Compute the minimal canonical cover for F.
d) Here, FD set: {Stud_ID → Name, Stud_ID → City, City → Country, Stud_ID → Age}, Candidate key: {Stud_ID}. 10

Why the table violates 3rd normal form? Decompose the table into 3rd normal form.

## SECTION B

(Answer **ANY THREE** questions from this section in Script B)

5. a) What is multilevel indices? Give an example. 06
b) Write down the algorithms (insertion and deletion) for updating single level indices. 15
c) Define B+ tree. Construct B+ tree for the following data. 14

(3, 66, 8, 13, 9, 31, 26, 7, 51, 47, 99, 1, 77, 22) with N = 4.

Show each step for the tree construction.

6. a) What is meant by database administrator (DBA)? Discuss the roles of DBA. 08
b) "A secondary index must contain pointers to all the records" – justify the statement. 07
c) What is the working principle of Wait for Graph (WFG)? How can it be used to detect deadlock in transaction? Explain with proper example. 08
d) Write down the queries for the following relational database schema. 12

EMPLOYEE

| Name | Ssn | Bdate | Address | Sex | Salary | Dno |
|---|---|---|---|---|---|---|

DEPARTMENT

| Dnumber | Dname | Mgr_ssn | Dno |
|---|---|---|---|

Suppose all the relations were created by user X, who wants to grant the following privileges to user accounts A, B, C, D:

i) X wants to grant A the privilege to insert and delete tuples in both of these relations but A is not able to propagate the privileges to other users.
ii) X wants to allow B to retrieve information from either of two tables and also to be able to propagate the select privilege to other users.
iii) X wants to grant C the privilege to retrieve only the NAME, BDATE and ADDRESS attributes and only for the tuples with DNO = 5.
iv) X wants to allow D to update only the SALARY attribute of EMPLOYEE.

7. a) Define concurrency control. What are the potential problems caused by concurrency? Explain briefly. 08
b) What is cascading roll-back? Explain with example. How does two-phase locking protocol avoid cascading roll-back? 10

c) What is the two-phase locking? Refer to the following figure: 12

| Time | $T_1$ | $T_2$ | balx |
|---|---|---|---|
| $t_1$ | | begin_transaction | 100 |
| $t_2$ | | Read (balx) | 100 |
| $t_3$ | | balx = balx +100 | 100 |
| $t_4$ | begin_transaction | Write (balx) | 200 |
| $t_5$ | Read (balx) | : | 200 |
| $t_6$ | balx = balx -10 | rollback | 100 |
| $t_7$ | Write (balx) | | 190 |
| $t_8$ | commit | | 190 |

Which concurrency problem does it reflect? Solve the problem using 2-phase locking protocol.

d) Define exclusive lock and shared lock in case of concurrency control. 05

8. a) What results you may get if you try to update a table through a wrong view? What are the remedies? Briefly explain by creating a table, creating a view and by updating the table through the wrong view. 12

b) Consider the following Orders table: (12)

| O_ID | Order Price | Customer |
|---|---|---|
| 1 | 1000 | Hansen |
| 2 | 1600 | Nilsen |
| 3 | 700 | Hansen |
| 4 | 300 | Hansen |
| 5 | 2000 | Jensen |
| 6 | 100 | Nilsen |

Now what will be the output of the following queries:

i) Select Customer, SUM (Order Price) from Orders.
Group by Customer

ii) Select Customer, SUM (Order Price) from orders.

iii) Select Customer, SUM (Order Price) from orders.
Group by Customer having SUM (Order Price) < 2000.

iv) Select Customer, SUM (Order Price) from orders.
where Customer = 'Hansen' OR Customer = 'Jensen'
Group by Customer having SUM (Order Price) > 1700.

c) Consider a table called EMPLOYEE having the following columns and data type: (11)

EMP_ID varchar (10) primary key
Name varchar (10)
SALARY number
DESIGNATION varchar (10)

Now consider the following table.

| Salary | Designation |
|---|---|
| ≥ 70000 | Professor |
| ≥ 50000 and < 70000 | Associate Professor |
| ≥ 40000 and < 50000 | Assistant Professor |
| < 40000 | Lecturer |

Now create a trigger on EMPLOYEE table so that when you insert or update salary field the designation field should automatically be filled or updated.