KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
B.Sc. Engineering 4th Year 1st Term Examination, 2015
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) Define full custom design. Explain the top down design hierarchy for full custom digital IC design. (12)
    b) Describe the level of integration of IC. (08)
    c) How to evaluate performance of an IC? (15)

2. a) What is noise margin? Explain it briefly. (10)
    b) Describe the cell based design approaches of an IC. (15)
    c) Draw the RTL design flow diagram. (10)

3. a) What is FPGA? How to configure the array for logic functions in FPGA? (15)
    b) Derive the expression for drain current (I_{ds}) for nMOS and discuss on the I-V characteristics using suitable diagram. (15)
    c) What is meant by beta ratio effects? (05)

4. a) Describe the CMOS fabrication process using necessary diagrams. (15)
    b) Draw the equivalent RC circuit models from CMOS inverter. (07)
    c) Draw and briefly explain the flow diagram of generalized ASIC (Application Specific Integrated Circuit) (13)

SECTION B

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

5. a) Write down the system timing considerations used in VLSI design. (07)
    b) Explain the operation of a dynamic flip-flop using proper circuit diagram. How can a clock load improve its performance? Explain in brief. (10)
    c) What is RAM? Draw the general schematic of a 2^n by one bit RAM and explain its operation. (12)
    d) What is PLA? What is the basic concept of PLA based design. (06)

6. a) Explain the operation of a one transistor RAM cell. Also discuss on the area requirement, power dissipation and volatility effect of this RAM. (10)
    b) Why are the design rules necessary in VLSI design? State the λ-based design rules. (10)
    c) Why stick diagram and mask layout is used in IC technology? (05)
    d) Draw the mask layout and stick diagram of 1 bit CMOS shift register cell. (10)

7. a) What is pseudo-nMOS logic? Determine the pull-up to pull-down ratio of pseudo-nMOS (12) inverter and mention its advantages.

   b) Define latch-up problem in CMOS circuits. Also write down its remedies. (10)

   c) What are the advantages of structured design approach? Implement a bus arbitration logic (13) circuit for n-line bus using structured design approach.

8. a) What are the limitations of cross bar switch? How can a barrel shifter reduce these (10) problems? Explain in details.

   b) Why is GaAs technology suitable for ultra-fast system? Explain using energy band concept. (08)

   c) Compare different features of CMOS, bipolar and GaAs technologies. (12)

   d) List the first and second generation GaAs devices. (05)

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
B.Sc. Engineering 4th year 1st Term Examination 2015
Department of Electronics & 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) Necessary graphs/charts: b-v curves of planar waveguides.   –
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? Why a cladding layer is essential for an optical waveguide?   (08)
    b) "The single mode silica optical fiber cables are used instead of copper coaxial cable for a submarine cable system of telecommunication"-Mention the reason of this.   (08)
    c) What is mode of propagation? Explain different types of modes for an optical waveguide. What are the parameters determine the number of modes supported by an optical fiber?   (10)
    d) The relative refractive index difference Δ between the core and cladding of an optical fiber designed for long distance transmission is typically 1%. If the core index is 1.48, then estimate: (09)
        (i) the critical angle at the core-cladding interface.
        (ii) the numerical aperture of the fiber.
        (iii) the solid acceptance angle in air for the fiber.

2. a) In the case of parallel polarization, the coefficient of reflection can be expressed as
        $$r_p = \frac{n_1 \cos\varphi_i - n_2 \cos\varphi_t}{n_1 \cos\varphi_i + n_2 \cos\varphi_t}$$
        Where n_1 and n_2 are the refractive indices of two media, φ_i and φ_t are the angles of incidence and refraction, respectively.   (09)
        (i)   Briefly explain $r_p = e^{j2\psi_p}$ in TIR.

        (ii) Prove $\psi_p = \tan^{-1}\left[\left(\frac{n_1}{n_2}\right)^2 \frac{\sqrt{\sin^2\varphi_i - \left(\frac{n_2}{n_1}\right)^2}}{\cos\varphi_i}\right]$

    b) Briefly discuss, with the help of suitable diagrams, the concept of the evanescent field and Goos-Haenchen shift in optical fiber transmission.   (09)
    c) A symmetric planar waveguide is consist of a polymer core layer of thickness d=1.20µm between the silica substrate and cover. At 1.33 µm optical wavelength, n_1=1.75 for the polymer core, and n_2=1.50 for the silica substrate and cover.
        (i) How many guided modes are supported by this waveguide? Sketch the field distribution of them.   (09)
        (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) What will be the maximum core diameter of a single-mode step-index optical fiber with relative refractive index difference Δ=3% and 0.3%, operating at λ_0=1.30 µm and n=1.48. Why should Δ be so small?   (08)

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3. a) How does dispersion limit the data rate of signal transmission in our digital communication? Explain all kinds of dispersion for an optical fiber. (12)

   b) What are dispersion compensation fibers (DCF) and dispersion shifted fibers? Explain, how to shift dispersion in such fiber during fabrication. (10)

   c) For a 6 km optical link, consist of multimode step-index fiber with core index 1.5 and cladding index 1.45, determine the modal dispersion and the maximum bit rate allowed. If the fiber is considered as a graded index with an optimum near parabolic index profile, what will be that dispersion and maximum allowed bit rate? Comment on the two types of fiber based on your obtained result. (13)

4. a) Explain the different sources of losses in optical fiber link. (10)

   b) What is nonlinear effect in optical fiber? Briefly explain the nonlinear phenomena of SRS and SPM in optical fiber communication. (10)

   c) Write short notes on polarization mode dispersion. (05)

   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: $W = 1.1428V - 0.996$, (10)

      where $W = Ka\left[\left(\beta/K\right)^2 - n_2^2\right]^{\frac{1}{2}}$, $V = Ka\left[n_1^2 - n_2^2\right]^{\frac{1}{2}}$, with $K = 2\pi/\lambda$ 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) Classify optical sources. What are the requirements of an optical source to be used with optical fiber? (08)

   b) Show that the optical power generated internally by the LED is given by $P_{int} = \eta_{int}\ i/e\ hf$, where the symbols have their usual meaning. (10)

   c) Briefly discuss about temperature effect on the LED output power and the line width of optical spectrum. (0?)

   d) The radiative and non-radiative recombination lifetimes of the minority carriers in the active region of a double-heterojunction LED are 60 ns and 100 ns respectively. Determine the total carrier re-combination lifetime and the power internally generated within the device when the peak emission wavelength is 0.87 μm at a drive current of 40 mA. (?)

6. a) What is an optical detector? Write down the basic criteria to choose an optical detector. (

   b) Discuss briefly the driving condition of Mach-Zehnder Modulator (MZM) for the operation of (i) Linear, (ii) On-off, (iii) Phase modulation. Use necessary figures in your illustration.

   c) Foe semiconductor laser, discuss briefly on differential external quantum efficiency and total efficiency.

   d) Deduce the condition of Bragg diffraction for the designing of distributed feedback laser.

7. a) Determine the sensitivity and Q-factor for APD receiver in the presence of ideal NRZ-OOK signal. (10)

   b) Discuss briefly on coherent optical receiver with its classification and practical implementation. (10)

   c) The rms value of the power fluctuation on the output from a single-mode semiconductor laser is 2×10^{-4}w when the relative intensity noise (RIN) is -160 dB Hz^{-1}. The emission, which is at a wavelength of 1.30 μm, is directly incident on an optical detector with a quantum efficiency of 70% at this wavelength. If the rms noise current at the detector output is 0.53 μA, and assuming that the RIN is the dominant noise source, calculate the mean optical power incident on the photo detector. (10)

   d) Write down the factors that limit the speed of response of a photodiode. (05)

8. a) What is OTDR? Explain the principle of finding fiber fault location using it. (08)

   b) Describe the working principles and advantages of EDFA. (07)

   c) Describe briefly on Cut-back method and modulation phase shift method for measuring the fiber attenuation and chromatic dispersion respectively. (10)

   d) A graded index fiber has a parabolic refractive index profile (α=2) and a core diameter of 50 μm. Estimate the insertion loss due to a 3 μm lateral misalignment at a fiber joint when there is index matching and assuming: (10)
   (i) there is uniform illumination of all guided modes only.
   (ii) there is uniform illumination of all guided and leaky modes.

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
B.Sc. Engineering 4th Year 1st Term Examination, 2015
Department of Electronics and Communication Engineering
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) What are the techniques for increasing the frequency spectrum? (07)
   b) Draw the simple block diagram of digital mobile communications system. (07)
   c) What do you mean by set up channel? Why is set up channel sometimes called "Access Channel" and "Paging Channel"? (07)
   d) Give the flowchart of evolution of wireless technology in USA and Europe. (07)
   e) Write down the full meaning of the following abbreviations: (i) EDGE (ii) GPRS (iii) WiMAX (iv) IMSI (v) LMDS (vi) CCITT (vii) NAEIA. (07)

2. a) What are the co-channel and adjacent channel interferences? Which factors depend on frequency reuse? (08)
   b) What are the engineer's role for planning and designing a cellular system? (07)
   c) Write down the procedures to improve the cell coverage area and capacity in cellular system. (08)
   d) For 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. Use suitable approximations. (12)

3. a) What is cell? Why is cell hexagonal in wireless communications? (07)
   b) Describe the geometry of a hexagonal cell of wireless communications. (12)
   c) "Transmit power must be reduced in order to fill the original coverage area with microcells"- Justify the statement. (08)
   d) Draw the protocol architecture of IEEE 802.16 and write down functions of protocol architecture of IEEE 802.16. (08)

4. a) Differentiate between "Access Channel" and "Paging Channel". (07)
   b) Give the comparative statement of 1G, 2G, 3G, 4G and 5G of wireless communications. (07)
   c) What is SIM? What are the informations carries by a SIM in GSM system? (07)
   d) Write down the functions of BTS, BSC, MSC and network manager. (07)
   e) Mr. Huq from Khulna is calling Mr. Mamun (Chittagong), establish the connection using GSM architecture. (07)

SECTION B

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

5. a) Write down the solutions of transmission problems used in cellular system. (05)
    b) Establish an impulse response model of a multipath channel. (12)
    c) What are the factors that influence small scale fading? (06)
    d) Describe the impulse response measurement system of a direct RF channel. (12)

6. a) Classify Handover. How do you initiate and control of a handover process? (10)
    b) Develop a 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.
    c) Distinguish between mobile assisted handoff and intersystem handoff. (10)

7. a) What do you mean by opportunistic spectrum access? How do you incorporate the cognitive cycle in cognitive radio? (10)
    b) What is the different spectrum sensing schemes in narrowband cognitive radio network? (09)
    c) What is hidden node problem? How to overcome this problem? (06)
    d) Discuss the role of WLL. What are the considerations for propagation of WLL? (10)

8. a) Draw the block diagram of IS-95 forward link transmission and also show the forward link channel parameters? (15)
    b) What are the significances of PN sequences? (05)
    c) Give the flowchart of IEEE 802.11 MAC logic. Illustrate clearly the MAC timing diagram of IEEE 802.11 standard. (15)

TIME: 3 hours   FULL MARKS: 210

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

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

1. a) What is an IPv4 address? Write down the short notes on i) Private address, ii) Loopback (07)
address.
   b) "IP is a connectionless, best effort delivery and media independent protocol"- Justify the (06)
statement.
   c) Draw the IPv4 header format and discuss about its different fields. (12)
   d) For the figure in Fig. 1(d), station A needs to send a payload size of 1400 bytes (including (10)
20 bytes of header) to station B across the networks as shown. Data needs to be fragmented
because the payload is too big to fit the smallest MTU size (600 bytes). Find the total data
length, identification number, more flag and fragmentation offset values for each fragmented
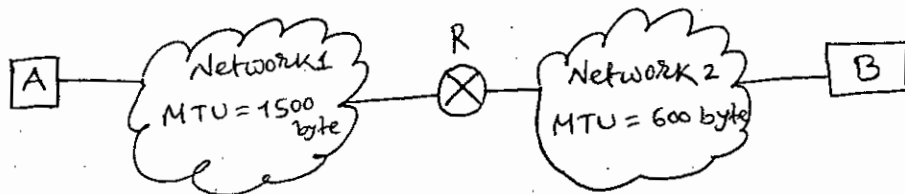packets only in network 2.

Fig. 1(d)

2. a) How does DHCP work? What is the purpose of it? Explain with proper network topology. (12)
   b) Describe NAT with proper network topology. Write down the solutions of NAT traversal (10)
problems with necessary topology diagram.
   c) Write down the error reporting messages of ICMP & describe source quench message. (05)
   d) Compare and contrast IPv4 and IPv6 header fields. Do they have any common fields? (08)

3. a) What is metric? What are the metrics for i) EIGRP, ii) OSPF, and iii) RIP routing protocols. (07)
   b) Write the algorithm for shortest path first (SPF) and using this algorithm develop the routing (14)
table of router 'u' in fig. 3(b), also show the resulting shortest-path tree from router 'u'(the
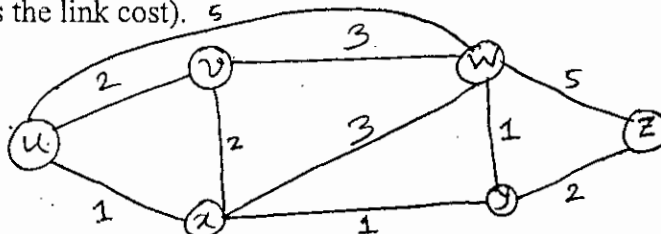value in each link denotes the link cost).

Fig. 3(b)

   c) What is 'count to infinity' problem and how to solve this problem according to solve this (07)
problem according to distance vector routing?
   d) What is the difference between routing and forwarding? (07)

4. a) "A transport layer protocol provides logical communication between processes running on (05)
different hosts, a network layer protocol provides logical communication between hosts"-
Justify the statement using necessary diagram.
   b) Since UDP is unreliable, why should we use it? Design a reliable data transfer protocol (12)
having bit error using finite state machine.
   c) Show the pictorial diagram of TCP's three way handshake. (08)
   d) "PAT is more economic than NAT"- Justify the statement. (10)

5. a) What do you mean by computer network? Classify computer network based on geographical (08)
   area coverage.
   b) Consider sending a packet from a sending host to a receiving host over a fixed route. List the (10)
   delay components in the end-to-end delay. Which of these delays are constant and which are
   variable?
   c) What are the benefits of packet switching over circuit switching? (09)
   d) Differentiate between virtual circuit network and datagram network. (08)

6. a) "Web application protocol HTTP is called stateless"-why? With stateless property how web (09)
   server recognizes clients?
   b) Why is it said that FTP sends control information out-of-band? Mention sample FTP (08)
   commands and corresponding return codes.
   c) Differentiate between HTTP and SMTP. (06)
   d) Suppose there is an institutional network where average request from the institutional (12)
   browsers to the origin servers are 15 per second and each request size is 100kbit. Now, i)
   What will be the total response time to satisfy the request? ii) If the access link bandwidth is
   increased from 1.5 Mbps to 10 Mbps, what will be the response time? iii) If without
   upgrading the access link, a web cache with hit rate 40% is installed, what will be the
   response time?

7. a) Write the importance of DNS in internet. For DNS address resolution, explain recursive (10)
   query and iterative query.
   b) Why SMTP is called a push protocol? (04)
   c) Write down the differences between symmetric key and public key cryptography. (07)
   d) What is the man-in-the middle attack? (06)
   e) Describe the role of KDC and CA in network security. (08)

8. a) Using RSA algorithm encrypt the message "5" and decrypt also the cypher text to retrieve (10)
   the original message. Choose P=5 and Q=7 to find out the public key and private key.
   b) How packet sniffing and IP spoofing are threats to internet security? What are the (10)
   countermeasures of them?
   c) Differentiate between hub, switch and router. (06)
   d) Why should a node have a MAC address in addition to an IP address? (09)

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
B.Sc. Engineering 4th year 1st Term Examination, 2015
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 are the methods of image sensing and acquisition? Briefly explain the common (10) types of sensor used for image acquisition.

   b) Define spatial and gray level resolution. (05)

   c) With the reference to the gray-level transformation curve, justify that the log (10) transform is a special case of power transform.

   d) Consider the image segment shown in figure 1(d). Let, V={0,2} and compute the (10) lengths of the shortest 4, 8 and m path between p and q. If a particular path doesn't exist these paths, explain why?

$$
\begin{array}{cccc}
3 & 1 & 2 & 0\ (q) \\
2 & 2 & 1 & 1 \\
1 & 2 & 1 & 1 \\
(p)\ \ 0 & 1 & 1 & 2 \\
\end{array}
$$

Figure 1(d)

2. a) If the continuous intensity values in an image have the PDF (08)

$$
P_r(r) = \begin{cases} \dfrac{2r}{(L-1)^2} & for \quad 0 \le r \le L-1 \\ 0 & otherwise \end{cases}
$$

Where, r is the continuous intensity values of the image. Then show that, the transformed/mapped image has a uniform PDF.

   b) (i) Show that the steps of histogram equalization for the following image of size 5×5 given in figure 2(b).

1	3	0	1	0
6	5	2	6	7
5	7	3	5	6
7	3	4	4	6
7	5	6	7	4

(15)

Figure 2(b)

(ii) Also perform the histogram matching operation for the specified histogram given below:

Z_q	0	1	2	3	4	5	6	7
Specified $P_z(Z_q)$	0	0	0	0.15	0.20	0.30	0.20	0.15

c) Perform the spatial correlation and convolution of a 2-D filter $\omega(x, y)$ with the image $f(x,y)$ given in figure 2(c). (12)

0	0	0	0	0
0	0	1	1	0
0	0	2	0	0
0	1	0	0	0
0	0	0	0	0

$f(x,y)$

1	2	3
4	5	6
7	8	9

$\omega(x, y)$

Figure 2(c)

3. a) What are the main applications of spatial and transform domain image processing? (06)
   b) Write down the steps in histogram matching. (05)
   c) Figure 3(c) shows a 8-bit noisy image of size 7×7. Now, show the result of filtering with a (i) Max filter of size 3×3, (ii) Min filter of size 3×3.
   What kind of noise is removed by these type of filtering-Write your observation based on the result you obtained. (14)

254	251	250	25	149	178	251
16	100	251	240	24	160	17
20	203	205	248	249	253	254
253	252	14	148	254	16	112
251	212	211	249	164	201	222
14	25	248	25	167	20	248
206	253	23	253	107	209	201

Figure 3(c)

   d) Determine the Hadamard matrix of order 8. (10)

4. a) Write down the significance of transform coding in image compression. (06)
   b) Show that classification of image transforms based on the nature of the basis functions. (09)
   c) Define basis function and orthogonal basis. (08)
   d) Perform the 2D DCT of the 4×4 image given in figure d(d). Also mention the application of DCT.

100	100	100	100
100	100	100	100
100	100	100	100
100	100	100	100

(12)

Figure 4(d)

SECTION B

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

5. a) What is meant by image compression? Briefly explain how data redundancy can be exploited in image compression. (10)
   b) Write down the application of fidelity criteria in image compression. (07)
   c) What do you mean by improved gray scale quantization? (08)
   d) Draw the block diagram of lossless predictive coding model of image compression. (10)

6. a) An image in needed to transmit from Khulna to Dhaka through a transmission channel. Design the transmission channel showing the maximum capacity needed to transmit the image. (13)

   b) Describe briefly I frame, P frame and B frame. (12)

   c) Why Karhunen-Loave transform (KLT) is seldom used in practice for image compression? (10)

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

   b) Write down the differences between JPEG and JPEG-2000 image compression standards. (08)

   c) What is image segmentation? Why is image segmentation necessary? (08)

   d) Write down the significance of 1st and 2nd derivative in edge detection. (06)

   e) Define global and adaptive thresholding. (06)

8. a) Write down the algorithm to select the basic global threshold value in image segmentation. (07)

   b) Write down the basic formulations of region growing and briefly explain the meanings of each formula. (10)

   c) How region splitting and merging can be used for image segmentation? (07)

   d) How effect of illumination can be removed for image segmentation? (06)

   e) Why edge linking is necessary for image segmentation? (05)