Question 5: (Answer two points only)

a- Sketch the different lensing schemes for optical fiber coupling improvement. Find an expression for the coupling efficiency of a nonimaging microsphere.

b- Derive the lasing conditions of a laser diode. A GaAlAs laser diode has a 500 μm cavity length, which has an effective absorption coefficient of 10 cm^{-1}. For uncoated facets the reflectivities are 0.32 at each end. What is the optical gain at the lasing threshold? If one end of the laser is coated with a dielectric reflector so that its reflectivity is now 90%, what is the optical gain at the lasing threshold?

a- How are fiber end faces prepared? What are the types of deformations in fiber end faces? Explain with the aid of sketches the fiber splicing methods. What are the main requirements for fiber connector design?

Question 6: (Answer two points only)

a- What are the different uses of the optical fiber amplifiers? Explain with the aid of sketches the idea of operation of the EDFA.

b- Find an expression for the probability of error in a digital optical receiver. What is meant by the quantum limit?

c- When a perform is drawn into a fiber, the principle of conservation of mass must be satisfied under steady state drawing conditions. This is represented by:

$$s = S\left(\frac{D}{d}\right)^2$$

where D and d are the perform and fiber diameters, and S and s are the perform feed and fiber drawing speeds, respectively. A typical drawing speed is 1.2 m/s for a 125 μm outer diameter fiber. What is the perform feed rate in cm/min for a 9 mm diameter perform?

Question 7: (Answer two points only)

a- Prove that the common core area of a two axially misaligned step index fiber is given by:

$$A_{common} = 2a^2 \arccos\left(\frac{d}{2a}\right) - d\left(a^2 - \frac{d^2}{4}\right)^{1/2}$$

where d is the axial displacement. If d=0.1a, what is the coupling efficiency in decibels?

b- Explain with the aid of sketches the structure and operation principles of single mode laser diodes.

c- Explain the types of noise resulting from laser diodes.

Best wishes.

Tanta University

Department: Electronics and Electrical Communication Eng.
Total Marks: 85 Marks

Faculty of Engineering

Course Title: Principles of Communications	Course Code: EEC3104	Year: 3rd
Date: 18/1/2011 (First term)	Allowed time: 3 hrs	No. of Pages: (1)

Remarks: (answer the following questions... assume any missing data... answers should be supported by sketches, equations)

Question 1

(A) Compare between the following:

(i) Energy and Power signal
(ii) Random and deterministic signal
(iii) Periodic and non-periodic signal

(B) Find Fourier series for the periodic signal shown in Figure 1, and sketch its amplitude and phase spectrum.

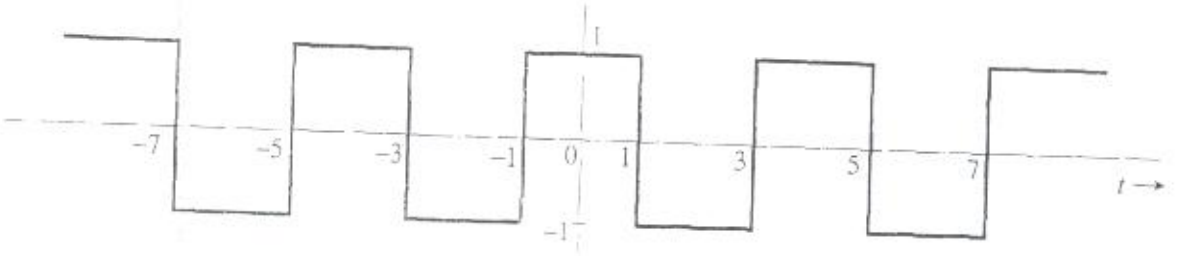


Figure 1

(C) Find the power for the signal shown in Figure 1.

Question 2

(A) Find the Fourier transform of the function $g(t)=rect(t/\tau)$, and Sketch its frequency spectrum.

(B) Explain one method to generate AM wave and one method to demodulate it.

(C) Consider the message signal $m(t)=A_m \cos w_m t$ and the carrier wave $c(t)=A_c \cos w_c t$

(i) Sketch the resulting AM wave in frequency domain.
(ii) Find the ratio of the total sideband power to the total power in the modulated wave.

Question 3

(A) Compare between NBFM and WBFM.

(B) A receiver picked up the signal $v(t)=10\cos[2\pi(4\times10^6)t+0.8\sin(2\pi\times600)t]$ and the modulating signal amplitude is 4 V.

(i) Define the modulation type; calculate the bandwidth of the modulated signal and carrier power.
(ii) Draw the frequency spectrum of the modulated signal and calculate the frequency deviation.
(iii) Show the effect of chaaging the modulating signal amplitude to 7 volt, and the effect of changing the modulating signal frequency to 350 Hz.

Best Wishes of Success

جامعة طنطا
كلية الهندسة
قسم هندسة الإنتاج والتصميم الميكانيكي

المادة/ الإدارة والتسويق
(EEC31H4)
الفرقة الثالثة(اتصالات) حد ير

بسم الله الرحمن الرحيم
التاريخ :٢٠١١/١/١٨
الزمن : ساعتان

أجب عن الأسئلة الآتية:- (٤٠ درجة)

السؤال الاول:-

١- ما المقصود بالتسويق- وما هى العناصر الاساسية للمفهوم التسويقى؟
٢- اكتب نبذة مختصرة عن اهم المفاهيم التى تحكم ادارة العمل التسويقى.
٣- تكلم عن اهم الفروق بين المفهوم التسويقى ومفهوم البيع.

السؤال الثانى:-

١- اكتب نبذة مختصرة عن فلسفة المفهوم الحديث للتسويق.
٢- ماالمقصود بكل من :-
التسويق التحويلى – التسويق الانشائى – التسويق التزامنى – التسويق المضاد
٣- تكلم بالتفصيل عن اهم المفاهيم العامة التى تستخدمها المؤسسات التنظيمية التى تمارس النشاط التسويقى.

السؤال الثالث:-

١- تكلم بالتفصيل عن دور التسويق فى سوق البائعين.
٢- اكتب نبذة مختصرة عن ظاهرة قصر النظر التسويقى مع ذكر امثلة.
٣- تكلم بالتفصيل عن اهم البيانات الثانوية اللازمة لاجراء دراسة الجدوى التسويقية.

السؤال الرابع:-

١- اكتب نبذة مختصرة عن سياسات التوزيع المختلفة.
٢- تكلم بالتفصيل عن البيئة التسويقة.

مع أطيب التمنيات بالنجاح
ا.د/عبد الفتاح مصطفى خورشد

Tanta University — Department: Electronics and Communications Eng. — Faculty of Engineering

Total Marks: 90 Marks

Course Title: Digital Electronics in communication systems	Course Code: EEC3111	Third Year
Date: January 23rd 2011 (First term)	Allowed time: 3 hrs	No. of Pages: (2)

Answer all the following questions:

Question (1) (15 degrees)

(1) Explain the principle of the open collector and Schottky TTL logic family. (5 deg.)
(2) Compare between logic families in terms of the speed and power dissipation. (5 deg.)
(3) Find Va and Ia in the circuit in Figure (1). (5 deg.)

I_{IL} = -1.6 mA
I_{IH} = 40 uA
V_{IL} = 0.8 V
V_{IH} = 2.0 V(min)
I_{OL} = 16 mA
I_{OH} = -400 uA
V_{OL} = 0.2 V
V_{OH} = 3.4V

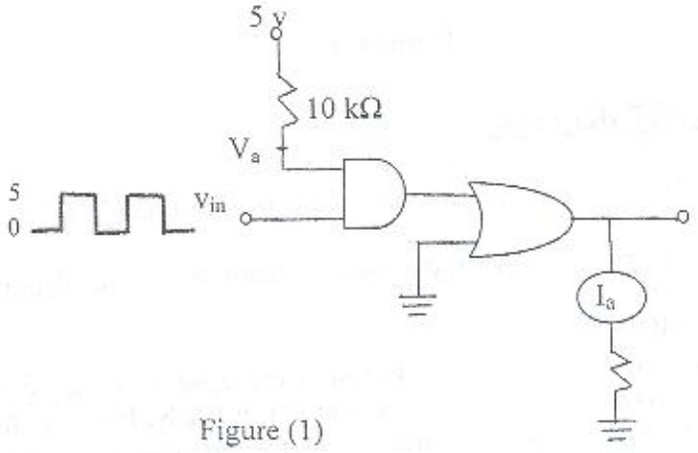


Figure (1)

Question (2) (15 degrees)

(1) Implement the function F(A,B,C,D)=Σ **m**(1,4,6,9,10,11,14,15) by using:
(i) A 74LS138 decoder. (4 deg.)
(ii) 8 x 1 multiplexer. (4 deg.)
(2) Design a 4-bit priority encoder. (7 deg.)

Question (3) (8 degrees)

(1) Find the unknown gates in Figure (2). (4 deg.)

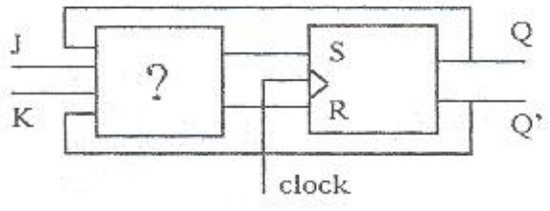


Figure (2)

(2) If a 4-to-1 multiplexer connected to *JK* FF as shown in Figure (3), and the inputs values to multiplexer as given in the diagram below. What are the outputs of the *JK* FF ***Q*** (the initial state of the FF is zero) if the value of the selection inputs to the multiplexer changes as the following 00, 10, 11, and 01 respectively. (4 deg.)

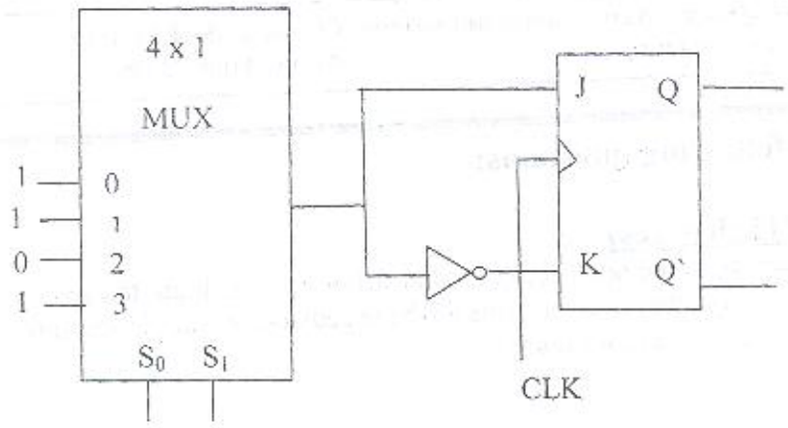


Figure (3)

Question (4) (17 degrees)

(1) Design a MOD-5 up ripple counter that counts in the sequence 6,7,8,9,10,6,7,8,…, and so on. (5 deg.)

(2) How many FF are required to build a binary counter that counts from 0 to 127, then determine:
- (i) The counter MOD. (3 deg.)
- (ii) The frequency at the output of the last FF if the input frequency is 2 MHz. (2 deg.)
- (iii) If the counter is initially zero, what count will it reach after 260 clock pulse? (2 deg.)

(3) Design a MOD-7 synchronous counter and sketch the timing waveforms. (5 deg.)

Question (5) (15 degrees)

(1) Show how to connect the IC 74LS 193 as a MOD-14 up counter. (4 deg.)

(2) Draw the diagram for a MOD-8 Johnson Counter and determine the counting sequence waveform. (5 deg.)

(3) An 8-bit universal shift register contents are 11000110. What are the register contents after 2 right shifts, 3 left shifts and 1 right shift? D_{in}=1. (6 deg.)

Question (6) (20 degrees)

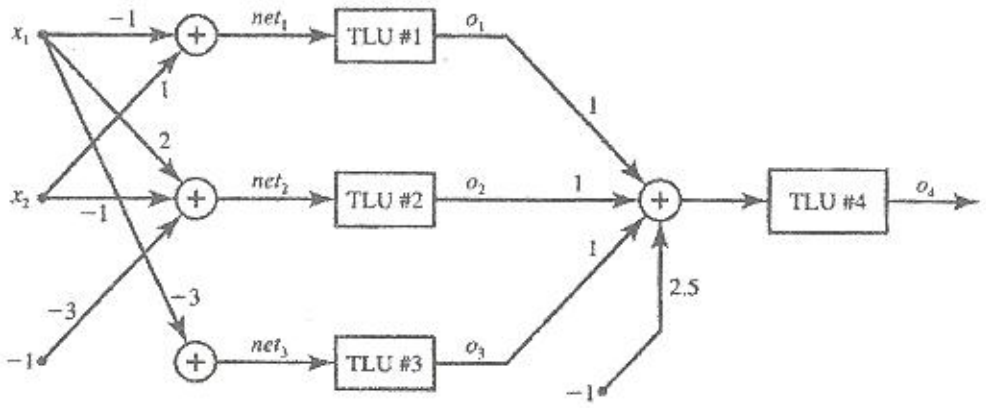
(1) An 8-bit single slope ADC with a 40 mV resolution uses a clock frequency of 2.5 MHz and a ramp generator with a slope of V_t=1V/ms. Determine:
- (i) The digital output for V_{in}= 6.0V. (4 deg.)
- (ii) The conversion times of this ADC. (4 deg.)
- (iii) Draw the block diagram of this type of ADC. (5 deg.)

(2) A 6-bit R/2R ladder DAC, Find the resolution and the output voltage if the digital input is 101101. Assume V_R=10 V and R= R_f=10 kΩ. (7 deg.)

Good Luck

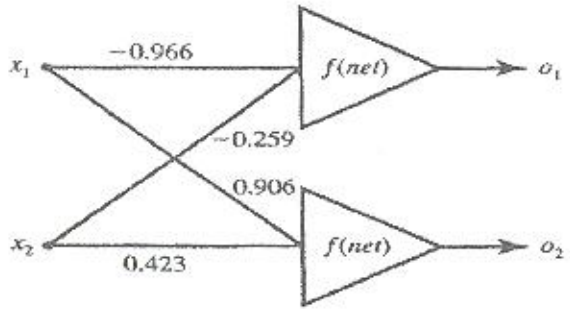
Dr. *Entessar Said*

Q1-a) The feed-forward network shown in Figure using bipolar (discrete) binary neurons is mapping the entire plane x_1, x_2 into a binary O value. Find the segment of the x_1, x_2 plane for which $O_4 = 1$.



b) The network shown in Figure using neurons a continuous bipolar activation function with $\lambda = 2$ has been designed to assign input vectors x_1, x_2, x_3 to cluster 1 or 2. The cluster number is identical to the number of the neuron yielding the larger response. Determine the most likely cluster membership for each of the following three vectors. The input vectors are

$$\mathbf{x}_1 = \begin{bmatrix} 0.866 \\ 0.5 \end{bmatrix}, \quad \mathbf{x}_2 = \begin{bmatrix} -0.985 \\ -0.174 \end{bmatrix}, \quad \mathbf{x}_3 = \begin{bmatrix} 0.342 \\ -0.94 \end{bmatrix}$$



Q2- Perform three training steps of a single neuron using the

a) Perceptron learning rule using discrete bipolar binary activation function for c =1.

b) Delta learning rule for c = 0.25, and $\lambda = 1$.

c) Widrow-Hoff learning rule for c =1.

Train the network using the following data pairs

$$\left(\mathbf{x}_1 = \begin{bmatrix} 1 \\ -2 \\ 3 \\ -1 \end{bmatrix}, \quad d_1 = -1\right), \quad \left(\mathbf{x}_2 = \begin{bmatrix} 0 \\ -1 \\ 2 \\ -1 \end{bmatrix}, \quad d_2 = 1\right),$$

$$\left(\mathbf{x}_3 = \begin{bmatrix} -2 \\ 0 \\ -3 \\ -1 \end{bmatrix}, \quad d_3 = -1\right)$$

The initial weights are $W^1 = [1\ 0\ 1\ 0]^t$.

Q3-a) Write down the steps of R-Category continuous perceptron training Algorithm.

b) Perform one training cycle (4 training steps) for single discrete perceptron classifier for classification of four patterns x with known class membership

$x_1 = 1, x_3 = 3, d_1 = d_3 = 1$: class 1

$x_2 = -0.5, x_4 = -2, d_2 = d_4 = -1$: class 2

Using c = 1, and with the initial weights $w^1 = [-2\ \ 1.5]^t$.

Q4 a) Show that the augmented weight correction formula during the training of neural network classifier is as follow

$$\mathbf{w}' = \mathbf{w} \pm c\mathbf{y}$$

b) Drive the mathematical expression for the hidden layer weight adjustment based on the generalized delta learning rule for multilayer feed-forward neural networks.

Q5-a) Prove that for the inputs to be ideally associated (perfect mapping) using linear associator the input vectors must be orthonormal.

b) Prove that the linear associator provides no means for suppression of the cross-talk noise.

c) Prove that the Hopfield autoassociative memory capable of error correction (noise suppression).

Department : Electronics& Communications

Tanta University

Faculty of Engineering

Course Title : Wave Propagation and Antennas 1 Course Code : EEC3110 Year : 3rd
Date : January 25th (Academic Year 2010/2011 First Term) Allowed time: 3 hrs No: of pages : (2)

Attempt all questions:

1- a- (1) Write down expressions for the different field components in a rectangular wave guide operating in the dominant mode. Then, derive an expression for the transmitted power W_T

(2) If the **Transverse electric field** component (E_y) in a rectangular wave guide of dimensions (5 cm x 4 cm), filled with a lossy- dielectric material with $\varepsilon_r = 9$ and $\sigma_d = 10^{-5}\,\upsilon/m$ and **the walls losses is negligible** is given by:

$$Ey(x,y,z,t) = -j10^{-3}\, e^{-\alpha Z} \sin(20\pi x)\cos(\omega t - 10\sqrt{3}\pi z) \quad \text{V/m}$$ **determine**

i- The mode of operation and its f_c and β_g ii- The operating frequency f and the other modes that can propagate. iii- α, V_g, η_g and W_T iv- Write expressions for the other field components and evaluate the magnitude of E_y at $z = 5m$

b- If the **Longitudinal electric field** component (E_Z) in an empty rectangular wave guide operating in the TM_{11} mode is given by:

$$Ez(x,y,z,t) = 10^{-4}\sin(20\pi x)\sin(25\pi y)\cos(12\pi x10^9 t - \beta_g z) \quad \text{V/m}$$

determine :

i- The W,G dimensions ii- $f_c, \beta_g, V_g, \eta_g$ and f at which walls losses are minimum

iii- Write expressions for the other field components iv- Sketch α_w versus frequency.

2- a- For an empty cylindrical wave guide operating in the TE_{01} mode, **write down** expressions for the different field components and wave guide parameters, then derive an expression for the walls losses per unit length.

b- If the **Transverse electric** field component (E_θ) in a cylindrical wave guide with radius 10 cm and walls are made of cupper with $\sigma_w = 10^8\ \Omega^{-1}/m$ and is filled with a lossy-dielectric material having $\varepsilon_r = 25$ *and* $\sigma_d = 10^{-4}\upsilon/m$ is given by:

$$E_\theta(r,\theta,z,t) = -j10^{-4}\, e^{-\alpha z} J_1(69.7r)\cos(4\pi x10^9 t - \beta z) \quad \text{V/m}$$

determine :

i- The mode of operation ii- $f, f_c, \eta, \alpha_d, \alpha_w$ *and* α and sketch α_w versus frequency

iii- Evaluate the magnitude of E_θ at $z = 10m$

3- a- (1) For a cubic cavity resonator operating in the TE_{101} mode , **write down** expressions for the field components in the cavity as well as the resonance frequency and the quality factor.

(2) i-If the resonance frequency and the quality factor of an **air filled** cubic cavity resonator are $3\sqrt{2}\,GHz$ *and* 20000 respectively. Calculate the length of the cavity and *the walls conductivity* σ_w.

ii-When the above cavity was re-filled with a **lossy dielectric material** the new values of the resonance frequency and the quality factor became $\frac{3\sqrt{2}}{4}\,GHz$ *and* 1000 respectively , evaluate the material parameters (ε_r and σ_d).

b-For **an air filled circular cavity** resonator with **radius 6 cm**, and **operating in the TM_{011}** mode:

(1) **Write down** an expression for the resonance frequency.

(2) i- If the **quality factor** and the **resonance frequency** of the above cavity is **3000** and **6 GHz** respectively, **calculate the length d of the cavity.**

ii-If the above cavity **is filled with a lossless dielectric material with** $\varepsilon_r = 36$ calculate the new values of the resonance frequency and quality factor.

4- a- <u>For the micro-strip lines</u>:-

(1) Discuss briefly its main applications

(2)Show with sketches the geometry of the micro-strip line indicating the distribution of both E and H fields showing briefly the losses in the micro-strip line

(3) Make a comparison between the micro-strip line and the wave guides.

(4) Calculate the characteristic impedance Z_0 of the microstrip line having the following parameters:

$\varepsilon_r = 7.59, h = 7\ \mu m, t = 2.8\ \mu m$ *and* $w = 10\ \mu m$

<u>b- For the optical fiber</u> :

(1) What are its main applications and advantages over other popular transmission lines

(2) Draw the single fiber structure indicating the characters and functions of each element.

(3) Write down what do you know about the basic optical lows , fiber types , fiber modes and the acceptance cone.

(4) If the light is traveling in **glass with refractive index of 1.6** towards a **glass-to-air interface** with **an incident angle of 40^0** , evaluate the reflection and refraction angles as well as the required incident angle to ensure total reflection.

(5) If the index profile of a fiber is given by:

$$n(r) = 1.45\ rect\frac{r}{250} + 0.03\ rect\frac{r}{100}\ , r\ in\ \mu m$$

i- Sketch n(r) indicating the fiber type and mode ii- Sketch the ray transmission

iii- Evaluate the critical angle

"ربي اشرح لي صدري ويسر لي أمري"

Dr. Abdel-Fattah A. Abu-Hashem

اتصالات

Tanta University	Physics & Mathematics Dept. Total Mark : 85	Faculty of Engineering
Course Title: Engineering Mathematics (4)	Course Code: PME3115	Year: Third Year Communications
Date: 27/1/2011 (Final First Term Exam)	Allowed time: 3 Hours	No. of Pages: (2)

Answer all the following questions:

Question 1 — 15 Marks

a- A certain item is manufactured by three factories, say A, B and C. It is known that A turns out twice as many items as B, and that B and C turn out the same number of items (during a specific production period). It is known that 8% of the items produced by A and B are defective, while 4% of those manufactured by C are defective, one item is chosen at random:
i) What is the probability that the chosen item is non-defective?
ii) If the chosen item was non-defective, what is the probability that it come from factory B or C?

b- If two dice are thrown, find the probability that the sum is neither 6 nor 10?

c- A random variable X has a *pdf*: $f(x) = 3x^2$, $0 \le x \le 1$, find 'a' and 'b' such that
i) $P(X \le a) = P(X > a)$ ii) $P(X > b) = 0.05$

Question 2 — 25 Mark

a- Find the probability that a person tossing three coins will get either all heads or all tails for the second time on the fifth toss.

b- A box contains four balls numbered 1, 2, 3, and 4. If two balls are drawn from the box at random (that is, each pair has the same chance of being selected) and then Z is the sum of the numbers on the two balls drawn, find:
i) The probability distribution function of Z and draw its histogram.
ii) The cumulative distribution function of Z and draw its graph.

c- Use the moment generating function to obtain the mean and variance of the random variable X whose density function is given by:

$$f(x) = \frac{1}{2}e^{-|x|}, \qquad -\infty < x < \infty$$

Question 3 — 20 Mark

a- An old farmer had bunions on his feet. He noticed that there seemed to be a relation between the number of bunions on his feet and inches of rainfall on his farm. He collected data for a week and then computed the following summary statistics. If X = number of bunions and Y= inches of rainfall, the farmer found that: $\overline{X} = 4$, $\overline{Y} = 4$, $\sum XY = 94$, $\sum X^2 = 124$, $\sum Y^2 = 150$. Do you think that the farmer is right in his notice? If the farmer wakes up with 5 bunions, how many inches of rain do you predict that day?

b- A random sample of size 81 is taken from an infinite population with mean 128 and a standard deviation of 6.3. With what probability can we assert that the sample mean will not fail between 126.6 and 129.4?

c- The contents of 7 similar containers of sulfuric acid are 9.8, 10.2, 10.4, 9.8, 10, 10.2, and 9.6 liters. Find a 95% confidence interval for the mean of all such containers, assuming an approximate normal distribution.

Question 4 — 25 Mark

a- An experiment is performed to determine whether the mean nicotine content of one kind of cigarettes exceeds that of another kind by 0.2 milligrams against that they not differ by this value. If a random sample of 50 cigarettes from the first kind show a mean nicotine content of 2.61 milligrams with a standard deviation of 0.12 milligrams, whereas a random sample of 40 cigarettes from the second kind show a mean nicotine content of 2.38 milligrams with a standard deviation of 0.14 milligrams, perform this test at 0.05 level of significance.

b- Customers arrive at a one-man barber shop according to a Poisson distribution with mean inter-arrival time of 20 minutes; customers spent a mean of 15 minutes in the barber chair. If an hour is used as a unit of time, and the shop is open all the day then:

i) What is the probability that a customer need not wait for hair cut?

ii) What is the expected number of customers in the barber shop and in the queue?

iii) How much time can a customer expect to spend in the barber shop?

iv) Find the average time that the customer spent in the queue.

v) The owner of the shop will provide an another chair and another barber when a customers average time spend in the shop exceeds 1.25 hour, by how much should the rate of arrival increase in order to justify a second barber?

vi) Find the number of hours that the shop will be empty?

vii) What is the probability that there will be 6 or more customers in the shop?

c- The mean and variance of the binomial distribution are 6 and 3 respectively; find $P(x \geq 1)$.

A part of the standard normal table

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2517	.2549
0.7	.2580	.2611	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4473	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817

A part of the t- table:

ν	0.10	0.05	0.025	0.02	0.015	0.01	0.0075	0.005	0.0025	0.0005
1	3.078	6.314	12.706	15.895	21.205	31.821	42.434	63.657	127.322	636.590
2	1.886	2.920	4.303	4.849	5.643	6.965	8.073	9.925	14.089	31.598
3	1.638	2.353	3.182	3.482	3.896	4.541	5.047	5.841	7.453	12.924
4	1.533	2.132	2.776	2.999	3.298	3.747	4.088	4.604	5.598	8.610
5	1.476	2.015	2.571	2.757	3.003	3.365	3.634	4.032	4.773	6.869
6	1.440	1.943	2.447	2.612	2.829	3.143	3.372	3.707	4.317	5.959
7	1.415	1.895	2.365	2.517	2.715	2.998	3.203	3.499	4.029	5.408
8	1.397	1.860	2.306	2.449	2.634	2.896	3.085	3.355	3.833	5.041

Tanta University
Faculty of Engineering
Dept. of Communications
Time Allowed:

Opto-Electronics
Date: 16-1-2011
Third Year
3 hours

Answer the following questions:

Question 1: (Answer two points only)

a- Sketch the block diagram of an optical fiber transmission link and state the function of each component in this diagram.

b- Explain with the aid of sketches two different fiber fabrication methods and compare between them.

c- Derive an expression for the numerical aperture of a step index fiber in terms of the refractive indices of the core and cladding. Calculate the numerical aperture of a step index fiber having n_1=1.48 and n_2=1.46. What is the maximum entrance angle of this fiber if the outer medium is air with n=1?

Question 2: (Answer two points only)

a- What is meant by dispersion of light in optical fibers? Explain the types of dispersion in optical fibers. Show mathematically how can you find and expression for the dispersion.

b- Consider a 30 km long optical fiber that has an attenuation of 0.7 dB/km at 1300 nm. Find the optical output power P_{out} if 250 μW of optical power is launched into the fiber.

c- Explain the mechanisms of absorption in optical fibers.

Question 3: (Answer two points only)

a- Derive an expression for the intermodal delay in an optical fiber using the ray-tracing method.

b- Explain the effect of radiation on optical fibers.

c- Explain how the carrier lifetime affects the bandwidth of the LED. Determine the 3-dB optical bandwidth of a LED, given a carrier life time of 5 ns.

Question 4: (Answer two points only)

a- What is meant by the cut-off wavelength of an optical fiber? Determine the cut-off wavelength for a step index fiber to exhibit single mode operation, when the core refractive index and radius are 1.46 and 4.5 μm, respectively, with the relative index difference being 0.25%.

b- Sketch the equivalent circuit of the optical receiver. Explain how the Fourier transform can be used to determine the output of the optical receiver.

c- Show the main differences between the pin and the avalanche photodiodes. Which one is more suitable for low optical power applications? Why?