KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B.Sc. Engineering 4th year 1st Term Examination, 2016

Department of Electronics and Communication Engineering

ECE-4101

(VLSI Design & 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) What is the significance of device miniaturization in the development of modern technology? Also discuss on the domination of Si based MOS technology in IC fabrication industries. (09)
   b) What are the general considerations in VLSI system design? Mention the problems associated with VLSI design and discuss on conventional steps to overcome them. (12)
   c) Why are the design rules necessary? Draw the stick diagram and mask layout of an n-type pass transistor based 4-way MUX following the design rules. (14)

2. a) What is RAM? Draw the internal circuit diagram of a typical memory element of coupling circuit used in RAM. (10)
   b) Why is the two-phase clocking necessary for memory design? Briefly explain the working of a logic gate based two-phase clock generator. (08)
   c) Explain the operation of an nMOS pseudo-static memory cell using necessary circuit diagram. (09)
   d) What are the advantages of one-transistor RAM cell? Estimate the storing capacity of 3mm×3mm chip of one-transistor RAM cells considering 2μm technology. (08)

3. a) What are the advantages of structured design approach? Design an *n*-bit parity generator using structured approach. (10)
   b) Write short note on CMOS domino logic. (07)
   c) Explain the operation of passive bus and active bus using nMOS or CMOS (08)
   d) What are the general requirements of a shifter used in microprocessor? Design an nMOS based 3×3 shifter fulfilling these requirements. (10)

4. a) Write down the advantages and limitations of sub-micron down-scaling of Si devices. (08)
   b) Briefly explain why GaAs technology provided much higher speed than conventional Si/Ge technology. (08)
   c) List different first and second generation GaAs devices and mention their ranges of speed and power dissipation. (08)
   d) What is meant by nanoelectronics? Which materials are promising for nanoelectronics devices? Explain in brief. (11)

SECTION B

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

5. a) How does capacitance form in the gate of MOSFET? Illustrate the distribution of charges on MOSFET channel under different operating modes. (09)
   b) What are the limitations of using resistive load in nMOS inverter? Discuss on the possible approaches to overcome these limitations. (09)
   c) What is noise margin? Explain the noise margin determination process of an nMOS inverter. (12)
   d) What is beta ratio effects? (05)

6. a) Explain the RC delay model of an inverter. (08)
   b) What is ROM? Design a psedu-nMOS ROM and explain its operation. (10)
   c) Design an nMOS saturated load inverter given the following specifications: (17)

V_{DD}=3.3 V	β_n=50 μA/V^2
V_L = 0.2 V	V_{TO}=0.75 V
P = 0.2 mW	γ=0.5$\sqrt{V}$
	$2\Phi_F$=0.6 V

   Find out the value of W/L ratio for each transistor and to determine the various parameters needed to determine the noise margin of it and also draw its VTC.

7. a) What is programmable logic devices (PLD)? How many types of PLD? What are the advantages of it? (10)
   b) Design a PLA using pseudo nMOS and PAL at gate level to realized the following sum of product (15)

$$W(A,B,C) = \sum m(2,3,7)$$
$$X(A,B,C) = \sum m(1,3,5,6)$$
$$Y(A,B,C) = \sum m(0,2,4,6)$$

   c) Describe the operation of output logic macrocell (OLMC) of Generic Array Logic (GAL). (10)

8. a) What is FPGA and CPLD? Describe the structure of CPLD with necessary diagram. (13)
   b) What is look up table (LUT)? Design a 2 input LUT circuit before and after programming. (08)
   c) What is self-aligned process? Illustrate the fabrication of CMOS considering self-aligned process. (14)

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B.Sc. Engineering 4th Year 1st Term Examination, 2016

Department of Electronics and Communication Engineering

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.
iii) b-V curves of planar waveguide

SECTION A

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

1. a) What is optical fiber? Why a cladding layer is essential for an optical waveguide? (08)
   b) Define acceptance angle. Show that the light collecting power of an optical fiber is independent of the dimension of the fiber. (10)
   c) Classify optical fiber according to the mode of propagation. What are the advantages and disadvantages of multimode fiber relative to single mode fiber? (08)
   d) Skew rays are accepted into a large core diameter step index fiber in air at a maximum axial angle of 42^0. Within the fiber they change direction by 90^0 at each reflection. Determine the acceptance angle for meridional rays for the fiber in air. (09)

2. a) Explain the zig-zag wave theory of light propagation through an optical fiber. Hence, show that the light of a certain mode is corresponding to a certain discrete incidence angle. (10)
   b) What should be the limit of propagation constant (β) for a guided mode? Explain the propagation conditions, when *i)* $\beta < n_2 k$ and *ii)* $n_2 k < \beta < n_1 k$, where n_1 and n_2 are the refractive indices of guided layer and cladding layer, respectively. (07)
   c) The TE_{mo} modes of light of $\lambda_0 = 1.0\,\mu m$ propagates in an asymmetric slab waveguide with a polymer film of thickness $d = 1.0\,\mu m$ and $n_1 = 1.77$, which is deposited on a silica substrate of $n_2 = 1.45$. The air is used as cover of the structure. (09)
      i) How many guided modes are supported by this waveguide? Sketch the field distribution of them.
      ii) Find the propagation constant for the fundamental TE mode of this waveguide.
      iii) Find the wavelength range, ignoring the dispersion of waveguide material, within which it is a single-mode waveguide.
   d) 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. (09)

3. a) What are the sources of dispersion in optical fiber? Briefly describe the mechanism of pulse broadening due to material dispersion and then deduce the general expression to estimate it. (12)
   b) What are dispersion compensation fibers (DCF) and dispersion shifted fibers? Explain how to shift dispersion in such fiber during fabrication. (10)
   c) A multimode step index fiber has a relative refractive index difference of 1% and a core refractive index of 1.46. The maximum optical bandwidth that may be obtained with a particular source on a 4.5 Km link is 3.1 MHz. (13)
      i) Determine the rms pulse broadening per kilometer resulting from chromatic dispersion mechanisms.
      ii) Assuming waveguide dispersion may be ignored, estimate the rms spectral width of the source used, if the material dispersion parameter for the fiber at the operating wavelength is 90 $ps.nm^{-1}.km^{-1}$.

4. a) What is non-linear effect in optical fiber? Briefly explain the non-linear phenomena of SRS and SPM in optical fiber communication. (10)

b) A 15 Km optical fiber link uses fiber with a loss of 1.5 $dB.km^{-1}$. The fiber is jointed every kilometer with connectors which give an attenuation of 0.8dB each. Determine the minimum mean optical power which must be launched into the fiber in order to maintain a mean optical power level of 0.3 μW at the detector. (08)

c) Explain what is meant by self-phase modulation. Identify and discuss a major application area for this non-linier phenomenon. (07)

d) Consider a single mode step-index fiber, which has a core radius of $a = 4.0\mu m$ and a relative index difference of $\Delta = 0.3\%$. The cladding of the fiber has a refractive index of $n_2 = 1.444$ at $\lambda = 1330\ nm$. Calculate the effective index of the LP_{01} mode at $1330\ nm$ from the following empirical formula by Rudolph and Neumann: $W = 1.1428V - 0.996$, where (10)

$$W = Ka\left[\left({}^{B}/_{K}\right)^2 - n_2^2\right]^{\frac{1}{2}}, \quad V = Ka[n_1^2 - n_2^2]^{\frac{1}{2}} \quad \text{and}$$

$K = {}^{2\pi}/_{\lambda}$ being the free space wave number and n_1 the core index.

SECTION B

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

5. a) Compare the electrical and optical bandwidths for an optical fiber communication system and develop a relationship between them. (07)

b) Define and explain briefly the internal quantum efficiency of an LED. What do you mean by DFB-LD? (08)

c) A planar LED is fabricated from gallium arsenide which has a refractive index of 3.6. The light output from LED is coupled into a step index fiber with a numerical aperture of 0.2, a core refractive index of 1.4 and a diameter larger than the diameter of the device. Estimate: (10)

i) The coupling efficiency into the fiber when the LED is in close proximity to the fiber core.

ii) The optical loss in decibels, relative to the power emitted from the LED, when coupling the light output into the fiber.

iii) The loss relative to the internally generated optical power in the device when coupling the light output into the fiber when there is a small air gap between the LED and the fiber core. The transmission factor at the crystal-air interface is 0.68.

d) A 1 cm long InGaAsP/InP first-order grating filter is designed to operate at a center wavelength of 1.52 μm. the reflected light is incident at an angle of 1^0 and the refractive index of InGaAsP is 3.1. Determine the corrugation period and estimate the 3dB bandwidth of filter. A large change in effective refractive index may be assumed. (10)

6. a) Discuss on amplitude modulation techniques that are widely used for optical fiber system with their relative advantages and disadvantages. Also mention the characteristics for amplitude modulator. (08)

b) A Non Return Zero (NRZ) On-Off Keying (OOK) optical fiber system is presented below where the Mach-Zender Modulator (MZM) is in push-pull operation. Write down the expressions for the point of A, B, C and D. (10)

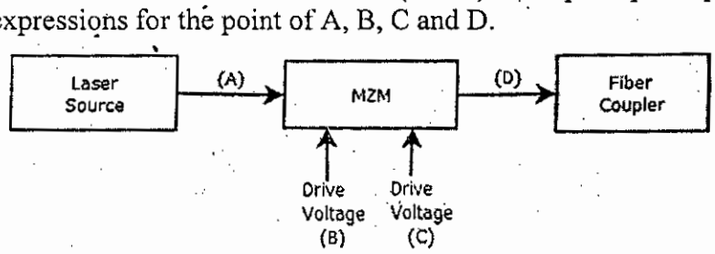

Figure for Q. 6(b)

c) Discuss in brief about the three-level and four-level population inversion process of semiconductor laser. (07)

d) Write down the basic criteria to choose an optical detector. Compare the advantages and disadvantages of PIN and APD. (10)

7. a) Draw the block schematic of the front end of an optical receiver showing the various sources of noise. (07)

b) Define noise equivalent power (NEP), detectivity(D) and specific detectivity(D*). Show that the NEP can be defined by the expression of $NEP = \frac{hc(2eI_d)^{1/2}}{\eta e\lambda}$, where the symbols have their usual meanings. (10)

c) Draw and describe the baseband receiver with the presence of low-pass filter, sample and hold circuit and decision circuit. Use example and necessary waveforms in your discussion. (08)

d) A Ge photo diode receiver working at a wavelength of 1.55 μm, has a dark current of 500 nA at the operating temperature. When the incident optical power is $10^{-6}W$ and the responsivity of the device is 0.6 AW^{-1}. Shot noise dominates in the receiver. Determine the SNR in dB at the receiver when the post-detection bandwidth is 100 MHz. (10)

8. a) Define: (i) Single-ended coherent receiver (ii) Balanced coherent receiver (iii) Homodyne receiver (iv) Heterodyne receiver (08)

b) A four-port multimode fiber FBT coupler has 60μW optical power launched into port 1. The measured output powers at port 2, 3, and 4 are 0.004, 26.0, and 27.5 μW respectively. Determine the excess loss, the insertion losses between the input and output ports, the crosstalk and the split ratio for the device. (10)

c) A multimode step index fiber has numerical aperture of 0.2 and core refractive index of 1.48. Estimate the insertion loss at a joint in fiber caused by a 5^0 angular misalignment of the fiber core axes. It may be assumed that the medium between the fibers is air. (08)

d) What is OTDR? Explain the principle of finding fiber fault location using OTDR. (09)

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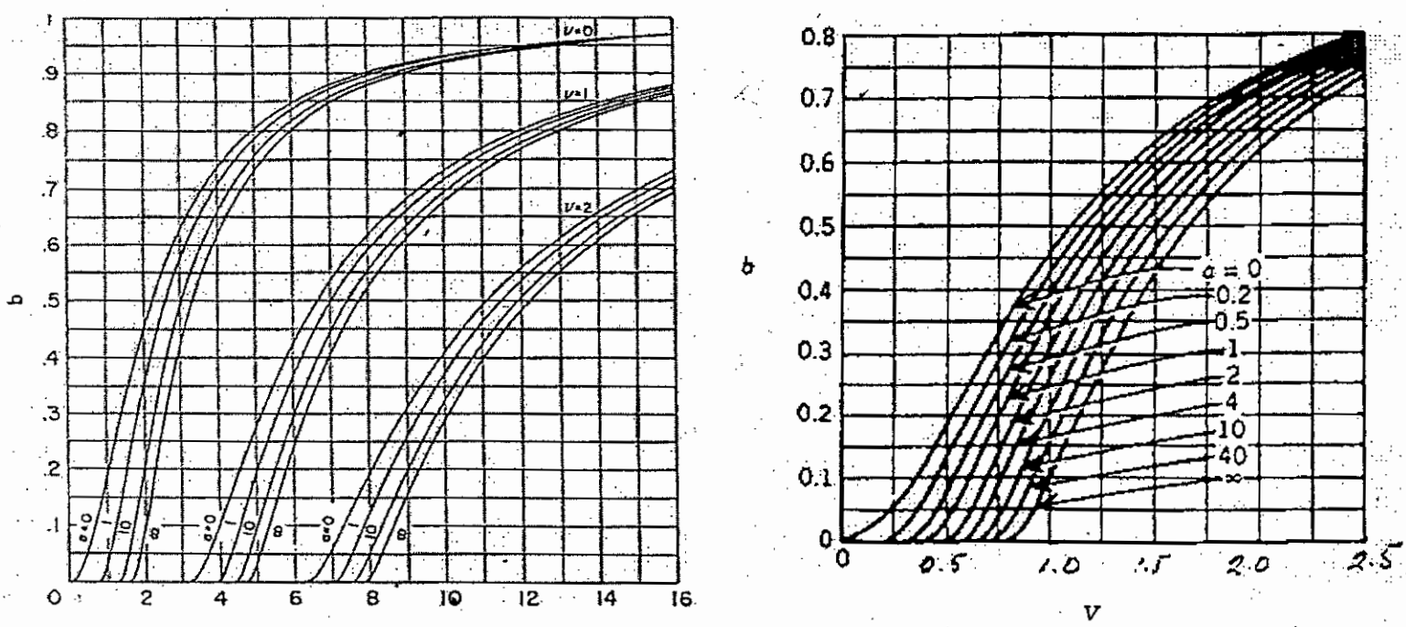

Figure: b-V curves for fundamental TE mode of planar optical waveguide

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B.Sc. Engineering 4th year 1st Term Examination, 2016

Department of Electronics and Communication Engineering

ECE-4103

(Wireless Communication)

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 the essential elements of a cellular system? (07)
   b) What do you mean by physical channel and logical channels? (3+4)
   c) Write down the full meaning of the following abbreviations: (1×4)
   (i) UMTS (ii) N-AMPS (iii) PLMN and (iv) TMSI
   d) A spectrum of 30 MHz is allocated to a wireless FDD cellular system which uses two 25 KHz simplex channels to provide full duplex voice and control channels, compute the no. of channels available per cell if a system uses (a) Four cell reuse, (b) Seven cell reuse, and (c) 12-cell reuse. If 1 MHz of the allocated spectrum is dedicated to control channels, determine an equitable distribution of control channels and voice channels in each cell for each of the three systems. (17)

2. a) Briefly explain the channel assignment strategy in mobile radio systems. (10)
   b) Distinguish between co-channel and inter-channel interference. (05)
   c) What is frequency re-use? Write down the factors that minimum distance allows the same frequency to be reused. (4+4)
   d) Design the cellular system in worst-case scenario with an omnidirectional antenna. (12)

3. a) What is traffic volume and traffic density? (5+3)
   b) Write down the functions of network manager. (07)
   c) Explain the direct sequence spread spectrum system of transmitter and receiver. (08)
   d) For a given path loss exponent (i) n=4 and (ii) n=3, find the frequency reuse factor and the 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)

4. a) Transmit power must be reduced in order to fill the original coverage area with microcell-justify the statement. (12)
   b) Mr. Huda is calling Mr. Shams from Teknaf to Tetulia. Establish the connection between them using GSM architecture. (08)
   c) Write down the scope of IEEE 802.16 standards. (05)
   d) What do you mean by paging system. Draw the simple block diagram of paging system. (4+6)

SECTION B

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

5. a) What do you mean by frame and burst? Establish the relation between burst and frame using block diagram. (10)
   b) What do you mean by Flat fading, slow fading and fast fading. Provide the expression for Rayleigh and Rice fading distribution and compare the cumulative distribution of these two types of fading. (18)
   c) What are the merits of interleaving and antenna diversity? (07)

6. a) What do you mean by spectrum sensing? What are the factors playing important role to enhance the spectrum utilization efficiency?
   b) Explain power difference handoffs and mobile assisted handoffs. Also, compare between them.
   c) Show the relationship between originating calls and handoff calls for the following cases: (15)
   (i) No queuing on either the originating calls or the handoff calls (ii) Queuing the handoff calls but not the originating calls.

7. a) Compare ground reflection (2-ray) model with free space propagation model. For ground reflection (2-ray) model, find path difference, phase difference and time delay. (15)
   b) When radio signal diffraction occurs? What are the models to describe radio signal diffractions. Give comparison among/between them. (14)
   c) What are the problems of hidden node? And, How it can overcome? (06)

8. a) Write down the necessity of an equalizer. Provide structural block of a linear transversal equalizer and explain. (12)
   b) Why we use diversity techniques? Derive the expression for selective diversity improvement. (08)
   c) What are the advantages of delayed handoff? Given σ=6, m=-104 dBm, A_5 = -96 dBm, find the value of δ_h during a handoff. Assume A_4 = -92 dBm, A_3 = -87 dBm, A_2=-80 dBm, A_1=-68 dBm, A_6=-99 dBm, and P_5=0.91, P_4=0.95, P_3=0.99, P_2=1= P_1 and P_6=0.79. (15)

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B.Sc. Engineering 4th Year 1st Term Examination, 2016

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) What are the properties of internet protocol (IP)? (08)
   b) What is an IPv4 address? Explain the importance of private IP address. (09)
   c) What is IP fragmentation? Explain IP fragmentation and reassembly with proper IPv4 header fields. (08)
   d) Determine the header checksum from the following information: i) packet type-IPv4 ii) HLEN=5, iii) Type of service = 2, iv) Total length = 28, v) Identity = 10, vi) Flag =0, vii) Offset = 0, viii) TTL= 4, ix) Protocol=TCP, x) Source IP=10.12.14.5, xi) Destination IP=12.6.7.9. (10)

2. a) What is class full IP addressing? What are the IP classes? (06)
   b) What is a link local IP address? What are the differences between private and public IP addresses? (08)
   c) How does a newly arriving client receive an IP address from the DHCP server? Explain with proper network topology and algorithm. (10)
   d) What are the query messages of ICMP protocol? Discuss the transition strategies from IPv4 to IPv6 address scheme. (11)

3. a) What is the difference between metric and administrative distance? What are the desirable properties of a router? (07)
   b) How do the nodes connected in Fig. 3(b) converge their routing information according to distance vector routing algorithm (The number in each link denotes link cost). (09)

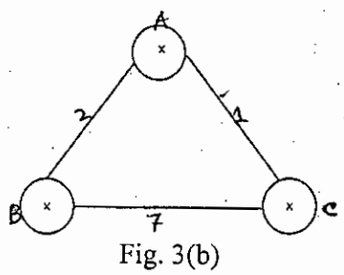

Fig. 3(b)

   c) Which algorithm is used in link-state routing? Write down the algorithm and its complexity. (13)
   d) Write short notes on - i) Poisson Reverse, ii) Oscillation problem. (06)

4. a) "PAT is more economic that NAT" – Justify the statement. (06)
   b) Using RSA algorithm encrypt the message "10" and decrypt the cypher text to retrieve the original message. Chose p =11 and q =13 to find out the public key and private key. (10)
   c) What is the man-in-the middle attack? (06)
   d) What is hash function? How is the hash function used to provide message integrity? (07)
   e) What are the differences between hubs, bridges and switches? (06)

SECTION B

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

5. a) HTTP is called stateless - why? How does web server recognize clients with stateless property? (09)
   b) What are the benefits of packet switching over circuit switching? (08)
   c) Differentiate between SMTP and POP3. (06)
   d) For the network topology given in Fig. 5(d), a packet of size 20 Mbits transmitted through link with each link speed 2 Mbps. Calculate the total time required for transmit this file from source to destination for, (12)
      i) without segmentation the file
      ii) with 10,000 segmentation of that file.

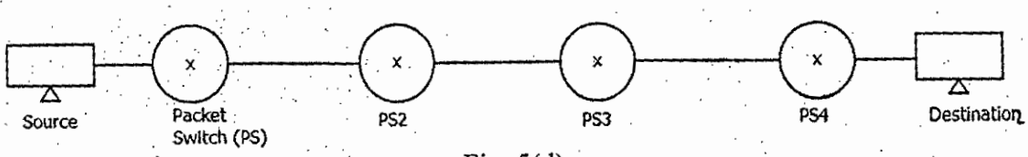

Fig. 5(d)

6. a) Golden rule of traffic engineering is $\frac{La}{R} < 1 -$ Justify the statement (R =link BW, L = packet length and a = average packet arrival rate). (07)
   b) Write the differences between persistent HTTP and non-persistent HTTP. (07)
   c) Describe how web caching can reduce the delay in receiving a requested object? (09)
   d) Compute the checksum for the four 8-bit words considering 1st word: 11001010; 2nd word: 01011011; 3rd word: 11110000; 4th word: 11011011. Why checksum cannot detect 2-bit error? (12)

7. a) Transport layer provide logical communication between application processes running on different hosts– Justify the statement. (07)
   b) Draw the state diagram of TCP connection termination phase. (07)
   c) Describe the process of selective repeat algorithm. (08)
   d) Consider the four samples RTT values of 106ms, 120ms, 140ms and 90ms. (13)
      i) Compute the estimated RTT after each of these sample RTT values is obtained, using a value of α=0.125 and assuming that the value of estimated RTT was 100 ms just before the first of these four samples were obtained.
      ii) Compute also the Dev RTT after each sample is obtained, assuming a value of β=0.25 and assuming the value of Dev RTT was 5 ms just before the first of these four samples was obtained.

8. a) Describe how TCP flow control works? (07
   b) Describe the causes and costs of congestion control for two senders and a router with finite buffers. (08
   c) Design a reliable data transfer protocol having bit error using finite state machine. (11
   d) Consider 10 Gbps throughput of TCP connection, 1500 byte segment size and 100ms end to end delay. Find out the TCP's loss rate to achieve this 10 Gbps throughput. (0

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

B.Sc. Engineering 4th Year 2nd Term Examination, 2016

Department of Electronics and Communication Engineering

ECE 4229

(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? Describe the basic components of a general purpose image processing system using suitable diagrams. (10)
   b) Briefly explain different stages of image processing and analysis that would be required to design an automated vehicle license plate reading algorithm. (15)
   c) What are the benefits of intensity transforms? Give a single intensity transformation function for spreading the intensities of an image, so that the lowest intensity is '0' and the highest is 'L-1'. With reference to the intensity transformation function, explain how a contrast stretching function can be changed to a thresholding function? (10)

2. a) What do you mean by smoothing of an image? Explain the mechanism of spatial filtering in order to smooth a noisy image. (11)
   b) Define histogram equalization. Gray level histogram of an image is given below: (13)

Gray level:	0	1	2	3	4	5	6	7
Frequency:	790	1023	656	329	245	122	81	612

   Compute the gray level histogram of the input image obtained by enhancing the input by histogram equalization technique. Also compare the computed and original histogram.
   c) A 3×3 image is given in figure 2(c). What will be the value of the center pixel when this image is passed through: (11)
   (i) Median filter, (ii) Geometric mean filter, and (iii) Harmonic mean filter.

4	2	1
6	2	3
5	3	7

Figure 2(c)

3. a) "Low pass filtering in the spatial domain can be thought as local averaging operations"-Justify the statement. (12)
   b) What is adjacency? Briefly explain different types of adjacency. (08)
   c) Explain basic procedures for image enhancement in frequency domain. (10)
   d) Discuss on different Laplacian masks frequently used to sharp digital images. (05)

4. a) What is Walsh transform? Write down the difference between Walsh transform and Hadamard transform. (10)
   b) Write the models (PDF) and sources of Gaussian and salt-pepper noises. Which filters are useful to remove these noises? (10)
   c) What are the differences between image enhancement and image restoration? Explain the Wiener filtering technique for image restoration. (15)

SECTION B

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

5. a) What do you mean by image compression? Explain the importance of image compression. (08)
   b) Write down the applications of fidelity criteria in image processing. (07)
   c) Draw the block diagram of lossy predictive coding model of image compression. (07)
   d) Design a transmission channel which will have maximum capacity to transmit an image from one place to another. (13)

6. a) Briefly explain multimedia video compression standards. (10)
   b) Write down the steps in JPEG image compression standard. (10)
   c) Write short notes on the following frames of moving image representation: (15)
      (i) I-frame, (ii) P-frame, and (iii) B-frame.

7. a) What is image segmentation? Why is the edge linking necessary for image segmentation? (09)
   b) Explain the significance of 1^{st} and 2^{nd} derivatives for edge detection using suitable examples. (09)
   c) Write down the importance of thresholding in image processing. Briefly explain watershed image segmentation method. (03+ 08)
   d) Define global and adaptive thresholding. (06)

8. a) Write down the basic formulations of region growing and briefly explain the meanings of each formula. (10)
   b) What is Sobel operator? Explain the Sobel edge detection technique. (10)
   c) Derive the expression of optimal threshold used in image segmentation. (10)
   d) Does noise play any role in thresholding? Justify your reason. (05)