كلية الاتصالات
٢٠١٩/٦/١

Tanta University

Electronics and Electrical Communications Engineering Dept.

Final Exam: Total 90 Degrees

Faculty of Engineering

Course Title: Digital Comm. Systems Date: Second Term 1/6/2019	Course Code: EEC 3220 Allowed Time: 3 Hours	Year: 3ed No. of Pages: (2)

Answer the following Questions

Question 1: [18 Marks]

a. Comment about the: Stationary process, Ensemble and time average, Ergodic process. [4 Marks]

b. Define and show how to estimate the cumulative distribution function, the probability density function, and the mass function, giving an example for each while commenting about their properties. [4 Marks]

c. Consider a sinusoidal signal with random phase, defined by: $X(t) = A\,cos(2\pi f_c t + \vartheta)$ where A and f_c are constants whereas ϑ is a uniformly distributed random variable as:

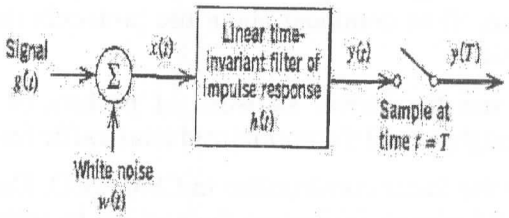
$$f_\vartheta(\theta) = \begin{cases} \dfrac{1}{2\pi}, & -\pi \le \theta \le \pi \\ 0, & elsewhere \end{cases}$$

Obtain and draw its autocorrelation. [5 Marks]

d. Suppose white Gaussian noise of zero mean and $N_0/2$ power spectral density is applied to an ideal low-pass filter of bandwidth B. Estimate and draw the power spectral density of noise at the filter output in addition to its autocorrelation function. [5 Marks]

Question 2: [18 Marks]

a. For the linear time invariant receiver shown, prove that the output pulse signal to noise ratio is given by: $\eta \le \frac{2}{N_o}\int_{-\infty}^{\infty}|G(f)|^2\,dx$. Then Comment. [5 Marks]



b. Consider a binary PCM based on polar non return-to-zero (NRZ) signaling, draw the construction of the matched filter receiver. Prove the conditional probability density function of its output given that the logic 0 was sent. [5 Marks]

c. State and explain the meaning of the three properties of the matched filter. [4 Marks]

d. Explain using the raised cosine in minimizing ISI indicating its merits and drawback. [4 Marks]

Question 3: [18 Marks]

a. Define and illustrate the minimum shift keying MSK modulation formats indicating its merits and drawbacks if any. [4 Marks]

b. Draw the construction and explain the design parameters for QPSK modulation technique including truth table, phasor and constellation diagram. Then illustrate its operation. [5 Marks]

c. Show how to estimate the bandwidth of 8 QAM digital modulation. Then show how to determine the output of such scheme when its binary input is 101. [5 Marks]

d. Discuss the operation of the Re-modulator loop carrier recovery circuit when its input is a binary BPSK signal e.g: $Am(t)\sin\omega_c t$. Assume a phase shift θ as compared to the receiver reference carrier. [4 Marks]

Question 4: [18 Marks]

a. Define and show how to estimate the ratio E_b/N_o. What is the difference between it and the well-known ratio C/N? Which one is preferred in comparing the performance of various digital techniques and why. [4 Marks]

b. Illustrate the meaning of multiplexing and multiple access. Then show what is meant by fixed, demand and random access techniques giving an example for each. Then explain the operation of the FDM/FM/FDMA. [5 Marks]

c. Define and indicate the construction of the SPADE system, then explain its operation briefly [5 Marks]

d. Illustrate an example for rapidly polling user population to resolve contention among users in the above SPADE system. [4 Marks]

Question 5: [18 Marks]

a. Illustrate with drawing the steps for information flow inside the demand assignment multiple access technique. Then comment about the protocols that could be used showing which is preferred and why. [4 Marks]

b. Show how to use the arrival statistics of packets to estimate the relation between the normalized throughput and the normalized total traffic for pure ALOHA technique. [4 Marks]

c. Explain briefly the frame construction in CSMA/CD. Draw an example of data stream using Manchester PCM formats indicating the concept by which the transmitting terminal ensures the end of the packet. [5 Marks]

d. Illustrates the concepts and the operation of Token Ring Networks. [5 Marks]

With best wishes

Dr. Mahmoud A. A. Ali

Course Coordinator: Prof. Mahmoud Ahmed Attia Ali

٣ - اتصالات

٢٠١٩/٦/٣

Electronics and Electrical Comm. Dept.
Total Marks: 85 Marks

Course Title: **Electromagnetic Waves (2)**	Course Code: EEC 3214	Year: 3rd
Date: Sept., 3-6-2019	Allowed Time: 3 Hours	No. of Pages: (2)

Question (4) [17 Marks]

a) If the general form of the magnitude of the electric field component of the long dipole is given by

$$|E_\theta| = 60\,\frac{I_m}{r}\left[\frac{\cos\left(\frac{\beta L}{2}\cos\theta\right) - \cos\left(\frac{\beta L}{2}\right)}{\sin\theta}\right]$$

For $\lambda/2$ dipole antenna find:

1. The average radiated power $\bar{P}_{av}$
2. The total radiated power W_{rad}
3. Input resistance.
4. Effective area.
5. Plot the E-plane and H-plane patterns of the antenna.

Question (5) [17 marks]

(a) For travelling wave antenna (TWA);

1. **Write only** the equation of the electric field component $|E_\theta|$.
2. Derive expressions for **location of nulls** and **location of peaks** of the TWA field pattern.

(b) For a TWA of length $L = 5\lambda$

1. Draw the radiation pattern of the antenna.
2. **Design and draw** its corresponding rhombic antenna to cancel the two main lobes problem of the TWA.

Course Coordinator: *Prof. Amr Hussein*

Electronics and Electrical Comm. Dept.
Total Marks: 85 Marks

Course Title: **Electromagnetic Waves (2)**	Course Code: EEC 3214	Year: 3rd
Date: Sept., 3-6-2019	Allowed Time: 3 Hours	No. of Pages: (2)

Answer the following questions:

Question (1) [17 Marks]

a) **Answer the following terms:**

1- **State** the different types of antennas in terms of **bandwidth** and **directivity**.
2- **Explain why** the parabolic antenna with cassegrain feed provides higher gain than the parabolic antenna with front feed.
3- **Explain** the **structure** and **applications** of aperture antennas.

b) **Derive** expressions for both **electric** and **magnetic** potential vectors of the antennas in the static case.

Question (2) [17 Marks]

a) **Explain** the following terms with **equations and drawing**:
1. Poynting vector.
2. Antenna radiation resistance.
3. Antenna effective area.

b) If the radial component of the radiated power density of the antenna is given by $P_{av} = 10\frac{\cos\theta}{r^2}\ \hat{r}$.
1. Determine the total power radiated from the antenna.
2. Determine the radiation intensity of the antenna.

Question (3) [17 Marks]

a) For **short dipole** antenna, **derive an expression for** the magnetic potential A_z.
b) For the short dipole antenna, **Find;**
1. The electric field component E_θ
2. The average radiated power $\bar{P}_{av}$
3. The total radiated power W_{rad}
4. Radiation resistance R_{rad}
5. Derive the half power beamwidth and null to null beamwidth of the antenna
6. **Plot** the **E-plane** and the **H-plane** patterns if the dipole antenna is oriented in **Y-direction**.

٣- اتصالات

٢٠١٩-٦-٨

Tanta University | Department: Electronics and Communication Engineering | Total Marks: (75) Marks | Faculty of Engineering

Course: Optical communications	**Course Code:** EEC 3213	**Year:** 2nd Semester 2017-2018
Date: 8/6/2019 (**Final Exam**)	**Allowed Time:** 3 hours	**No of Pages:** (3) pages

Remarks: Answer all of the following Questions and assume any missing data.

Question # 1: (15) Marks

(a) (**5 Marks**) Define what is meant by a photodiode response time, draw a simple model of photodiode receiver and its equivalent circuit, then mention **three** factors that affect the photodiode response time.

(b) (**5 Marks**) If the photodiode capacitance is 3pF, the amplifier capacitance is 4 pF, the load resistor is 1kΩ, and the amplifier input resistance is 1 MΩ, Evaluate the circuit bandwidth. If we reduce the photodetector load resistance to 50Ω, then Reevaluate the circuit bandwidth and comment your results.

(c) (**5 Marks**) A high-speed $In_{0.53}Ga_{0.47}As$ PIN photodiode is made with a depletion layer thickness of 0.15 μm.
(i) What percent of incident photons are absorbed in this photodiode at 1310 nm if the absorption coefficient is 1.2 μm^{-1} at this wavelength?
(ii) If the photodetector has the following parameters at a wavelength of 1310 nm: $I_D = 5$ nA, $\eta = 0.85$, $R_L = 2$ kΩ, and the surface leakage current is negligible. The incident optical power is 500 nW. and the receiver bandwidth is 20 MHz. Find the photodiode responsivity and primary photocurrent.
(iii) Find the various noise terms of the receiver then evaluate the SNR in dB.

Question # 2: (15) Marks

(a) (**5 Marks**) Explain **Briefly** the following: Bit error rate, receiver sensitivity, and quantum limit.

(b) (**5 Marks**) Derive the following expression of a bit error rate in a digital receiver: $BER = \frac{1}{2}\left[1 - \text{erf}\left(\frac{V}{2\sqrt{2}\sigma}\right)\right]$, where σ is the rms noise and $\frac{V}{\sigma}$ is the peak SNR.

(c) (**5 Marks**) Consider an optical receiver to have a load resistor $R_L = 400\Omega$ and let the temperature be $T = 300^0$ K. Assume the electrical bandwidth B_e of the receiver is assumed to be **half** the data rate B. Assume the photodiode responsivity $\mathscr{R} = 0.9$ A/W. Let the amplifier noise figure be $F_n = 4$ dB, assume an operating BER $= 10^{-9}$

is needed at 1550 nm, what is the receiver sensitivity at a 2.5 Gb/s data rate for the following cases: (i) InGaAs PIN photodiode (ii) InGaAs APD photodiode for which $M = 10$ and $F(M) = 5$. Then compare between both sensitivities.

Question # 3: (15) Marks

(a) **(5 Marks)** An engineer has the following components available: GaAlAs laser diode operating at 850 nm and capable of coupling 10 μW into a fiber. Five sections of cable each of which is 400 m long, has a 3 dB/km attenuation, and has connectors on both ends. Connector loss of 2 dB/connector. Using these components, the engineer wishes to construct a 2 km link operating at 20 Mb/s. A PIN photodiode receiver with sensitivity of -40 dBm and an APD receiver with sensitivity of -52 dBm. (i) Which photodiode should be used if at least 6 dB system margin is required? (ii) (iii) Draw the received power versus distance d for the optical link.

(b) **(5 Marks)** Assume that the laser diode together with its drive circuit has a rise time of 0.025 ns. Taking a 1550nm laser diode spectral width of 0.1 nm and an average dispersion of 2ps/(nm.km) for the fiber, we have a GVD-related rise time degradation of 12 ps over a 60 km long optical cable. Assuming the InGaAs-APD-based receiver has a 2.5 GHz bandwidth. What is the system rise time? does this rise time meet the NRZ data requirement of being less than 70 % of a pulse width?

(c) **(5 Marks)** Consider the generator polynomial $x^3 + x + 1$. Calculate the CRC for the data unit 1101. If the resulting code word has an error in the second bit when it arrives at the destination, what is the CRC calculated by the receiver?

Question # 4: (15) Marks

(a) **(6 Marks)** Explain briefly what is meant by: (i) harmonic and inter-modulation distortion. (ii) beat-stacking. (iii) spur free dynamic range (SFDR).

(b) **(3 Marks)** Consider a four channel FDM system having carriers at f_1, $f2 = f_1 + \Delta$, $f3 = f_1 + 2\Delta$, and $f4 = f_1 + 3\Delta$, where Δ is the spacing between carriers. On a frequency plot, show the number and location of the triple-beat and two-tone third-order inter-modulation products.

(c) **(3 Marks)** Calculate the gain for a directly modulated analog link using the parameter values given as: $S_M = 0.3W/A$, $\eta_{LF} = \eta_{FD} = 0.8$, $T_F = 0.7$, $R_{load} = 50\Omega$, $R_M = 45\Omega$, $\mathscr{R} = 0.6A/W$ at 850 nm.

(d) **(3 Marks)** Explain what is meant by the microwave photonics indicting its key components.

Question # 5: (15) Marks

(a) **(5 Marks)** Derive an expression for the scattering matrix of a 3 dB coupler. With the aid of this matrix, prove that the power is divided equally between the output ports in the 3-dB coupler.

(b) **(5 Marks)** Explain the construction and idea of operation of 2×2 Mach-Zehnder Interferometer (MZI) Multiplexers. Then prove that the length difference in the interferometer arms should be $\Delta L = \frac{c}{2n_{eff}\Delta\nu}$, where $\Delta\nu$ is teh frequency separation of the two wavelengths.

(c) **(5 Marks)** Use 2×2 MZIs to design an 8×1 multiplexer that can handle a channel separation of 25 GHz. Let the shortest wavelength be 1550 nm. Specify the value of ΔL for the 2×2 MZIs in each stage.

Formulas and Constants:

Electron charge, $q = 1.602 \times 10^{-19}$ C

Planck's constant, $h = 6.625 \times 10^{-34}$ J.s

Velocity of light, $c = 3 \times 10^{8}$ m/s

Boltzmann's constant, $k_B = 1.38 \times 10^{-23}$ J/K

(1) Two-tone terms: $D_{1,2} = \frac{1}{2}\left\{N - 2 - \frac{1}{2}[1 - (-1)^N](-1)^r\right\}$

(2) Triple-beat terms: $D_{1,1,1} = \frac{r}{2}(N-r+1) + \frac{1}{4}\left\{(N-3)^2 - 5 - \frac{1}{2}[1-(-1)^N](-1)^{N+r}\right\}$

Good Luck

Dr. Hussein E. Seleem (Course Coordinator)

Tanta University

Department: Electronics & Comm. Engineering
Total Marks: 75 Marks

Faculty Faculty of Engineering

Course Title: Applications of Microprocessor in Comm. Sys. Course Code: EEC3215 Year: Third Year
Date: 12/6/2019 (Second term) Allowed time: 3 hrs No. of Pages: (2)

Remarks: (answer the following questions… assume any missing data… answers should be supported by sketches…etc)

Question (1): **[20 mark]**

a. Put (✓) sign in the front of correct statement and (×) sign in the front of incorrect one:

Item	Statement	Sign
1	MOS devices are sensitive to static charge, so we use conductive foam.	
2	The logic function of the PLD can be changed without rewiring and used for different applications	
3	In VHDL Structural approach can be described in terms of basic logic gates and their interconnections	
4	In VHDL Data flow approach can be described by how signals flow through the logic gates	
5	A VHDL architecture describe the operation of a logic function	
6	In VHDL, the number of input and output ports is determined by the function being described.	
7	A GAL has a reprogrammable AND array, a fixed OR array, and programmable output logic.	
8	Multiple –bit adders can be implemented in FPGAs using the carry chain.	
9	In structural VHDL programming, components are used to allow the reuse of predefined VHDL code.	
10	An example of behavioural modelling is a state diagram.	

b. Sketch the flow chart of the VHDL programming process and explain the function of each element. **[5 Marks]**

c. The flight safety system requires a logic 1 to illuminate the indicator lights .Each hydraulic system has a sensor that returns a logic 1 when the hydraulic system is operable and a 0 when it is not. ***Write the VHDL code*** of the SOP logic for monitoring the flight safety hydraulic system as shown in Fig1. **[5 marks]**

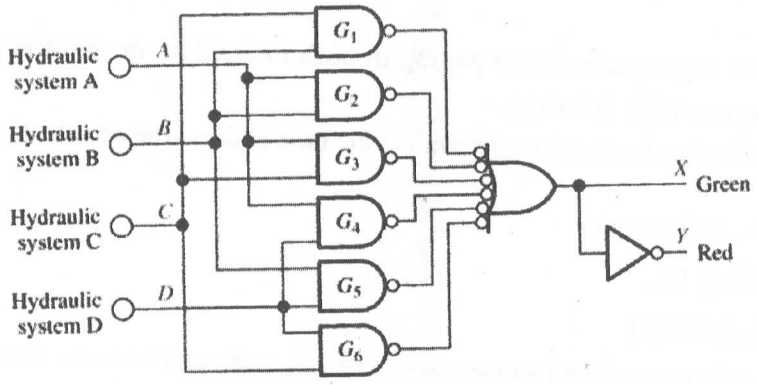


Fig.1

Question (2)

[15 Marks]

a. Sketch a system block diagram of the traffic light controller system and explain its operation and the function of each block.

b. (i) Write a VHDL program that reads a set of 7 input bits then counts the number of bits that are "1" ,and sends the count to an output port.
(ii) Write a complete VHDL program for a BCD - to Decimal decoder.

c. (i) Sketch the block diagram of an FPGA, and explain its operation and the function of each block? Explain how a look-up-table (LUT) works?
(ii) Explain the difference between the basic concept of antifuse and SRAM interconnection?

Question (3)

[15 Marks]

Complete the following sentences:

a. The fetching cycle takes the ..... required from memory and stores it in the instruction register.
b. ..... is used to store return addresses.
c. DX register holds.....
d. Memory address register (MAR) holds.....
e. .....are stored in the flag register.
f. .....unit contains ALU.
g. Instruction decoding unit decodes instructions; sends information to .....
h. Accumulator register is a register in which.....
i. Base register is the only general purpose register whose contents can be used for .....
j. A bus system connects .....of a computer.
k. Control unit controls.....
l. If tarp flag is set, the processor .....
m. Offset address selects any location within .....
n. ..... tables are a maximum of 64K bytes in length.
o. The first.....byte of memory is called the DOS memory.

Question (4)

[25 Marks]

a. What are the BIU registers in 8086 microprocessors? Mention the function of each one.
b. List the main parts of both the selector and the descriptor in the memory protected mode. Which part is responsible for determining the level of memory protection and which part is invisible?
c. Compare between segmentation and paging in both the real mode and the protected mode. Indicate your answer with drawing.
d. For each of the following instructions determine: the base address-the offset address-the addressing mode.
    1. MOV AX, DS: [1235]
    2. MOV [8088], DL
    3. MOV AL, [BP+SI]

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End of Questions
Good Luck

Prof./ Mustafa Mahmoud
Dr./ Roayat Ismail

Tanta University

Department: Electronics and Electrical Communications Engineering

Faculty of Engineering

Total Marks: 70 Marks

Final Exam

Course Title: Biomedical Electronics (Elective course 2) Course Code: EEC3216 Year: 3rd

Date: 15/06/2019 Allowed time: (3) hr. No. of Pages: 2

Please answer the following questions

Question # 1: (20 Marks)

A) Compare between the characteristics of the deterministic and stochastic biosignals.

B) Demonstrate the parts of the x-ray tube with detailed explanation of their functionality.

C) What are the main characteristics for selecting the proper sensor?-Define each and mention at least 6 characteristics.

D) Compare between each of the following pairs:

1- **Active and passive sensors**

2- **Digital and analog sensors**

3- **Deflection and null methods**

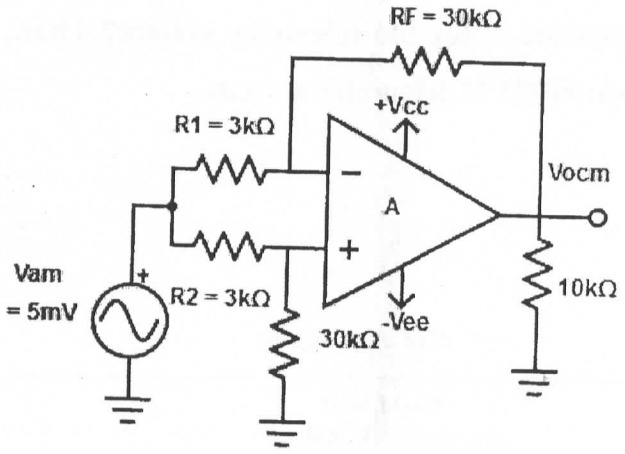
4- **Variable inductance and capacitance transducers**

Question # 2: (20 Marks)

A) In the 12 lead ECG systems, draw the 3 circuits of the polar augmented limb leads with explanation.

B) Draw the ECG amplifier circuit with right leg driver and mention its use.

C) In the following circuit, determine the common mode output voltage. Given CMRR=65 dB.

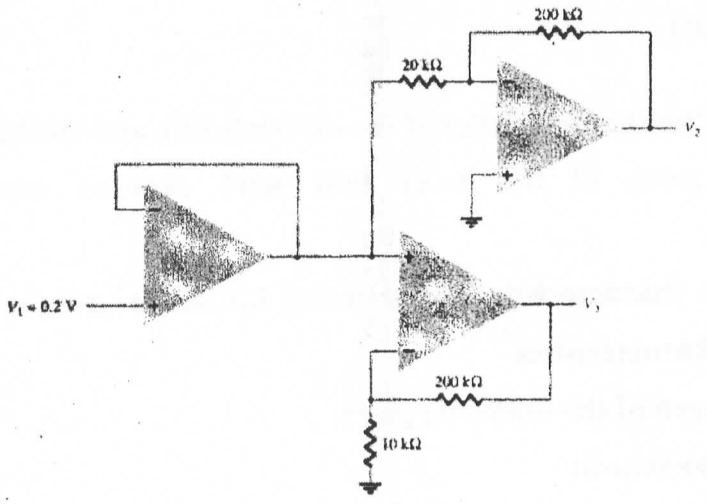


D) Illustrate the 3-Layered RC Electro-Surgery Unit (ESU) filter. Then, draw the LC ESU circuit.

Question # 3: (20 Marks)

A) Mention the main two types of the Electromyogram electrodes. Then, draw the block diagram of the EMG circuit.

B) Calculate the output voltages V_2 and V_3 in the following circuit.



C) What are the properties of an ideal pre-amplifier that can be used in the biomedical circuits? Then, mention the different types of the Tachometer and its different applications in the medical domain.

D) Compare between the x-ray and the computed tomography imaging systems.

Question # 4: (10 Marks)

A) Draw the simple block diagram of the patient monitoring system and the bed-side monitoring circuit.

B) What are the main components of the bio-telemetry system? Then, provide the block diagram of the single channel PWM telemetry system.

End of questions

Good luck
Dr. Amira S. Ashour

٣-١ نصارت

٢٠١٩/٩/١٩

Tanta University | **Department of Electronics and Electrical Communication Engineering** | **Faculty of Engineering**

Course Title: **Acoustics and Ultrasonics** | Course Code: EEC 3221, | Students: **3rd year.**
Date: **Wed.,19-June-2019,** | Time Allowed: **3 hours,** | No. of Pages: **2**
Total Marks: **85**
Final Exam

Question 1: *[15 points]*

Choose the correct answer for the following questions.

You MUST draw this table in your booklet and put the answers in it.

1-		5-		9-		13-	
2-		6-		10-		14-	
3-		7-		11-		15-	
4-		8-		12-			

1- *The sound LL for feeling threshold is....*

A 140 dB B 120 dB
C 140 phon D 120 phon

2- *The sound LL for threshold of pain is ....*

A 140 dB B 120 dB
C 140 phon D 120 phon

3- *The sound wave's phase velocity is different from group velocity if ....*

A The medium is irregular B The medium is dispersive
C The temperature varies D None of these answers

4- *The sound wave energy is transported by a velocity called ....*

A Phase velocity B Bothe A, C
C Group velocity D None of these answers

5- *The intensity of sound in a spherical wave diminishes as ..... from the source.*

A $1/r^2$ B r^2
C $1/r$ D $1/r^3$

6- ..... *Is the ratio of sound pressure to particle velocity in an infinite plane wave.*

A Sound field impedance B Acoustical impedance
C Characteristic impedance D Wave impedance

7- *The unit of characteristic impedance is .....*

A N/sm^3 B Nm/s
C Ns/m^3 D None of these answers

8- *The ultrasonic waves can be used in many applications, including .....*

A Ranging, and flow meter B Both A, C
C Welding and drilling D Other applications.

9- *In human ear, the "middle ear" parts act as .....*

A Band pass filter B Acoustical resonator
C Low pass filter D Mechanical transformer

10- *The ultrasonic waves have frequencies ....*

A Over 20 KHz B Over 10 KHz
C Below 20 KHz D below 10 KHz

11- *These are ultrasonic waves features except ....*

A They have heating effects B They can be reflected
C They always experience high losses in solids D They have high energy

12- *The percentage at which the speech is understood correctly is called.....*

A intelligibility B articulation
C Threshold of hearing D None of these answers

13- *The shape of the pinna is important because.....*

A It helps in attenuating high pressures B It protects inner ear
C It helps in directional hearing D A, B, C

14- *Humans may be able to detect rms sound pressures ranges from....*

A 10 Pa to 100 Pa B 5 uPa to 100 uPa
C 5 Pa to 100 Pa D 5 uPa to 100 Pa

15- *Sensitivity of a microphone is defined as output in millivolts for the...*

A Sound level of 10 uPa B sound pressure of 10 pascal at 1 KHz
C sound pressure of 1 pascal at 10 KHz D sound pressure of 1 pascal at 1 KHz

***Question 2:** [15 points]*

a) compare the different acoustical impedances and show how they can be related to each other.

b) For an obliquely incident sound wave on an interface between two media: Draw the incident, reflected and transmitted waves, and write the equations for reflection and transmission coefficients for all reactions of the receiving medium.

c) A sinusoidal sound wave is described by the displacement wave function in air

$$s(x,t) = (7.00\ \mu m)\ sin[(12.7m^{-1})x - (758s^{-1})t]$$

i. Find the displacement amplitude, wavelength, and speed of this wave.

ii. Find the temperature of the air.

iii. Determine the instantaneous displacement of air at the position $x = 0.2m$ at $t = 15.0\ ms$.

***Question 3:** [15 points]*

a) Draw the model of the human ear and show the function of each part.

b) Define: Loudness, Pitch, and Timbre, Reverberation and Reverberation time.

c) To calculate the total (unweighted) sound pressure level using *band-limited* data for noise, one usually assumes that the octave band signal components are uncorrelated. A certain spectrum has the following octave band sound pressure level data:

Octave band (Hz)	**63**	**125**	**250**	**500**	**1K**	**2K**	**4K**	**8K**
Lp [dB] re. 20 uPa	**55**	**44**	**65**	**66**	**70**	**48**	**45**	**38**

Calculate, assuming the signal components uncorrelated, the linear sound pressure level.

***Question 4:** [20 points]*

a) Briefly explain the sound levels due to direct and reverberant fields. Support your answers with the necessary equations.

b) An auditorium has dimensions $10.0m\ high \times 30.0m\ length \times 20m\ width$. The floor is carpeted and one of the longer walls has gypsum boards mounted on studs the entire length, while the other three walls and the ceiling are constructed of plaster. The 20m wall has three glass windows with $3m \times 2m$. At the $2\ KHz$, use the given data in the table to find:

	Octave band center frequency (Hz)					
	125	**250**	**500**	**1000**	**2000**	**4000**
Carpet on concrete	**0.02**	**0.06**	**0.14**	**0.37**	**0.60**	**0.65**
Gypsum, board 0.5 in.	**0.29**	**0.10**	**0.05**	**0.04**	**0.07**	**0.09**
Plaster,	**0.02**	**0.03**	**0.04**	**0.05**	**0.04**	**0.03**
Glass, standard window	**0.35**	**0.25**	**0.18**	**0.12**	**0.07**	**0.04**

i. determine the reverberation time from the Sabine equation.

ii. Suggest a method for reducing that reverberation time

iii. compute the room constant R.

c) Draw the microphone sensitivity measurement system.

Question 5: [20 points]

a) Distinguish between the methods for generating the ultrasonic waves by explaining the principle of operation, circuit diagram, advantages and disadvantages.

b) A piezoelectric based ultrasonic generator has a quartz crystal with thickness of $1.2\ mm$ and a young's modulus of $Y = 7.9 \times 10^{10}\ N/m^2$ and a density $\rho = 2650\ Kg/m^3$. Find the fundamental vibration frequency and first possible three harmonics.

c) Using sketches, compare the structure of the different types of microphones.

d) Using sketches, compare the structure of the different types of loudspeakers.

The end of questions

Use only black or blue pens or pencils in your answer
Do not make any mark in your booklet
Answer only the required questions (Extra answers will not be considered)

Good luck
Dr. Sameh A. Napoleon (Coordinator of the Course)