KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B.Sc. Engineering 4th Year 1st Term Examination, 2019

Department of Electronics and Communication Engineering

ECE 4101

(VLSI Design and Nanotechnology)

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) State Moors laws. Explain the different scales of integration in microelectronics evolution. (10)
   b) What are the differences between semi-custom and full-custom VLSI design? Briefly explain the top down design hierarchy of full-custom VLSI design. (12)
   c) What are the advantages of lambda-based design rules? Draw the stick diagram and mask layout of an n-type pass transistor based 4x1 MUX following the design rules. (13)

2. a) What is the importance of two-phase clocking in VLSI memory design? Briefly explain the working of a logic gate based two-phase clock generator. (08)
   b) Design a basic static latch using nMOS logic and extent it to JK flip-flop to overcome the racing condition. Explain the working principle during this condition. (09)
   c) Define RAM. Draw and explain the general schematic of $2^n \times 1$ RAM including the internal diagram of memory element and coupling circuit. (13)
   d) Estimate the storing capacity of 3mm×3mm chip of typical one transistor RAM cells considering 2 μm technology. (05)

3. a) Write down the advantages of structural design approach. Design an n-line bus arbitration logic circuit using structured approach and explain its working principle. (13)
   b) Explain the following logic using suitable example: (12)
      i) BiCMOS logic ii) Pseudo nMOS logic
   c) What are C^2MOS logic and CMOS domino logic? Realize the following function using both logics separately. (10)

$$Z = \overline{A + BC}$$

4. a) Write down the reasons behind the domination of SI-based MOS technology in IC fabrication industries. Also mention the limitations of submicron downscaling of Si devices. (10)
   b) Why GaAs is more suitable than Si for ultrafast systems? Explain using energy band concept. (08)
   c) Write short note on different generations of GaAs devices. (07)
   d) What is meant by nanoelectronics? Which materials are promising for nanoelectronics devices? Explain in brief. (10)

SECTION B

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

5. a) What is Elmore delay? Estimate the rising and falling propagation delay and also contamination propagation delay of 4-input NAND driving h identical gates. (12)

   b) Find step response of CMOS inverter driving in load capacitor. (08)

   c) Design an nMOS resistive load inverter for the following specifications: V_{DD}=3.3 V, Power (P)=0.1 mW when V_L=0.2 V, K_n=60 μA/V^2, V_{TN}=0.75 V. Find the value of the load resistance R and the W/L ratio of the switching transistor M_s. (15)

6. a) Determine the static and dynamic power dissipation during the process of charging and discharging the load capacitance in CMOS inverter. (10)

   b) What is noise margin? Explain the noise margin determination process of an nMOS type inverter. (12)

   c) Design CMOS digital logic circuit that realize the Boolean functions: (13)

   i) $y = ac+bc$ ii) $y = \overline{ab + cd}$

   Also draw the equivalent RC circuits for each of them.

7. a) What is PLD? What are the advantages of reducing the number of ICs using PLD? (08)

   b) Design ROM, PAL, PLA using resistor for the following SOP functions: (15)

$$Z_0 = AB + B\overline{C}$$
$$Z_1 = \overline{A}BC + A\overline{B}C + AB\overline{C}$$
$$Z_2 = AB + \overline{B}\,\overline{C}$$

   c) Describe the working principle of output logic macrocell (OLMC) of generic array logic (GAL). (12)

8. a) What is FPGA? Classify of it. (06)

   b) Describe the comparison between CPLD and FPGA. (09)

   c) What is LUT? Design gate level structure of the following SOP functions and also implement of it by LUT: (12)

$$f_1 = (ab\overline{c} + def)(a\overline{b}c + \overline{a}bc)(ghi + jk + lm)$$

   d) Draw the design flow diagram of Xilinx FPGA. (08)

B.Sc. Engineering 4th year 1st Term Examination, 2019
Department of Electronics and Communication Engineering
KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

ECE 4105
(Optical Fiber 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) What is optical Fiber? Mention its advantages and limitations in communication system. (08)
   b) Define acceptance angle. Show that the light collecting power of an optical fiber is independent of the dimension of the fiber. (09)
   c) What is mode of propagation? What are the parameters determine the number of modes supported by an optical fiber? (06)
   d) A step-index optical fiber has a numerical aperture of NA=0.1. Its cladding is pure silica and has a refractive index of n_2=1.465. (i) What is the refractive index n_1 of the core? (ii) What is the largest core diameter for which the fiber remains single moded at an optical wavelength of 1.3 μm. (iii) If the core diameter is found to be 8 μm, what is the wavelength in which fiber remains single moded. (12)

2. a) With the help of suitable diagram, discuss about the concept of (i) GOOS-Haenchen shift; (ii) Mode field diameter (MFD), in optical fiber transmission. (10)
   b) What should be the limit of propagation constant β for a guided mode? Explain the propagation conditions when $\beta < n_2 k$, where n_2 is the refractive index of cladding and K is the wavenumber. (08)
   c) An electromagnetic wave having amplitude of 1 V/m arrives at an angle of 30° to the normal in an air on a glass plate of index 1.60. The wave's electric field is entirely perpendicular to the plane of incidence. Determine the amplitude of the reflected wave. (08)
   d) A multimode step index fiber with a core diameter of 80 μm and a relative index difference of 1.5% is operating at a wavelength of 0.85 μm. If the core refractive index is 1.48, estimate (i) the normalized frequency for the fiber, (ii) the number of guided modes. (09)

3. a) Explain the zig-zag wave theory of light propagating through an optical fiber. (10)
   b) A single mode step index fiber has core and cladding refractive index of 1.46 and 1.457 respectively, material dispersion parameter D_m= -2 ps/ns-km excited by an LED source with rms spectral width σ_w = 50 nm. If the core radius is 4 μm, calculate the total dispersion for operating wavelength 1550 nm. Use the following empirical formula by Rudolph and Neumann: W= 1.1428 V-0.996; and normalized propagation constant $b = \left(\frac{W}{V}\right)^2$ (10)
   c) What are dispersion compensation fibers (DCF) and dispersion shifted fibers (DSF)? Explain how to shift dispersion in such fiber during fabrication. (10)
   d) Explain, what is meant by self-phase modulation (SPM)? (05)

4. a) What are the sources of dispersion in optical fiber? Show that the material dispersion parameter, $D_{mat} = -\lambda / c \frac{d^2 n}{d\lambda^2}$, where the symbols have their usual meanings. (12)
   b) What is non-linear effect in optical fiber? Briefly explain the non-linear phenomena of four waves mixing (FWM) and stimulated Raman Scattering (SRS) in optical fiber communication. (08)

c) A graded index fiber with a parabolic index profile supports the propagation of 742 guided modes. The fiber has a numerical aperture in air of 0.3 and the core diameter of 70 μm. Determine the wavelength of the light propagating in the fiber. Further estimate the maximum diameter of the fiber which gives single mode operation at the same wavelength. (10)

d) Draw the mode patterns for the LP_{41} and LP_{14} mode. (05)

SECTION B

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

5. a) Classify optical sources. What are the requirements of an optical source to be used with optical fiber? (08)

b) Show that internal optical power generated by the LED is $P\text{int} = \eta_{\text{int}} \frac{h_{ci}}{e\lambda}$, where the symbols have their usual meanings. (10)

c) Explain construction of Dome LED. Why do we need the Dome LED? (07)

d) A planar LED is fabricated from gallium arsenide which has a refractive index of 3.6. (i) Calculate the optical power emitted into air as a percentage of the internal optical power for the device when the transmission factor at the crystal air interface is 0.68. (ii) When the optical power generated internally is 50% of the electric power supplied, determine the external power efficiency. (10)

6. a) What are meant by upward and downward transition rates of electrons? From the Boltzmann statistics prove that the spectral density, $P_f = \frac{A_{21}/B_{21}}{[(g_1B_{12}/g_2B_{21})\exp(hf/KT)]-1}$ where the symbols have their usual meanings. (12)

b) Prove that the Bragg wavelength of DFB laser is directly proportional to the grating period if the effective refractive index and order of grating are constant. (10)

c) The total efficiency of an injection laser with a GaAs active region is 18%. The voltage applied to the device is 2.5 V and the bandgap energy for GaAs is 1.43 eV. Calculate the external power efficiency of the device. (08)

d) Draw the block diagram of the front end of an optical receiver showing the various sources of noise. (05)

7. a) Explain the factors that limit the speed of response of a photodiode. (13)

b) Define NEP, detectivity (D) and specific detectivity (D*). Prove that $D^* = \frac{\eta e\lambda}{hc(2eI_d/A)^{1/2}}$, where the symbols have their usual meanings. (06)

c) A photodiode has a quantum efficiency of 65% when photons of energy $1.5\text{x}10^{-19}$ j are incident upon it. Calculate (i) at what wavelength is the photodiode operating, and (ii) the incident optical power required to obtain a photo current of 2.5 μA when the photodiode is operating as describe above. (10)

d) What are the characteristics of amplitude modulator? (06)

8. a) Explain the operation of Mach-Zehnder modulator (MZM) with its pros and cons. (10)

b) Explain the lateral coupling efficiency and lateral misalignment loss in multi-mode fiber joints. (06)

c) List the factors to be considered to design a long optical fiber link. Explain the principle of function splicing. (08)

d) What is SONET? Explain the generic structure of SONET. What are the differences between SONET and PON. (11)

B.Sc. Engineering 4th year 1st Term Examination, 2019
Department of Electronics and Communication Engineering
KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

ECE 4103
(Wireless 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) Write down the purposes of digitization of mobile communications. (07)
   b) What are the essential elements of a cellular system? (07)
   c) Give the flowchart of evolution of wireless technology in USA and Europe. (08)
   d) What do you mean by physical channel and logical channel? (08)
   e) Write down the full meanings of the following abbreviations: N-AMPS (ii) CCITT (iii) TMSI (iv) FCC (v) TACS (05)

2. a) Write down the roles of an Engineer for planning and designing a new mobile station. (08)
   b) Describe the techniques for numbering all the GSM channels, showing setup channel and voice channel. (08)
   c) Give the flow chart for diagnostic and problem solving procedure for system configuration in mobile communication system. (07)
   d) For a given path loss exponent (i) n=4 and (ii) n=3, find the frequency re-use factor and cluster size that should be used for maximum capacity. The signal to interference ratio of 15 dB is minimum required for satisfactory forward channel performance of a cellular system. There are 6 co-channel cells in the first tier and all of them are at the same distance from the mobile station. Use suitable approximation. (12)

3. a) What is dynamic spectrum management? Write down the factors that minimum distance allows the same frequency to be reused. (08)
   b) Design the mobile communication system in worst possible case with an omnidirectional antenna. (09)
   c) Write down the functions of BTS and MSC. (08)
   d) Let us consider a cellular system with 395 total allocated voice channel frequencies. If the traffic is uniform with an average call holding time of 120 seconds and the call blocking during the system busy hour is 2%, Calculate (i) the number of calls per (10)

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cell site per hour. (ii) The mean S/I ratio for cell reuse factors equal to 4,7, and 12. Assume omnidirectional antenna with six interferers in the first tier and a slope for the path loss of 40 dB/decade (r=4)

4. a) Draw the protocol layers of IEEE 802 comparing with OSI model. (10)
   b) Dr. Robi wants to call with his friend from KUET to CANADA by his mobile phone, Now establish the connection between them using GSM architecture. (08)
   c) Give the comparative statement among 1G, 3G and 5G mobile communications. (09)
   d) What do you mean by frequency management and channel assignment in cellular system? (08)

SECTION B

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

5. a) What is fading? What are the factors that influence fading? (10)
   b) Develop a response model of a multipath channel for the impulse function. (12)
   c) Explain the multipath measurement technique named "Frequency Domain channel sounding". (13)

6. a) Deduce the expressions for Rayleigh and Rician fading distributions. (08)
   b) What is ciphering and how the equalizer should be done? (08)
   c) Why FH-SS is used? Give the block diagram of transmitter and receiver of FH-SS system. (11)
   d) Explain the working principle of a RAKE receiver. (08)

7. a) Discuss the role of wireless local loop (WLL), What are the propagation considerations of WLL? (10)
   b) How does a handoff initiation occur? Explain the advantages of delayed handoff. (4+5)
   c) Show the relation between originating calls and handoff calls for the following cases; (i) No queuing on either the originating calls or the handoff calls (ii) Queuing the handoff calls but not the originating call. (16)

8. a) What do we use diversity techniques? Derive the expression for selective diversity improvement. (10)
   b) When radio signal diffraction occurs? What are the models to describe radio signal diffractions? Give the comparison among them. (12)
   c) Why non-linear equalization is used? Explain the operation for maximum likelihood sequence estimation with an adaptive matched filter. (3+10)

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B.Sc. Engineering 4th Year 1st Term Examination, 2019

Department of Electronics and Communication Engineering

ECE 4109

(Computer Networks)

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) Define i) internet ii) network protocols. How can the end systems be connected to edge router? (05)

   b) What are the differences between packet switching and circuit switching? Which switching technique is more suitable to be used in computer network and why? (08)

   c) Define routing and forwarding. How do loss and delay occur? What are the sources of packet delay in internet? Describe them briefly. (12)

   d) Explain DoS and IP spoofing attack briefly. (10)

2. a) Consider Fig. 2(a), for which there is an institutional network connected to the internet. Suppose that the average object size is 200000 bits and that the average request rate from institution's browser to the origin server is 7 requests per second. Also suppose that the amount of time it takes from when the router on the internet side of the link forwards an HTTP request until it receives the responses is 3 seconds on average. (15)

      i) Find the total average response time (before cache installed).

      ii) Now suppose a cache is installed in the institutional LAN. Suppose the hit rate is 0.6. Find the total response time.

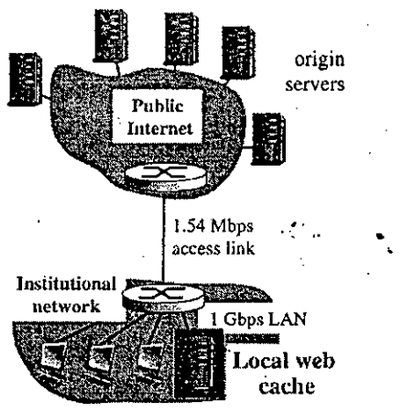

Fig. of Q.2(a)

   b) Differentiate between virtual circuit network and datagram network. (08)

   c) Suppose, your web browser requests for a webpage which contains 7 small objects in the same server (8 objects including the base HTML file). RTT_0 denotes the RTT between two end systems. Also, pipelining is not considered. How much time is required in terms of RTT_0 from when the client clicks on the link until the client receives the full webpage considering only propagation delay (RTT_0)? (12)

      i) Using non-persistant HTTP, ii) Using persistant HTTP.

3. a) To distribute a file among N number of clients, where N>1, why peer-to-peer is better than client-server architecture in terms of the file transmission delay? Explain with example. (10)

   b) Knowing that UDP cannot provide many transport services that TCP can, why UDP is still used? Give examples of applications which use UDP as a transport layer protocol. (07)

   c) Define congestion control. What is the difference between TCP Tahoe and Reno in terms of congestion control? (08)

   d) Consider the following two 16-bit integers: 1011100011001010, 1010011010101011 calculate UDP checksum which will be sent by the UDP sender to check potential bit error. Also show how using this checksum receiver can determine whether there is any error or not. (10)

4. a) How does DHCP work? Explain elaborately. (08)
   b) How does TCP establish and close a connection? Explain with diagram. (10)
   c) Consider *n* number of bits can be used to generate sequence number of two pipelining protocols i.e. G-B-N and SR. Find: i) sequence number size ii) maximum sender and receiver window size, iii) number of timers required for these protocols. (09)
   d) Explain how SMTP and POP3 work. (08)

SECTION B

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

5. a) Briefly explain OSI model and relate OSI model with TCP/IP model. (10)
   b) What are the differences between classfull and classless addressing for IPv4? Write down the IP classes for IPv4 address. (09)
   c) What is IP fragmentation? Explain IP fragmentation and reassembly with proper topology and IPv4 header fields. (08)
   d) Determine the header checksum of the IPv4 packet: i) HLEN=6, ii) TOS=2, iii) Total length=30, iv) Identity=15, v) Flag=0, vi) offset=0, vii) TTL=5, viii) Protocol=UDP, ix) Source IP=10.10.109.5, x) Destination IP=192.168.2.100 (08)

6. a) Write down the error reporting messages of ICMP and describe 'Redirection' message. (08)
   b) Why PAT is more economic than NAT? Write down the solutions of PAT transversal problems with necessary diagram. (10)
   c) What are the differences between private and public IP addresses? (06)
   d) Let you are the network admin of ISP routers shown in Fig. 6(d). The required no. of IP addresses that to be needed are also shown. If you assign an address block 200.190.192.0/22, how would you provide network address for the subnetworks? (11)

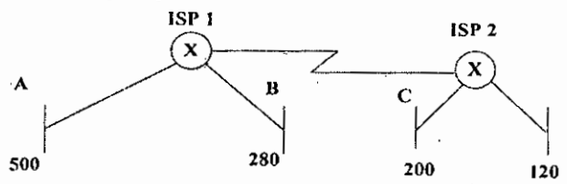

Fig. of Q.6(d)

7. a) What aspects should be considered while designing a routing algorithm? (06)
   b) Write differences between: i) Global and distributed routing, ii) Inter-AS and Intra-AS routing (10)
   c) Write the algorithm for shortest Path First (SPF) algorithm and using this develop the routing table of router 'u' in Fig. 7(c), also show the resulting shortest-path tree from router 'u'. (14)

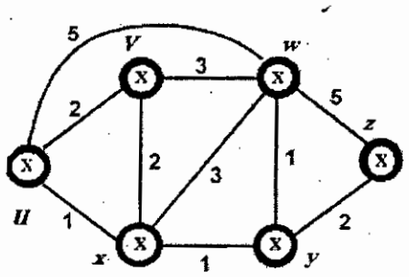

Fig. of Q.7(c)

   d) Describe the 'Header Translation' process for transitioning from IPv4 to IPv6 addressing. (05)

8. a) Write short notes on: i) Playback attack, ii) Man-in-the middle attack, iii) DOS attack. (09)
   b) What are the differences between symmetric key and public key cryptography. Describe the process of DES cryptographic technique. (09)
   c) Using RSA algorithm encrypt the message "F" and decrypt the cipher text to retrieve the original message. Chose p=5 and q=7 to find out the public and private key. (09)
   d) Write short notes on: i) Hash function, ii) Diffie-Hellman algorithm. (08)

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B.Sc. Engineering 4th Year 1st Term Examination, 2019

Department of Electronics and Communication Engineering

ECE 4129

(Digital Image 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 is meant by Digital Image Processing? What are the applications of Digital Image Processing (08)

   b) What are the fundamental steps in Digital Image Processing? Briefly explain each step with necessary diagram. (12)

   c) What is image interpolation? Explain 'Nearest Neighbor' and 'Bilinear' interpolations. What are their applications? (09)

   d) What is meant by adjacency? Briefly explain different types of adjacency. (06)

2. a) Consider the image segment shown in Fig. 2(a). Let V={0,1} and compute the lengths of the shortest 4, 8, and *m* path between p and q. If a particular path does not exist these paths, explain the reason. (10)

	3	1	2	1	(q)
	2	2	0	2	
	1	2	0	2	
	1	2	1	1	
(p)	1	0	1	2	

Figure of Q. 2(a)

   b) What is Gamma correction? Why Gamma correction is necessary in DIP? Draw the image transformation curves for different values of 'Gamma'. (10)

   c) Define histogram equalization. For the given image in Fig. 2(c), perform histogram matching operation with the specified target image gray level distribution given below: (15)

Gray level	0	1	2	3	4	5	6	7
No. of Pixels	0	0	0	0	3	6	8	8

0	1	5	1	7
0	0	5	5	5
4	5	1	4	1
5	1	2	4	5
5	2	6	4	0

Figure of Q.2(c)

3. a) What are Salt and Pepper noises? Which filters are best to remove these noises? (06)

b) A 5×5 image is given in Fig. 3(b). Find out the filtered images after applying the following filters: (15)

i) Harmonic mean filter; ii) Geometric mean filter; iii) Alpha trimmed mean filter for d=2.

4	2	1	2	2
6	2	3	2	3
5	3	7	3	4
3	4	7	5	5
4	7	7	5	6

Figure of Q. 3(b)

c) Find Walsh Transform basis for N=4. Apply that basis on the given image of Fig. 3(c) and find the transformed image. (14)

$$f = \begin{bmatrix} 3 & 4 & 5 & 3 \\ 4 & 4 & 5 & 5 \\ 4 & 5 & 6 & 7 \\ 5 & 6 & 6 & 7 \end{bmatrix}$$

Figure of Q. 3(c)

4. a) "Low pass filtering in the spatial domain can be thought as local averaging operations"- justify the statement. (10)

b) What is 'image convolution' and 'image correlation'? Apply image convolution on the image of Fig. 4(b). Use 'Prewitt Operator' as kernel. (10)

4	3	5
5	3	6
5	4	7

Figure of Q.4(b)

c) Perform 2D DFT of the 4×4 image given in Fig. 4(c). (10)

$$f = \begin{bmatrix} 0 & 1 & 2 & 1 \\ 1 & 2 & 3 & 2 \\ 2 & 3 & 4 & 3 \\ 1 & 2 & 3 & 2 \end{bmatrix}$$

Figure of Q. 4(c)

d) Classify image transform methods based on the nature of basis functions. (05)

SECTION B

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

5. a) What is meant by image compression? Show the relation between compression ratio and redundancy for various values of information carrying units. (11)

   b) Consider the simple 4×8, 8-bit image shown in Fig. 5(b). (12)

      i) Compress the image using Huffman coding.

      ii) Compute the compression achieved and effectiveness of the Huffman coding.

21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243

Figure of Q. 5(b)

   c) Explain the following terms in image processing context: i) Spatial and temporal redundancy, ii) Bit plane coding, iii) Lossless predictive coding. (12)

6. a) The arithmetic decoding process is the reverse of the encoding procedure. Decode the message 0.23355 given the coding model shown in Fig. 6(a). (08)

Symbol	Probability
a	0.2
e	0.3
i	0.1
o	0.2
u	0.1
!	0.1

Figure of Q. 6(a)

   b) Can variable-length coding procedures be used to compress a histogram equalized image with 2^n intensity levels? Explain. (07)

   c) Write down the steps in JPEG image compression standard. (07)

   d) Why Karhunen-Loeve transform is seldom used in practice for image compression compared to other transformations? (07)

   e) Write down the features of Wavelet coding. (06)

7. a) Write down the steps of Canny edge detection algorithm. (07)

   b) In Hough transform, develop a general procedure for obtaining the normal representation of a line from its slope-intercept form, $y=ax+b$. Also find the normal representation of line $y= -2x+1$ (08)

   c) Write down the significance of 1st and 2nd derivatives in edge detection. (08)

   d) Determine the minimum average code word length per source symbol considering noiseless channel and communication system. (12)

8. a) Derive the expression of optical threshold used in image segmentation. (12)

   b) Write short notes on Otsu's method for optimal global thresholding. (07)

   c) Briefly explain watershed segmentation algorithm. (08)

   d) How region splitting and merging can be used for image segmentation? (08)