

Math 2215
Linear Algebra, Complex Variables and Vector Analysis

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 meant by the consistent system of linear equations? Find the value of k for which the following system of equations is consistent. (12)

$$\begin{aligned} 3x_1 - 2x_2 + 2x_3 &= 3 \\ x_1 + kx_2 - 3x_3 &= 0 \\ 4x_1 + x_2 + 2x_3 &= 7 \end{aligned}$$

- b) Find all values of x, y, z for which A is a symmetric matrix. Where, (10)

$$A = \begin{bmatrix} 2 & x + y + 2z & 2x + 4y - 3z \\ 9 & -3 & 0 \\ 1 & 3x + 6y - 5z & 4 \end{bmatrix}$$

- c) Test the linear dependence of the matrices (13)

$$M_1 = \begin{pmatrix} 2 & 3 \\ -4 & 7 \end{pmatrix}, M_2 = \begin{pmatrix} -1 & 2 \\ 3 & 1 \end{pmatrix}, M_3 = \begin{pmatrix} 5 & 11 \\ -9 & 22 \end{pmatrix} \text{ and if possible find a linear combination among them.}$$

2. a) Define subspace of a vector space. Show that $s = \{(x, y, z, t): x + y = z, t = 2y\}$ is a subspace of \mathbb{R}^4 . (10)

- b) Define Null space. Find the basis and dimension for the solution space of the following homogeneous system (13)

$$\begin{aligned} 2x + 2y - z + s &= 0 \\ -x - y + 2z - 3t + s &= 0 \\ x + y - 2z - s &= 0 \\ z + t + s &= 0 \end{aligned}$$

- c) Split the matrix (12)

$$A = \begin{pmatrix} 2+i & 3 & 4-i \\ 2i & 3+i & 4 \\ 3 & 5 & -7 \end{pmatrix}$$

into two parts, one is Hermitian and the other is skew Hermitian.

3. a) Consider the vector space \mathbb{R}^3 with the Euclidean inner product. Use the Gram Schmidt process to transform the basis $s = \{(1,1,1), (0,-1,1), (0,1,1)\}$ into orthonormal basis s' . If $v = (-2,3,4)$ also find $[v]_{s'}$. (13)

- b) Define basis of a vector space. Find a subset of the vectors $v_1 = (1, -2, 0, 3)$, $v_2 = (2, -5, -3, 6)$, $v_3 = (0, 1, 3, 0)$, $v_4 = (2, -1, 4, -7)$, $v_5 = (5, -8, 1, 2)$ that forms a basis for the subspace of \mathbb{R}^4 spanned by these vectors. Express each vector not in the basis as a linear combination of the basis vectors. (15)

- c) Use the function f and g in $C[-1,1]$ to find $\|f\|$, $\langle f, g \rangle$, $d(f, g)$ for the inner product (07)

$$\langle f, g \rangle = \int_{-1}^1 f(x)g(x)dx$$

4. a) Define eigenvalue and eigenvector of a matrix. Find the eigenvalues and eigenvectors of the matrix (12)

$$A = \begin{bmatrix} 2 & 3 \\ 2 & 1 \end{bmatrix}$$

- b) Use Cayley-Hamilton theorem to find A^{-2} where (13)

$$A = \begin{bmatrix} 2 & 3 & 4 \\ -3 & 1 & 2 \\ 3 & 4 & 5 \end{bmatrix},$$

if possible.

- c) If $A = \begin{bmatrix} 2 & 1 & 0 \\ 3 & 2 & 0 \\ 1 & 0 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 1 & 1 & 0 \\ 2 & 1 & 1 & 0 \\ 2 & 3 & 1 & 2 \end{bmatrix}$. Then find AB by partitioning. (10)

Section B

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

5. a) Define analytic function. Derive the Cauchy-Reimann equations in Cartesian coordinates. (13)
Also write its counterpart in polar form.

- b) If $f(z)$ is analytic inside and on a simple closed curve C except at $z = z_0$ then prove that (11)

$$\oint_C f(z) dz = \oint_{C_1} f(z) dz$$

Where C_1 is a closed curve enclosing $z = z_0$ and both C and C_1 traversed in the positive sense relative to their interiors.

- c) Let $w = u + iv$ is analytic and $u + v = x^2 - y^2 - 2xy + 5x + 5y$. Find w . (11)

6. a) Define singularity of a function. Classify them with example. (11)

- b) Identify different types of singularities of (12)

$$f(z) = \frac{z^5}{(z-2)^2(z+2i)} + \frac{z\sqrt{z-3}e^{1/(z-2)}}{\sin z}$$

- c) Evaluate $\oint_C \frac{f(z)}{z-3i} dz$ where C is the curve (i) $|z-i|=1$, (ii) $|z-1|+|z+1|=13$ and $f(z) = e^{i\pi z}$. (12)

7. a) What is meant by directional derivative? Find the directional derivative of $x^2yz + z^2 + x$ at (1, -1, 2) for the direction $3\mathbf{i} - 4\mathbf{j} + 5\mathbf{k}$. (13)

- b) State divergence theorem. Use it or otherwise to evaluate $\oiint_S \mathbf{F} \cdot d\mathbf{S}$ where S is the surface of the paraboloid $y^2 + z^2 = x$ with the boundaries $y=0, z=0, x=6$ and $\mathbf{F} = x^2yzi + y^2zj + x^2yk$. (15)

- c) Transform Green's theorem in vector notation. (07)

8. a) Show that Green's theorem can be applied to find the area of a closed curve. Hence find the area between $x^2 = y$ and $x + y = 0$. (15)

- b) State the Stoke's theorem. Also write its modified forms. (08)

- c) Define solinoidal and rotational vector. Test whether the vector $\mathbf{F} = x^2\mathbf{i} + xyz\mathbf{j} + y^2z\mathbf{k}$ falls in either of the category or not. (12)

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2018
Department of Biomedical Engineering

BME 2231

Biomedical Instrumentation

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) Describe basic concepts of biomedical instrumentation using an example. (08)
- b) Why instrumentation amplifier is used instead of differential amplifier? Draw and calculate the differential gain of an instrument amplifier. (13)
- c) Write short notes on: Faraday cage, Gain- bandwidth product, slew rate. (09)
- d) Mention measurand, its amplitude, frequency range and electrode type for ECG, EEG and EMG signal acquisition system. (05)

2. a) Describe EEG acquisition system with a block diagram. (10)
- b) Discuss about the noises associated with electrodes for the measurement of bioelectric potential and also mention their reduction techniques. (10)
- c) Briefly discuss instrumentation for a 12-channel ECG system. (12)
- d) What are the differences between vector cardiography (VCG) and ECG? (03)

3. a) Briefly discuss methodology and instrumentation for measuring nerve conduction velocity (NCV) by using evoked EMG. (12)
- b) What is the principle of cardiac defibrillator? Describe working principle of a modern biphasic waveform defibrillator. (10)
- c) Draw a block diagram of Heart-lung machine showing its main parts and connection to the body. (08)
- d) Define Phonocardiography, Plethysmography, Heart sound and murmurs. (05)

4. a) Describe Ultrasound Doppler blood velocity measurement system with mathematics and block diagram. (12)
- b) Explain leakage current. Briefly describe different types of leakage currents. (10)
- c) What is meant by applied parts? Explain type B, BF, CF applied parts. (07)
- d) Distinguish among the class 0, I, II and III medical devices. (06)

Section B

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

5. a) Classify the biomedical sensors in terms of the quantities that they measure. Briefly describe them. (06)
- b) What is calibration? Why is calibration so important? (07)
- c) Describe the important points that should be considered to determine a transducer suitable for a specific measurement system. (12)
- d) Define physiological variable. Explain how electrical physiology is measured. (10)
6. a) What do you mean by errors? How we can reduce the errors of a transducer? (08)
- b) Briefly describe the working principle of an amperometric O₂ sensor. (12)
- c) Discuss the operation principle of a simple semiconductor temperature sensor. (05)
- d) Write short notes on: (10)
- i) Ion selective electrode
 - ii) Physico-chemical transducer
7. a) What is meant by fiber optic biosensor? Briefly describe the working principle and sensing details of a fiber optic biosensor. (13)
- b) Define surface Plasmon Resonance (SPR). Briefly describe the working principle of SPR optical biosensor. (10)
- c) Write short notes on: (12)
- i) Thermistor
 - ii) IC Temperature Transducers
 - iii) Piezoelectric pressure sensor
8. a) Classify electro-chemical transducer according to detection approaches. Briefly describe them. (05)
- b) What are the critical care analytes of Blood in clinical setting? (06)
- c) Describe the working principle of a glucose biosensor or a mono enzyme electrode. (10)
- d) Sketch and briefly describe the working principle of P_{CO₂} electrode. (14)

Khulna University of Engineering & Technology
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Hum 2215
Economics and Sociology

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 meant by law of demand? Why does demand curve shift? Explain with example. (15)
- b) Use a production possibilities frontier (PPF) to illustrate economy's trade-off between wheat and gun. (10)
- c) How do the technology and government policy affect the supply of any goods or services. (10)
2. a) What is price-elasticity of demand? Explain the types of price-elasticity of demand. (15)
- b) The R.J Smith corporation is a publisher of novels. The corporation hires an economist to determine the demand for its product. After months of hard work, the economist informs the company that the demand for the firm's novel is given by the following equation: (20)

$$Q_x = 12,000 - 5,000P_x + 5I + 500P_c$$

Where,

Q_x is the demand for R.J smith novels.

P_x is the price charged for R.J smith novel.

I is the income per capita.

P_c is the price of novels from competing publishers.

Assume that the initial values of P_x , I and P_c are \$5, \$10000 and \$6 respectively.

Using the above information, the company's manager wants to-

- (i) Determine what effect a price increase would have on total revenue.
 - (ii) Evaluate how rates of the novel would change during a period of rising income.
 - (iii) Assess the problem impact if competing publishers would raise their price.
3. a) Define cost and cost of production. (05)
 - b) What is short-run? How a competitive firm choose the level of output that maximize profit. (20)
 - c) What is shut-down position? Explain the shut-down position of a competitive firm with figure. (10)
 4. a) What is project evaluation? Explain the cost-benefit analysis of a project. (20)
 - b) What is production function? Explain the factors of production. (15)

Section B

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

5. a) "Sociology is the scientific study of human behavior and social groups"- explain this statement in the light of your own society. (15)
- b) Critically describe contribution of Auguste Comte and Herbert Spencer behind origin and development of Sociology as a distinct discipline. (15)
- c) What do you mean by crime? (05)
6. a) What is meant by Society? Explain types and characteristics of society with relevant example. (20)
- b) Discuss the positive and negative impact of Urbanization on society. (15)
7. a) What is community? Describe basic pre-conditions of community with example. (15)
- b) What is Sociological perspective? Critically explain major Sociological perspectives. (10)
- c) What do you mean by Ethnocentrism? Explain with example. (10)
8. a) 'Rapid Urbanization is blessings for any country'- do you agree with this statement? Give reasons in favor of your opinion. (15)
- b) What is sub-urbanization? Explain consequences of sub-urbanization. (15)
- c) What do you mean by marriage? Describe functions of marriage. (05)

BME 2211
Signals and Systems

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) Define signal. Differentiate between discrete-time and digital signal with suitable example. (10)
 Schematically show how we can obtain discrete and digital signal from continuous signal.
- b) Test whether the given signal is an energy or a power signal: $x(t) = e^{-2t}u(t)$. (08)
- c) Find the even and odd components of $x(n) = \{3, 2, 1, 4, 5\}$ (10)
- d) Find $x(\frac{3t-4}{9})$ for the given signal $x(t)$ shown in Fig. 1(d). (07)

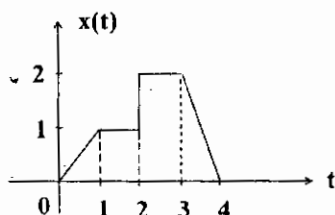


Fig. 1(d)

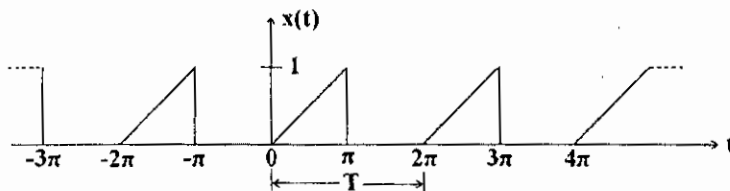


Fig. 3(a)

2. a) What do you mean by convolution integral? Let $x(t)$ be the input to an LTI system with unit impulse response $h(t)$, where $x(t) = e^{-at}u(t)$, $a > 0$ and $h(t) = u(t)$. Find the output $y(t)$ of the LTI system. (12)
- b) Define system. Classify system with example. (12)
- c) What is Fourier transform? Determine the Fourier transform of the signal $x(t) = e^{-at} \cos \omega_0 t u(t)$ (11)
3. a) What is continuous-time Fourier series representation? Determine the Fourier series coefficients (exponential representation) of the signal shown in above Fig. 3(a). (15)
- b) What is ROC? "Laplace transform exists for signals that do not have a Fourier transform". Justify this statement with example. (10)
- c) Determine the Laplace transform, ROC, and locations of poles and zeros of $X(s)$ for the given signal $x(t) = e^{-2t}u(t)$. (10)
4. a) What do you mean by frequency response function? What are the characteristics of frequency response function of LTI system? (08)
- b) Find the inverse unilateral Laplace transform of (10)

$$X(s) = \frac{3s + 4}{(s + 1)(s + 2)^2}$$
- c) Use the Laplace transform to find the voltage across the capacitor, $y(t)$, for the RC circuit shown in Fig. 4(c) in response to the applied voltage $x(t) = 3e^{-10t}u(t)$ and initial condition $y(0^-) = 5$. (10)

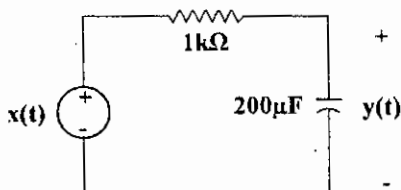


Fig. 4(c): RC circuit, Where $RC = 0.2$ S.

- d) A system has the transfer function (07)

$$H(s) = \frac{3}{s + 2} + \frac{2}{s - 3}$$

Find the impulse response, (i) assuming that system is stable and (ii) assuming that system is causal. Can this system be both stable and causal?

Section B

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

5. a) Illustrate some basic operations on sequence. (10)
- b) Clarify the Shift Invariance property of a discrete-time system. A system has input-output relationship given by the following equation. Is this system shift-invariant? (10)

$$y[n] = \sum_{k=-\infty}^n x[k]$$

- c) Explain the stability of a discrete-time system. Determine if the following system is BIBO stable. (10)

$$y[n] = \sum_{k=-\infty}^{\infty} (n-k) u[n-k] x[k]$$

- d) Why linear time invariant systems play a fundamental role in signal and system analysis? (05)

6. a) Demonstrate an arbitrary discrete signal can be expressed by weighted superposition of shifted impulses. Hence express the unit step $x[n] = u[n]$ signal using impulse signals. (08)
- b) Define convolution sum. Determine the response of a LTI system, whose impulse response (15) and input signal to the system are shown in Fig. 6(b).

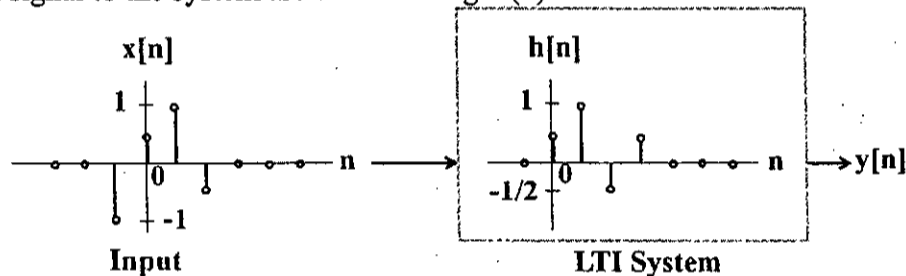


Fig. 6(b)

- c) Illustrate the distributive property of convolution sum. (06)
- d) Show that impulse response of a discrete-time LTI system is the first difference of its step response. (06)
7. a) State Nyquist sampling theorem and verify it. (12)
- b) Define discrete Fourier series (DFS). Represent a periodic impulse train with DFS coefficient. (08)
- c) What is aliasing effect? How can we remove aliasing effect? (08)
- d) Find DFT of a rectangular pulse as shown in Fig. 7(d). (07)

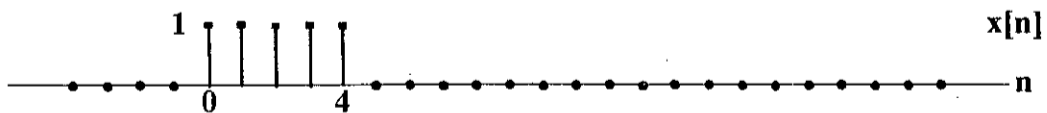


Fig. 7(d)

8. a) Find the Z-transform of $x[n] = a^n u[n]$ and plot the ROC for different real values of a . (08)
- b) Find the inverse Z-transform (12)

$$X(z) = \frac{1 + 2z^{-1} + z^{-2}}{1 - 3z^{-1} + 2z^{-2}}$$

- c) Find the Z-transform of a discrete-time system whose input $x[n]$ and output $y[n]$ are related through the following difference equation and determine impulse responses by analyzing the ROC. (15)

$$y[n] - \frac{1}{2}y[n-1] = x[n] + \frac{1}{3}x[n-1]$$

Khulna University of Engineering & Technology
B. Sc. Engineering 2nd Year 2nd Term Examination, 2018
Department of Biomedical Engineering

BME 2201
Human Physiology

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) Enumerate the membranous and non-membranous organelles of human cell. Write down the functions of endoplasmic reticulum. (10)
- b) Enumerate the ABO blood grouping system. Write down the process of platelet plug formation. (10)
- c) What is pain? Enumerate the pathway of pain. Explain the process of planning and execution. (10)
- d) Write short note on Stages of lymphoma. (05)
2. a) What is mitochondria? Write down the structure and function of the mitochondria. (10)
- b) What is hematopoiesis? Draw the steps of hematopoiesis. (10)
- c) What is secondary active transport? Enumerate the differences between primary and secondary active transport. (10)
- d) Write short note on Golgi body. (05)
3. a) What are the common problems of eye? Enumerate the causes and treatment of the problems with figures. (15)
- b) What is hemophilia? Why it is rare in female - explain in details. (10)
- c) What is intercellular junction? Enumerate the types of junctional complex. (05)
- d) Write short note on Gustatory pathway. (05)
4. a) What are the layers of eye? Explain the process of visual pathway. (10)
- b) Write down the extrinsic and intrinsic pathway of blood coagulation. (10)
- c) Write short notes on : (15)
 - i) Na⁺ - K⁺ pump
 - ii) Neutrophil
 - iii) Basophil

Section B

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

5. a) Write down the special characteristics of cardiac muscle. Explain with the diagram of the "All - or - none law" phenomenon of cardiac muscle. (10)
- b) Define heart sound. Write down the types of heart sound with diagram. (08)
- c) Draw and label the cardiac action potential with brief description. Write down the significance of plateau phase. (07)
- d) Write short notes on : (10)
- i) Stroke volume
 - ii) Cardiac Output
6. a) What are the components/events of respiration? Define Alveolar pressure and Transpulmonary pressure. (06)
- b) Apply the law that describe the relation between volume and pressure with diagram and write down the short description of that law. (10)
- c) An unknown gas was confined with in a 6.75 L container at 4.50 atm, what would be the volume if the pressure increased to 5.95 atm at room temperature. (06)
- d) Explain the mechanism of breathing. Write down the movements of rib cage during respiration. (13)
7. a) What does the kidney do? Write down the mechanism of urine formation with proper diagram. (15)
- b) If a man has been suffering from diarrhoea and suddenly his pressure fall, then how the blood pressure is regulated by kidney? (08)
- c) What is GFR? How the urine become acidic. (07)
- d) Write short notes on: (05)
- i) Pulse pressure
 - ii) Mean pressure
8. a) Write down the mechanism of HCl secretion by gastric parietal cell. (10)
- b) List the gastric hormones with their function. (07)
- c) How lipid is digested in the GI tract? What is the end product of lipid digestion? (08)
- d) What are the main cells in GI tract? Write down the main organ and accessory organ of GI tract. (10)