Khulna University of Engineering & Technology
B. Sc. Engineering 3rd Year 1st Term Examination, 2019
Department of Biomedical Engineering

BME 3101
Cell Biology

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 **Answer Script A**)

1.	a)	What is cell biology? How can you differentiate the bacterial cell from animal cell?	(08)
	b)	List the name of the different types of human cell. Define stem cell. Enumerate the characteristics of stem cell.	(10)
	c)	What are the components of cell membrane? Briefly explain with proper diagram.	(12)
	d)	Write short note on chloroplast.	(05)
2.	a)	Which organelle is selected for drug delivery and why? Briefly explain with diagram. List the difference and similarity of Lysosomes and peroxisome.	(12)
	b)	Where and how cellular respiration takes place in plant cell? Explain with neat sketch.	(08)
	c)	Which part of the cell controls the cell? Draw and label the cell controlling organelle with short description.	(10)
	d)	How microtubules in cilia and flagella are arranged?	(05)
3.	a)	What is membrane transport? Describe reverse osmosis and forward osmosis with proper diagram.	(10)
	b)	What is receptor? List it's importance. Discuss about ligand-gated ion channel with neat sketch.	(10)
	c)	Write down the classification of cell junction. Briefly explain the gan junction as a electrical synapse with proper diagram.	(15)
4.	a)	What are major four tissues in human body? Explain the three mechanisms by which cell-surface molecules can mediate cell-cell adhesion.	(10)
	b)	Write short notes on: (i) CAMs, (ii) ECM, (iii) BMR.	(12)
	c)	For human cell where the cellular respiration takes place and how?	(06)
	d)	What are calories? Calculate the total kcal from a large size egg that's weight is 259 g and it contains Fat: 19.2 g, Protein: 33.5g and Carbohydrate: 0.9 g.	(07)

Section B

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

5.	a)	What is RNA? What are the major types of RNA? Enumerate the structural characteristics of t-RNA?	(15)
	b)	What is DNA? Draw the Watson-Crick model of DNA. Enumerate its characteristics in details.	(10)
	c)	Write down the differences between mitosis and meiosis?	(10)
6.	a)	Draw and label the given stage of cell cycle: (i) Telophase, (ii) Metaphase, (iii) Prophase, (iv) Diplotene, (v) Diakinesis.	(15)
	b)	What are the basic steps of PCR? Write down the importance of PCR.	(10)
	c)	Write short notes on: (i) Mitogen, (ii) Cyclin.	(10)
7.	a)	What is Cloning? Enumerate the process of cloning in details.	(10)
	b)	What is cell cycle? Explain the major stages of cell cycle.	(10)
	c)	Enumerate different kinds of stem cell with example. Write down the importance of IPS.	(10)
	d)	***Write short notes on Hypertrophy and Hyperplasia.***	***(05)***
8.	a)	What is recombinant DNA technology? Explain the importance of recombinant DNA technology in modern days.	(10)
	b)	What is metastasis? Enumerate different route of metastasis with example.	(10)
	c)	What is DNA replication? Explain the replication process in details.	(10)
	d)	Write short note on m-RNA.	(05)

Khulna University of Engineering & Technology
B. Sc. Engineering 3rd Year 1st Term Examination, 2019
Department of Biomedical Engineering

BME 3103

Bioelectricity

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 **Answer Script A**)

1. a) What is neurotransmitter? Enumerate different types of neurotransmitter. Write down the functions of these following neurotransmitter: (i) Dopamine; (ii) Ach; (iii) Endorphins. (15)

b) What is pain? Enumerate the pathway of pain. (10)

c) What is reflex arc? Enumerate the basic steps of reflex arc. (10)

2. a) Classify nervous system. Write down the differences between sympathetic and para-sympathetic nervous system. (10)

b) Explain the pyramidal tract pathways. (10)

c) Classify generalized seizure. What are common treatment procedures that are used in epilepsy? Explain the use of vagal stimulation in epilepsy. (15)

3. a) What is resting membrane potential? Write down the characteristics of resting membrane potential. (10)

b) Derive Nernst equation for equilibrium condition associated with semipermeable cell membrane. (10)

c) What is ion channel? Draw and label the schematic of ion channel. What are the importances of ion channel? (10)

d) Write down the differences between sensory and motor nervous system. (05)

4. a) What are the common features of Parkinson's disease? Write down the application of bioelectricity in Parkinson's disease. (13)

b) Discuss applications of bioimpedance in clinical settings. (12)

c) Write short notes on different types of bioelectric stimulations. (10)

Section B

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

5. a) What are the purposes of modeling biological systems? How many ways can you model volume sources? (07)

b) Define Lead vector. How can you construct orthonormal lead systems using image surface approach? Explain with neat sketch. (11)

c) Deduce mathematical expression of lead voltage using principle of reciprocity. (12)

d) Distinguish between sensitivities in EEG lead system and in bioimpedance measurement lead system. (05)

6. a) Discuss voltage clamp method with proper circuit diagram. (10)

b) Develop cable equation for neuron. What process is described by cable equation? (15)

c) What are the predictions of Hodgkin-Huxley model? Explain. (10)

7. a) Define bioimpedance. Explain bioimpedance measurement methods of TPIM and EIT mentioning their respective advantages and disadvantages. (16)

b) Construct a model to explain electrical behavior of biological cells or tissues. (11)

c) Draw a basic electronic circuit for bioimpedance measurement. (08)

8. a) Discuss application of Lead theory to EEG lead system. (10)

b) How can you describe active conduction in neuron? Develop necessary equation. (13)

c) Write short notes on: (12)
(i) Dielectric and polarization property of tissue.
(ii) Cole-cole plot for bioimpedance.

Khulna University of Engineering & Technology
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BME 3111

Biomedical Signal 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 **Answer Script A**)

1. a) Define biosignal, digital signal and digital signal processing. What are the applications of biomedical signal processing? (08)

b) What do you understand by the following terms: Nyquist frequency, Nyquist rate, Sampling rate, sampling frequency? (12)

c) What are the different types of biomedical signal? Mention their amplitude and frequency characteristics. What kind of information is obtained from these biomedical signals? (15)

2. a) What is the role of DFT in digital signal processing? Calculate FFT of the data sequence $x(n) = \{0,1,2,3,3,2,1,0\}$ using butterfly structure and plot the amplitude and phase spectra if the data is sampled at 8 kHz. (15)

b) What is computational complexity of FFT and DFT? Derive them. For $N = 1024$, what is the ratio of computational complexity on DFT and FFT? (12)

c) Verify that $\boldsymbol{X}_N = \boldsymbol{W}_N \boldsymbol{x}_N$, where the symbols have their usual meanings. (08)

3. a) Find the discrete time sequence, $x(n)$ in closed form, with the following z-transform by using any method: (15)

$$X(z) = \frac{z^2 + 2z + 1}{z^2 - z + 0.3561}.$$

b) The transfer function of a discrete time system has poles at $z = 0.5$, $z = 0.1 \pm j0.2$ and zeros at $z = -1$ and $z = 1$. (14)
(i) Sketch the pole-zero diagram for the system,
(ii) Derive the system transfer function H(z),
(iii) Develop the difference equation.

c) Sketch the mapping of complex Laplace variable to complex Z-variable by showing the location of the pole in s-plane and z-plane. (06)

4. a) Define cross correlation and auto correlation. Write down their applications in biomedical signal analyses. (08)

b) Determine the output of an electrical system of impulse response function {0, 0.899, 0.990, 0.991, 1} when the input {0, 2.5, 5.0, 0} (volts) is applied by using: (15)
(i) Direct convolution and
(ii) Convolution theorem.

c) A test signal $x(n) = \{1, 1, 1\}$ is applied to a system with an unknown impulse response, $h(n)$. The observed output is $y(n) = \{1, 4, 8, 10, 8, 4, 1\}$. Determine $h(n)$. (12)

Section B

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

5. a) Define filter and digital filter. Briefly describe the limitations of digital filter over analog filter. (10)

b) Briefly describe the specification of filters in frequency domain with the help of tolerance scheme. (10)

c) What are the properties of an FIR and IIR filter? State their importance. State the transfer function of FIR and IIR filter mathematically. What are the criteria for choosing FIR and IIR filters. (15)

6. a) An FIR digital filter has impulse response, $h(n)$, defined over the interval $0 \leq n \leq N-1$. Show that if $N = 7$ and $h(n)$ satisfies symmetry condition $h(n) = h(N-n-1)$ the filter has a linear phase characteristics. (10)

b) Compare the window, optimum and frequency sampling methods for FIR filter's coefficient calculation. (10)

c) Using the pole-zero placement method determine the transfer function, the difference equation as well as the coefficients of a notch filter that meets the following specifications. (15)

Notch Frequency	50 Hz
3 dB width of notch	±5 Hz
Sampling frequency	500 Hz

7. a) It is required to design a digital filter to approximate the following normalized analogue transfer function: (20)

$$H(s) = \frac{1}{s^2 + \sqrt{2}s + 1}$$

Using the impulse invariant method obtain the transfer function, H(z), of the digital filter, assuming a 3 dB cutoff frequency of 150 Hz and a sampling frequency of 1.28 kHz. In case of complex conjugate poles the transfer function may be represented by

$$H(z) = \frac{2C_r - [C_r \cos(P_i T) + C_i \sin(P_i T)]2e^{p_r T} z^{-1}}{1 - 2e^{p_r T} \cos(P_i T)\, z^{-1} + e^{p_r T} z^{-2}}.$$

b) It is required to design a digital filter to approximate the following analogue transfer function: (15)

$$H(s) = \frac{1}{s^2 + \sqrt{2}s + 1}$$

Using BZT method obtain the transfer function, H(z), of the digital filter, assuming a 3 dB cutoff frequency of 150 Hz and a sampling frequency of 1.28 kHz.

8. a) Illustrate amplitude and phase spectra. Why spectrum estimation is important in signal processing? (10)

b) What is spectral leakage? Explain spectral leakage with suitable example. (10)

c) Briefly describe the autoregressive spectrum estimation method. (10)

d) Write short note on run length encoding. (05)

Khulna University of Engineering & Technology
B. Sc. Engineering 3rd Year 1st Term Examination, 2019
Department of Biomedical Engineering
CSE 3115
Microprocessors and Microcontrollers

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 **Answer Script A**)

1. a) What is assembly language? Compare the advantages, disadvantages between assembly language and high level language. (08)

b) Construct the binary code for each of the following 8086 instructions using tableQ1(b): (12)
(i) ADD BX, 59H[DI] (ii) MOV 43H[SI], DH (iii) MOV CX, [437AH]

Table Q1(b): MOD and R/M bit patterns for 8086 instructions

MOD / R/M	00	01	10	11	
				W=0	W=1
000	[BX]+[SI]	[BX]+[SI]+d8	[BX]+[SI]+d16	AL	AX
001	[BX]+[DI]	[BX]+[DI]+d8	[BX]+[DI]+d16	CL	CX
010	[BP]+[SI]	[BP]+[SI]+d8	[BP]+[SI]+d16	DL	DX
011	[BP]+[DI]	[BP]+[DI]+d8	[BP]+[DI]+d16	BL	BX
100	[SI]	[SI]+d8	[SI]+d16	AH	SP
101	[DI]	[DI]+d8	[DI]+d16	CH	BP
110	d16(direct address)	[BP]+d8	[BP]+d16	DH	SI
111	[BX]	[BX]+d8	[BX]+d16	BH	DI

c) Draw the internal block diagram of 8086 microprocessor. (10)

d) Write short notes on 8086 flag registers. (05)

2. a) Differentiate between Intra-segment Jump and Inter-segment Jump for 8086 microprocessor. (08)

b) Consider a system where the job of 8086 is to check a temperature sensor and turn on a green lamp or a yellow lamp depending on the value of the temperature it reads in. If the temperature is below 30°C, we want to turn on a yellow lamp otherwise we want to light a green lamp. (12)
(i) Draw a flowchart of the system
(ii) Write a program using assembly language to implement the system.

c) (10)

```
                        ; Clock Cycles
          MOV CX,N      ; 4=Co
Kill_Time :NOP          ; 3
          NOP           ; 3
          LOOP Kill_Time ; 17 or 5
```

Find the value of N, where the delay loop produces a delay of 1ms on an 8086 with a 5 MHz clock.

d) Illustrate the significance of Directives in 8086 microprocessor. (05)

3. a) Illustrate Reentrant procedure with necessary figure. Write down the conditions that are crucial for a procedure to be Reentrant. (12)

b) Specify Macros. Explain how you can pass parameters to macros with necessary examples. (10)

c) "The priority resolver of 8259A acts as a judge"- Justify the statement. (08)

d) Why is the INTR input automatically disabled as a part of the response to an INTR interrupt? Justify your answer. (05)

4. a) Specify Brain Implants. How do Brain Implants work? (10)

b) Illustrate pipelining and dual-pipelining to achieve instruction-level parallelism using necessary figures. (10)

c) Multiply two numbers using the following approaches: (10)
(i) CISC approach
(ii) RISC approach

d) Demonstrate the different advantages of bit-slice microprocessors. (05)

Section B

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

5. a) What are the criteria for choosing a microcontroller? Briefly explain Von Neumann and Harvard architecture of microcontroller with appropriate figure(s). (10)

b) Differentiate between microprocessors and microcontrollers. (08)

c) How do 8086 and 8087 execute their respective instructions? (08)

d) Convert 9.75_{10} to single-precision (short real) floating point. (09)

6. a) What are the conditions of stack in math co-processor (8087) after performing following operations sequentially? (08)

(i) After reset
(ii) Perform 5 PUSH operations
(iii) Perform 3 POP operations
(iv) Perform 2 PUSH operations

b) What is DMA? How a DMA controller operates in a microcomputer system? (12)

c) How does MMU manage segment based virtual memory? (10)

d) Write down the salient features of 80286. (05)

7. a) What are the functions of Program Status Word (PSW)? State the contents of the RAM locations after the following programs: (10)

```
SETB  PSW.4
MOV  R0, # 99H
MOV  R1, # 85H
MOV  R2, # 3FH
MOV  R7, # 63H
MOV  R5, # 12H
```

b) What is pull up register? Explain the dual role of port 2 in 8051 microcontroller. (08)

c) Calculate the data storage of RAM and ROM in a 8051 microcontroller. (10)

d) How does Program Counter (PC) work in a 8051 microcontroller? Explain with example. (07)

8. a) Explain the operations of Interrupt Enable Register and Interrupt Priority Register with appropriate figure(s). (08)

b) Illustrate the salient features of 8051 microcontroller. (08)

c) Design a microcontroller based traffic light system for road intersection control. In this design, you must include the hardware and software design. (12)

d) What is wrong with the following for ATmega32 (Arduino): (07)

```
/*Turns on an LED on for one second, then off for one second,
repeatedly. This example code is in the public domain.*/

int led=13;
void setup(){
pinMode(led, INPUT);
}
void loop(){
digitalWrite(led, HIGH);
delay (1000);
digitalWrite(led, LOW);
delay (1000);
}
```

Khulna University of Engineering & Technology
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BME 3141

X-ray and Ultrasound Imaging

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 **Answer Script A**)

1. a) What is x-ray? Explain different radiations phenomena behind the production of x-ray? (15)

b) Write short notes on: (i) Photoelectric effect; (ii) Penumbra effect. (10)

c) State Beer-Lambert law. An incident x-ray beam penetrates through 'fat+muscle+bone' layer with thickness of '0.2 cm + 3 cm + 1 cm' and the tissue's linear attenuation coefficients are '0.9 cm^{-1} + 1.2 cm^{-1} + 7 cm^{-1}' respectively. Calculate the detected to incident x-ray ratio. (10)

2. a) Explain the working principle of flat panel x-ray detector using necessary diagrams. (12)

b) What is Radon transform? Explain the importance of Radon transform in CT imaging. (08)

c) Write down the limitations of Fourier reconstructed CT. How does the filtered back projection algorithm overcome these problems? Explain mathematically. (15)

3. a) Draw the flow chart of equiangular fan beam CT reconstruction technique. (10)

b) Write down the sources of noises in CT. Briefly discus on different artifacts occurred in CT. (16)

c) Describe the working principle of CBCT. Write down the applications of CBCT in various branches of dentistry. (09)

4. a) What is mammography? Briefly explain about the equipment used in modern mammography. (11)

b) What is angiography? Briefly explain the procedure and applications of angiography. (10)

c) What are the quality characteristics of digital radiography? (07)

d) Write short note on image intensifier used in fluoroscopy. (07)

Section B

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

5. a) What is ultrasound? Write down the properties of ultrasound. (08)

b) Explain the basic principle of ultrasound imaging. Mention some medical diagnostic applications of ultrasound imaging. (13)

c) Define acoustic impedance. Write down the characteristics of acoustic impedance. (07)

d) The sound level 30 m from a loudspeaker is $65dB$. What is the sound power produced by the loudspeaker, assuming it to be an isotropic source? (07)

6. a) Write down the relationship among frequency, resolution and depth of penetration. (08)

b) Briefly discuss about the different phenomena occurs in interactions of ultrasound with tissue. (13)

c) At a 'liver-air' interface $Z_1 = 1.65 \times 10^{-4} kg/(m^2 sec)$ and $Z_2 = 0.0004 \times 10^{-4} kg/(m^2 sec)$. Calculate reflection and transmission coefficient. Comment on results. (06)

d) What is Doppler effect? Explain a practical example that is a piece of evidence for the Big Bang theory. (08)

7. a) State Huygens's principle. Briefly discuss on near field and far field ultrasound beam patterns using necessary diagrams. (12)

b) Explain the construction of an ultrasound probe. (12)

c) What is focusing? Explain different methods of focusing. (11)

8. a) What is Doppler ultrasound? Briefly explain different types of Doppler ultrasound imaging. (12)

b) Write short notes on: (i) B-mode ultrasound imaging; (ii) M-mode ultrasound imaging. (06)

c) Define phase aberration. How does phase aberration affect the ultrasound image quality? (08)

d) Briefly explain the biological effects of ultrasound. (09)