Khulna University of Engineering & Technology
B. Sc. Engineering 3rd Year 1st Term Examination, 2017
Department of Biomedical Engineering

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 Script A)

1. a) What is biosignal? Explain the nature and origin of biosignals. Draw the block diagram for representing biomedical signal processing steps. (12)

b) Explain the difficulties encountered in biomedical signal analysis and acquisition. (09)

c) Briefly explain the real world applications of biosignals and signal processing. (07)

d) What are the practical suggestions of using electrodes in a human body? Explain in a nutshell. (07)

2. a) What is "twiddle factor" of DFT? Explain the difference between DFT and DTFT. (06)

b) Calculate the DFT of the sequence {1, 0, 0, 1, 0, 1, 1, 0} using butterfly structure. If the data is sampled at 8 kHz, then plot the amplitude and phase spectrum. (16)

c) Draw the signal flow graph to obtain FFT using decimation in time approach with necessary equations for N = 8. (13)

3. a) What is the practical application of z-transform in biomedical signal processing? Show the relationship of Laplace transform and z-transform by mapping of s-plane and z-plane. (09)

b) Find the discrete-time sequence x(n) with the following z-transform using Residue method. (12)

$$X(z) = \frac{z^2}{(z-0.5)(z-1)^2}$$

Assume c is a circle of $|z| = 1$.

c) A causal linear time-invariant system has impulse response h[n], for which the z-transform is (14)

$$H(z) = \frac{1+z^{-1}}{(1-0.5z^{-1})(1+0.25z^{-1})}$$

(i) What is ROC of H(z)?
(ii) Is the system stable? Why?
(iii) Find the impulse response h[n] of the system.

4. a) Define correlation and convolution. What is their applications in biomedical signal analysis? (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 (15)
(i) By direct convolution, and
(ii) By applying the convolution theorem.

c) Determine the circular convolution of the following two finite duration sequences: (12)
$x_1(n) = \{1, -1, -2, 3, -1\}$ and $x_2(n) = \{1, 2, 3\}$.

Section B

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

5. a) What is a digital filter? Explain the input-output relationship of FIR and IIR filter. How can you choose the filter types? (10)

   b) Obtain linear phase realization of $H(z) = 1 + \frac{z^{-1}}{4} + \frac{z^{-2}}{4} + z^{-3}$. (10)

   c) An FIR filter is given by $y(n) = x(n) + \frac{4}{5}x(n-1) + \frac{3}{2}x(n-2) + \frac{2}{3}x(n-3)$. Find the lattice structure coefficients. (15)

6. a) Mention the computational complexity of direct form I and II realization. (09)

   b) Obtain direct form I realization of the system described by (11)
   $$y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) + \frac{1}{2}x(n-1).$$

   c) A system has an impulse response as $h(n) = (0.5)^n u(n) + n(0.2)^n u(n)$. Show the parallel realization of the system. (15)

7. a) Why data reduction required in biomedical signal processing? Mention the different data reduction techniques. Explain the advantages and disadvantages of turning point algorithm. (10)

   b) Define PRD in data reduction techniques and mention its significance. (06)

   c) Write down the classification of EEG rhythms based on frequency bands. (06)

   d) After applying the AZTEC algorithm to a signal, the saved data array is {2, 50, -4, 30, -6, 50, -6, 30, -4, 50, 2, 50} (13)
   (i) Draw the waveform that AZTEC would reconstruct from these data.
   (ii) What is the amount of data reduction?
   (iii) What is the peak-to-peak amplitude of a signal reconstructed from these data?

8. a) Draw the general data compression scheme and define compression ratio. (07)

   b) Using RLC, find the compression ratio for the following string: (09)
   11111000001111000011100011001O

   c) Let us consider the string SEMESTER. We would like to individually encode each character. (10)
   (i) Construct the Huffman coding tree.
   (ii) Show the Huffman code table.
   (iii) What is the entropy of this string?

   d) The input to the LZW decoder is 1 2 4 5 2 3 4 6 1, and the initial string table is (09)

Code	String
1	A
2	B
3	C

   Determine the output of the LZW decoder.

Khulna University of Engineering & Technology
B. Sc. Engineering 3rd Year 1st Term Examination, 2017
Department of Biomedical Engineering

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 Script A)

1. a) What is X-ray? Explain the principle of Breamsstrahlung radiation for X-ray production. (10)

   b) Explain the scattering interactions of x-ray with tissues. What measure is usually taken to reduce scattering effect? (10)

   c) Write down the name of different components of x-ray tube and mention their functions. (08)

   d) An incident x-ray beam penetrate through "muscle + fat + bone" layers with thickness of "2cm + 0.35cm + 0.65cm" and linear attenuation coefficients are 0.8 cm^{-1}, 6.5 cm^{-1} and 0.5 cm^{-1} respectively. Calculate the detected to incident x-ray ratio. (07)

2. a) What do you meant by direct detection and indirect detection in x-ray imaging? (06)

   b) What is CT? List the main technical features of different generations in CT technology development. (10)

   c) What is Radon transform? Discuss the importance of radon transform in CT imaging. (08)

   d) Explain the Fourier slice theorem for CT image formation. (11)

3. a) Describe the filtered back-projection algorithm for CT image reconstruction. (15)

   b) What are the different resolution measures in CT? Explain in brief. (10)

   c) Briefly discuss on the noises and the artifacts of CT. (10)

4. a) Briefly explain digital radiography system with necessary diagram. (10)

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

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

   d) What is mammography? Why is compression needed in mammography? (08)

Section B

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

5. a) What is ultrasound? Write down the properties of ultrasound. (07)

   b) Explain the basic principle of ultrasound imaging. Also write down the benefits and risks of ultrasound imaging. (13)

   c) Write short notes on: (06)
      (i) Spatial pulse length
      (ii) Pulse repetition period.

   d) The sound level 25m from a loudspeaker is 71dB. What is the rate at which sound energy is being produced by the loudspeaker, assuming it to be an isotropic source? (09)

6. a) What are reflection coefficient and acoustic impedance? Write down their significance in ultrasound imaging. (08)

   b) At a "Liver-air" interface, $Z_1 = 1.65$ and $Z_2 = 0.0004$ (both multiplied by 10^{-4} with units $kg/(m^2sec)$). Evaluate reflection and transmission coefficient. Comment on results. (06)

   c) How are the attenuation, depth of penetration and resolution affected with ultrasound frequency? (09)

   d) Define scattering. Write down the conditions for scattering sound waves from an object. (06)

   e) Write short note on B-mode ultrasound imaging. (06)

7. a) Explain the construction of an ultrasound probe. (12)

   b) Briefly discuss about near field and far field ultrasound beam pattern with necessary diagram. (10)

   c) What is focusing? Why we need focusing in ultrasound imaging? (07)

   d) What is duplex ultrasound imaging? Mention some applications of this imaging. (06)

8. a) What is Doppler ultrasound? Briefly explain different types of Doppler ultrasound imaging. (14)

   b) What is ultrasound speckle? How can you reduce speckle noise in ultrasound images? (06)

   c) What do you mean by phase aberration? How phase aberration affects the ultrasound image quality? (07)

   d) Briefly explain the biological effects of ultrasound. (08)

Khulna University of Engineering & Technology
B. Sc. Engineering 3rd Year 1st Term Examination, 2017
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 Script A)

1. a) What is nucleotide? Write down the difference between DNA and RNA. (07)

b) What is "DNA replication"? Explain the replication process of DNA. (13)

c) Write down the structural characteristics of t-RNA. Draw and label the secondary structure of t-RNA. (15)

2. a) What is cell cycle? Explain the major stages of the cell cycle. (07)

b) Define chromosome. Draw and label the structure of chromosome. Enumerate the common structural abnormalities of chromosome. (12)

c) Write short notes on: (16)
(i) Types of chromosome (ii) Metaphase
(iii) Anaphase (iv) Function of mitosis

3. a) Write down the differences between mitosis and meiosis. (08)

b) What is PCR? Write down the basic steps of PCR. (07)

c) Write short notes on: (20)
(i) Cyclin (ii) Telophase
(iii) m-RNA (iv) mitotic poisons

4. a) What is neoplasm? Mention the danger signs of cancer. (08)

b) What is stem cell? Enumerate different kinds of stem cell with example. What is umbilical cord stem cells? (10)

c) What is proto-oncogene? Mention the function, mutation and cancer related to these proto-oncogene: (09)
(i) Myc (ii) RAS

d) Write short notes on: (08)
(i) Mitogen (ii) Tumor suppressor gene

Section B

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

5. a) Define cell. Classify the types of cell with examples. Draw and label an Eukaryotic cell. (12)

   b) What are the principal components of plasma membrane? Sketch and label the structure of a cell membrane. (12)

   c) What is cytoplasm? Write down the differences between animal cell and plant cell. (06)

   d) Write short notes on microtubule. (05)

6. a) Define enzyme. Write down the properties of enzyme. Classify enzyme according to their action. (10)

   b) What is vector? Mention the requirements of the vector. (07)

   c) What is recombinant DNA technology? Explain the importance of recombinant DNA technology. (08)

   d) Write short notes on: (10)
   (i) Iso-enzyme (ii) Non-competitive inhibitor mechanism of enzyme

7. a) What is nucleotide excision repair? Describe the nucleotide excision repair mechanism in prokaryotes. Write down the importance of base excision repair. (13)

   b) What is hematopoietic stem cell? Explain the blood cells formation from the hematopoietic stem cell. (12)

   c) Write short notes on: (10)
   (i) Dysplasia (ii) Neoplasm

8. a) What is the largest organelle of a Eukaryotic cell? Draw and label the anatomy of the Nucleus. Write down the function of Nucleus. What is Ribosome? (15)

   b) Classify membrane transport. Describe osmosis and simple diffusion with examples. What is filtration and where it happens? (10)

   c) Where the cellular respiration takes place? Illustrate the structure of mitochondria with diagram. Write down the function of Golgi body. (10)

Khulna University of Engineering & Technology
B. Sc. Engineering 3rd Year 1st Term Examination, 2017
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 Script A)

1. a) Define Bioelectricity. What is the origin of bioelectricity? (05)

   b) Define autonomic nervous system (ANS). Write down the function of ANS. What are the neurotransmitters in ANS. (15)

   c) Discuss the electrical properties of nerve tissue. Compare the autonomic and somatic motor system. (15)

2. a) What is neuron? What are the parts of a neuron? Sketch and label a neuron. (11)

   b) Write down the name of cranial nerves. How does the neuron transmit and receive information? Draw and label the diagram. (12)

   c) Write short notes on electrical properties of biological tissues. What is the cole-cole plot? (12)

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

   b) What is meant by EIT? Explain the basics of 8 electrodes 2D EIT. Also mention the advantages and disadvantages of EIT. (13)

   c) Derive cole-cole model for biological tissue and hence discuss the effect of external ac and dc electrical fields on biological tissue. (12)

4. a) Write down the action potential of cardiac muscle. Compare the cardiac and skeletal muscle action potential with diagram. (12)

   b) Describe electrical conduction system of human heart. (13)

   c) What is neuromuscular junction? Describe the mechanism of muscle contraction. (10)

Section B

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

5. a) Derive Nernst equation for equilibrium condition associated with semipermeable cell membrane. Find E_{k+} when the concentration of k^+ ion inside and outside the cell membrane are 140 mM and 5 mM respectively. (15)

   b) Show that the membrane potential $V_m = \frac{\rho I l}{2\pi l a}$; where the symbols carry their usual meanings. (12)

   c) Write down the factors that affect electrical conductivity. (08)

6. a) What is neurotransmitter? Classify neurotransmitter with their function. (10)

b) Define ion channel. Write down the classification of ion channel. What is patch clamping? (13)

c) How Na^+ channel and K^+ channel can be blocked? Write down the function of voltage gated Na^+ and K^+ ion channel. (12)

7. a) Discuss voltage clamp method with proper circuit diagram. What is its advantage? (12)

b) What is the Ohm's law? Write down the core conduction model. (10)

c) Discuss about some insights that can be found from Hodgkin-Huxley model. (13)

8. a) Explain the Hodgkin-Huxley model with diagram and equation. What is the specific conductance of a solution? (12)

b) What is spatio-temporal integration of neural signal? Explain TIC and DOC with net sketch. (13)

c) Mention clinical applications of bioelectricity. (10)

Khulna University of Engineering & Technology
B. Sc. Engineering 3rd Year 1st Term Examination, 2017
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 Script A)

1. a) Briefly explain general purpose and flag registers of 8086. (10)

   b) If CS = 24F6h and IP = 634Ah find the (10)
   (i) Logical address
   (ii) Offset address
   (iii) Physical address
   (iv) Lower range of the segment
   (v) Upper range of the segment

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

   d) What is memory banking? (07)

2. a) Explain the following instructions with diagram: (12)
   (i) MOV DX , [BX + DI] where memory address = 2010 H , DS = 100 H , BX = 100 H and DI = 10 H
   (ii) MOV AL , [1234 H] where DS = 1000 H
   (iii) MOV BX , CX

   b) Obtain the opcodes for the following instructions: (12)
   (i) MOV CH , BL
   (ii) MOV CS : [BX] , DL
   (iii) MOV CX , [437A H]

   c) What is Interrupt pointer table? If INT 12 is called then calculate the physical address of vector 12: CS and IP. (11)

3. a) Using SHL instruction multiply AX by 10 and explain your codes with example. (10)

   b) What is the single-precision representation of 639.6875? (06)

   c) What is opcode? Find binary code for MOV SP , BX instruction. (09)

   d) Explain master/slave concept in the interrupt controller. (10)

4. a) Draw and describe the timing diagram during memory read-write operation of 8086. (12)

   b) How does 80286 address upto 1GB of virtual memory by using segmentation? (13)

   c) Write short notes on: (10)
   (i) DMA
   (ii) 8255A
   (iii) Risc

Section B

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

5. a) What is microcontroller? Write down the applications of microcontroller in the context of Biomedical Engineering. (12)

b) Differentiate among (12)
(i) Microcontroller and Microprocessor.
(ii) 8 bit Microcontroller and 32 bit Microcontroller.

c) Explain Princeton and Harvard architecture of microcontroller. Which type you will prefer over another and why? (11)

6. a) What are the criteria for selection of a microcontroller for embedded system? Briefly explain each of them with proper example. (11)

b) Write down the functions of different I/O ports available in 8051 microcontroller. (12)

c) Write down the procedure to develop density based traffic controlling system. (12)

7. a) Briefly describe instruction execution with proper timing diagram. (10)

b) Calculate the address range of 128 byte of RAM. (07)

c) What are the different types of memory available in 8051 microcontroller? (06)

d) What are the requirements for embedded system design? Briefly explain. (12)

8. a) Briefly describe single cycle ALU operation in ATmega32 microcontroller with proper timing diagram. (12)

b) What is pull up register? How can you select register banks of 8051 microcontroller? (10)

c) Explain PUSH and POP operation of stack with appropriate figure. (13)