

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Energy Science and Engineering

B. Sc. Engineering 1st Year 1st Term Examination, 2022

Math 1113

(Differential and Integral Calculus)

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.

iii) Assume reasonable data if any missing.

SECTION – A

- 1(a). Define limit and continuity of a function. A function $f(x)$ is defined as follows: 15

$$f(x) = 2 - x \quad \text{for } 1 \leq x \leq 2$$
$$= x - \frac{1}{2}x^2 \quad \text{for } x > 2$$

Discuss the continuity and differentiability of $f(x)$ at $x = 2$.

- 1(b). Define subtangent and subnormal. In the curve $x^m y^m = a^{m+n}$, show that the subtangent at any point varies as the abscissa of the point. 10

- 1(c). Evaluate $\lim_{x \rightarrow 1} \left[\frac{x}{x-1} - \frac{1}{\log x} \right]$. 10

- 2(a). State Leibnitz's theorem. If $y = \sin^{-1} x$, then show that 14

(i) $(1 - x^2)y_2 - x y_1 = 0$

(ii) $(1 - x^2)y_{n+2} - (2n + 1)xy_{n+1} + n^2 y_n = 0$.

Find also the value of $(y_n)_0$.

- 2(b). Define maximum and minimum. Find the maximum and minimum values u where: 12

$u = \frac{4}{x} + \frac{36}{y}$ and $x + y = 2$.

- 2(c). If $v = z \tan^{-1} \frac{y}{x}$, then show that $\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2} + \frac{\partial^2 v}{\partial z^2} = 0$. 09

- 3(a). Define tangent and normal. Find the equation of the tangent and normal at the point $(1, -1)$ to the curve $x^3 + xy^2 - 3x^2 + 4x + 5y + 2 = 0$. 13

- 3(b). State Euler's theorem. If $F(x^2 + y^2 + z^2) f(xy + yz + zx)$, then show that, 12

$$(y - z) \frac{\partial u}{\partial x} + (z - x) \frac{\partial u}{\partial y} + (x - y) \frac{\partial u}{\partial z} = 0.$$

- 3(c). If $\sin y = x \sin(a + y)$, then show that, $\frac{dy}{dx} = \frac{\sin^2(a+y)}{\sin a}$ 10

- 4(a). Define asymptote. Determine the asymptotes of following: 13

$$x^3 + x^2 y - xy^2 - y^3 + 2xy + 2y^2 - 3x + y = 0.$$

- 4(b). State Taylor's theorem. Expand $f(x) = x^3 + 5x^2 + 2x - 11$ in a Taylor's series in power $x - 2$. 10

- 4(c). Define radius of curvature. If ρ_1 and ρ_2 be the radii of curvature at the ends of the focal chord of the parabola $y^2 = 4ax$, then show that, $\rho_1^{-2/3} + \rho_2^{-2/3} = (2a)^{-2/3}$ 12

SECTION – B

5. Integrate the followings:
- (a). $\int \frac{dx}{(2x+3)\sqrt{x^2+3x+2}}$ 12
- (b). $\int \frac{\sec x \, dx}{a+b \tan x}$ 10
- (c). $\int \sin^{-1}\left(\sqrt{\frac{x}{x+a}}\right) dx$ 13
- 6(a). State Fundamental theorem of calculus. Evaluate $\int_0^{\pi/2} \log \cos x \, dx$ 11
- 6(b). Evaluate $\lim_{n \rightarrow \infty} \left\{ \left(1 + \frac{1}{n^2}\right)^{\frac{2}{n^2}} \left(1 + \frac{2^2}{n^2}\right)^{\frac{4}{n^2}} \left(1 + \frac{3^2}{n^2}\right)^{\frac{6}{n^2}} \dots \dots \left(1 + \frac{n^2}{n^2}\right)^{\frac{2n}{n^2}} \right\}$ 10
- 6(c). State Walli's formula. If $I_n = \int_0^{\pi/4} \tan^n \theta d\theta$, then show that $n(I_{n+1} + I_{n-1}) = 1$. 14
- Hence find the value of $\int_0^{\pi/4} \tan^8 \theta d\theta$
- 7(a). Define Gamma and Beta function. Write down the relationship between Gamma and Beta function. 13
- Evaluate (i) $\int_0^{\infty} e^{-x^2} dx$ (ii) $\int_0^{\pi/2} \sqrt{\tan \theta} \, dx$
- 7(b). Prove that, $\sqrt{m} \sqrt{m + \frac{1}{2}} = \frac{\sqrt{\pi} \sqrt{2m}}{2^{(2m-1)}}$ 12
- 7(c). Evaluate $\int_0^{\pi/2} \frac{dx}{6+3 \cos x}$ 10
- 8(a). Show that the entire length of the curve $x^{2/3} + y^{2/3} = a^{2/3}$ is $6a$. 11
- 8(b). Find the surface area generated by the revolution of the cardioid $r = 2a(1 + \cos \theta)$ about the initial line. 12
- 8(c). Find the volume of the solid generated by revolving the ellipse $b^2 x^2 + a^2 y^2 = a^2 b^2$, $a > b$ about the major axis. 12

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Energy Science and Engineering

B. Sc. Engineering 1st Year 1st Term Examination, 2022

Hum 1113

(Sociology and Behavioral Science)

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.

iii) Assume reasonable data if any missing.

SECTION – A

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|-------|---|----|
| 1(a). | Explain the view about sociology. | 10 |
| 1(b). | Explain the contributing faction for the development of sociology. | 15 |
| 1(c). | Write down the importance of sociology for the students of Energy Science and Engineering department. | 10 |
| | | |
| 2(a). | How does socialization help in our personality development? Explain their roles with example. | 15 |
| 2(b). | What is social structure? What are the elements of social structure? Explain their roles for maintaining social stability. | 10 |
| 2(c). | Why is the sense of “ We- feeling”- required for community development? | 10 |
| | | |
| 3(a). | Define social stratification. What are the significant classifications of social stratification in our society? Discuss it with examples. | 15 |
| 3(b). | Explain the role of different agencies of social control. | 10 |
| 3(c). | When does cultural lag occur in a society? Explain it with example. | 10 |
| | | |
| 4(a). | Identift the major urban social problems in Bangladesh. Discuss any two ofthem. | 10 |
| 4(b). | What are the barriers of industrialization in third world countries? | 15 |
| 4(c). | Distinguish between white-collar crime and property crime. | 10 |

SECTION – B

- | | | |
|-------|---|----|
| 5(a). | What is organizational behavior? Discuss the key factors of it. | 20 |
| 5(b). | Define training? How does training play an important role for organizational development? | 15 |

6(a).	Explain the way of improving employee relation.	10
6(b).	Is psychological contract at work important? Give your opinion.	10
6(c).	Describe the motivational theory of Hackman and Oldham.	15
7(a).	What is "Quality of work life"? How do you evaluate the advantages and disadvantages of it?	18
7(b).	Define organization design. Show the relationship between organizational structure and performance.	17
8(a).	Discuss the impact of organizational culture.	10
8(b).	Make a comparison between authoritarian and participative leadership.	10
8(c).	Describe the common reasons for resistance to change in an organization.	15

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Energy Science and Engineering

B. Sc. Engineering 1st Year 1st Term Examination, 2022

Ch 1113

(Chemistry I)

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.

iii) Assume reasonable data if any missing.

SECTION – A

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|-------|--|----|
| 1(a). | What is standard free energy? Derive a relation between standard free energy change and equilibrium constant of a reaction at a given temperature. | 10 |
| 1(b). | Define reversible and irreversible reactions. "Equilibrium can be initiated from either side of a chemical reaction" – explain with diagram. | 10 |
| 1(c). | Calculate the free energy change associated with chemical reaction for which the equilibrium constant at 298 K is 0.01. ($R = 8.314 \text{ J. mol}^{-1} \text{ K}^{-1}$) | 07 |
| 1(d). | Explain the Law of mass action based on the molecular collision theory.. | 08 |
| | | |
| 2(a). | What is Li-polymer battery? Construct an electrochemical cell for Li-ion battery and discuss the charging and discharging mode of Li-ion battery. | 10 |
| 2(b). | Illustrate proton exchange membrane fuel cell along with its reaction mechanism. | 10 |
| 2(c). | The resistance of a 0.1 N solution of a salt is found to be $2.5 \times 10^{-3} \Omega$. Calculate equivalent conductance of the solution. | 07 |
| 2(d). | Explain why EMF of an electrochemical cell can not be measured with the help of voltmeter? | 08 |
| | | |
| 3(a). | What is electrical double layer? Discuss the mechanism of electrical double layer formation. | 10 |
| 3(b). | What is half cell? "On progressive dilution, specific conductance of an electrolyte decrease but molar conductance increases"- discuss. | 10 |
| 3(c). | Define diffusion current in electrochemistry. How this current is different from migration and convection current? | 08 |
| 3(d). | Mention the differences between electroplating and galvanizing. | 07 |
| | | |
| 4(a). | Define radiochemistry and nuclear chemistry. "radioactivity is a nuclear phenomena"- explain. | 10 |
| 4(b). | What is nuclear fusion? How it relates with solar energy? Explain with reaction mechanism. | 10 |
| 4(c). | The radioactive decay constant of radium is 1.36×10^{-11} . How many disintegrations per second occur in 100 g of radium? | 07 |
| 4(d). | What are the differences between natural and artificial radioactivity? Discuss artificial disintegration of atoms with three examples. | 08 |

SECTION – B

- 5(a). Define conducting polymer and living polymer. Polyaniline is a conducting polymer, explain with its conducting mechanism. 10
- 5(b). What is isoprene? Draw the molecular structure of natural rubber. 06
- 5(c). What is prepolymer? In a polymerization reaction, styrene acts as a monomer in the presence of benzoyl peroxide. Discuss the mechanism of this polymerization reaction. 12
- 5(d). A polymer consists of 9 gram having molecular weight 30,000 and 5 gram having molecular weight 60,000. Calculate the number average molecular weight and weight average molecular weight. 07
- 6(a). Example of the following terms: 12
- (i) Chain terminating agent
 - (ii) Macromolecule
 - (iii) Degree of polymerization
- 6(b). What is glass transition temperature? Explain glass transition temperature region graphically. 10
- 6(c). Describe the characteristic properties of a good fuel. 06
- 6(d). What is CNG? Write down its compositions. 07
- 7(a). What is petroleum? How will you improve an octane number of a fuel? 10
- 7(b). What is Doctor's treatment? Describe the methods to synthesize gasoline. 13
- 7(c). High percentage of moisture is undesirable for a good fuel. Why? 06
- 7(d). Write down the advantages of gaseous fuel over solid and liquid fuel. 06
- 8(a). What is heavy metal? Discuss the biochemical effects of arsenic. 10
- 8(b). Which method is used for the determination of dissolved oxygen of water sample? Describe with chemical reactions. 12
- 8(c). Make a differentiate between BOD and COD. 07
- 8(d). How can photochemical smog be controlled? 06

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Energy Science and Engineering

B. Sc. Engineering 1st Year 1st Term Examination, 2022

Ph 1113

(Physics)

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.

iii) Assume reasonable data if any missing.

SECTION – A

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|-------|--|----|
| 1(a). | Explain the reason of negative value of packing fraction. | 07 |
| 1(b). | How much energy can be obtained from the fission of 1 mole of ^{235}U and 1 kg of ^{235}U ? | 10 |
| 1(c). | Explain the properties of nuclear force. | 08 |
| 1(d). | Define and calculate 1 atomic mass unit in kg and energy equivalent of it in MeV. | 10 |
| | | |
| 2(a). | What is meant by radioactivity? State and explain radioactive decay law. From the decay law, find an expression for half-life of a radioactive sample. | 13 |
| 2(b). | In case of successive disintegration, discuss the secular and transient equilibriums. | 12 |
| 2(c). | The half-life of 1 gm sample of $^{90}_{33}\text{Sr}$ against beta decay is 28 years. Calculate the decay constant, rate of radioactive disintegration and mean life. | 10 |
| | | |
| 3(a). | Derive an expression for De Broglie wavelength hence derive De Broglie wave velocity and finally comment on its value. | 10 |
| 3(b). | Derive an expression of De Broglie group velocity hence prove that De Broglie group velocity associated with a moving body travels with the same velocity of the body. | 10 |
| 3(c). | State Uncertainty principle. Prove the non-existence of electron in nucleus and calculate the energy need for a electron to be confined to an atom. | 15 |
| | | |
| 4(a). | Describe all quantum numbers used in Vector model. Write down two sets of quantum numbers of electron for $n = 2$. | 15 |
| 4(b). | Calculate the limiting value of wavelengths for Paschen series and Pfund series. | 10 |
| 4(c). | Calculate the expression of maximum number of electrons in a shell. | 10 |

SECTION – B

- 5(a). Derive expression of time period for simple pendulum. 07
- 5(b). Prove that average potential energy is equal to the average kinetic energy of SHM. 15
- 5(c). Graphically represent the displacement, velocity and acceleration of SHM. 05
- 5(d). For a particle vibrating simple harmonically, the displacement is 8 cm at that instant the velocity is 6 cm/s and the displacement is 6 cm at that instant the velocity is 8 cm/s. Calculate amplitude, frequency and time period. 08

- 6(a). What is stationary wave? Show that there is no transference of energy across any section of the medium in the case of a stationary wave. 12
- 6(b). Establish the differential equation of a damped harmonic oscillator and solve it to obtain an expression for the displacement of the oscillator. 13
- 6(c). When a simple harmonic wave is propagated through a medium, the displacement of the particle (in cm) at any instant of time is given by: 10

$$y = 10 \sin \frac{2\pi}{100} (36000t - 20).$$

Calculate (i) the amplitude of the vibrating particles, (ii) wave velocity, (iii) wavelength, (iv) frequency, and (v) time period.

- 7(a). What are the types of solids? Discuss briefly about the Bravais lattices and unit cell characteristics of seven crystal systems. 13
- 7(b). Calculate number of atoms per unit cell for simple cube, body-centered cube and face-centered cube. 10
- 7(c). In a unit cell of simple cubic structure, find the angle between the normal to pair of planes whose Miller indices are: 12
- (i) (1 1 1) and (1 2 1),
(ii) (0 1 1) and (2 1 0).

- 8(a). Explain Hall effect. Derive an expression for Hall voltage and Hall coefficient. 12
- 8(b). According to Einstein model, the average energy of an oscillator is 13

$$\bar{\epsilon} = \frac{1}{2} h\nu + \frac{h\nu}{e^{(h\nu/k_B T)} - 1}$$

Where the symbols have their usual meanings. Now derive the expression for the lattice heat capacity of a solid and discuss the validity of this model at low and high temperatures.

- 8(c). Find the Hall coefficient and electron mobility from Germanium for a given sample of length 1 cm, breadth 5 mm and thickness 1 mm. If a current of 5 milliamperes flow from a 1.35 volts supply, develop a Hall voltage of 20 millivolts across the specimen in a magnetic field of 0.45 weber/m². 10

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KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Energy Science and Engineering

B. Sc. Engineering 1st Year 1st Term Examination, 2022

ESE 1101

(Fundamentals of Energy Resources)

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.

iii) Assume reasonable data if any missing.

SECTION – A

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|-------|--|----|
| 1(a). | What are meant by 'Forms of energy' and 'Resources of energy'? Describe the disadvantages of renewable and non-renewable energy resources. | 10 |
| 1(b). | What are the major energy sources? Briefly discuss about the various energy resources of Bangladesh. | 13 |
| 1(c). | How the energy resources are classified? Explain in brief. | 06 |
| 1(d). | Why world energy consumptions as well as energy demands are increasing? Discuss. | 06 |
| | | |
| 2(a). | Discuss and state about new exploration of natural gas fields in Bangladesh between 2015 to 2022. | 07 |
| 2(b). | Mention the different grades of coal. "Peat is not actually coal, but the precursor to coal". Explain. | 10 |
| 2(c). | Explain the uses of coal in different sectors. Describe the advantages and disadvantages of using coal to produce electricity. | 12 |
| 2(d). | Explain the differences between origin of petroleum oil and coal. | 06 |
| | | |
| 3(a). | What is meant by coal exploration? What are the components of coal exploration program? | 08 |
| 3(b). | Explain the Abiogenic theory of formation process of petroleum oil. | 12 |
| 3(c). | What is meant by crude oil? Why distillation of crude oil is necessary? | 06 |
| 3(d). | Write a briefly note on classification of petroleum. Describe the composition of petroleum. | 09 |
| | | |
| 4(a). | Define and classify the natural gas. How it is formed? | 08 |
| 4(b). | Mention the benefits of using natural gas as a fuel over petroleum oil. Compare the characteristics of CNG, LNG and LPG. | 10 |
| 4(c). | Distinguish between nuclear fission and fusion reactions. Discuss about the major elements of a nuclear reactor. | 09 |
| 4(d). | Briefly discuss about the uses of nuclear energy in different sectors. | 08 |

SECTION – B

- 5(a). What reactions are responsible for energy liberated within the sun? How solar radiation is measured on the earth surface? 08
- 5(b). Describe schematically the eight possible pathways for conversion of solar energy. 09
- 5(c). Explain the followings with example: 09
- i) Solar chemical conversion
 - ii) Solar thermal conversion
 - iii) Solar electrical conversion
- 5(d). What is meant by doping? How a photovoltaic cell works? Describe with neat sketch. 09
- 6(a). Why biomass need to be converted? Describe any one process of thermo-chemical conversion of biomass. 09
- 6(b). What are the different sources of biomass? What are meant by bio-chemical conversion and thermo-chemical conversion of biomass? Explain. 08
- 6(c). How biogas is produced from biomass? What are the steps of reactions for biogas production? 09
- 6(d). What are the basic components of a biogas digester? What factors affect biogas production? Explain. 09
- 7(a). Describe how a hydropower plant works and classify them. 09
- 7(b). What are the different types of turbines used in hydropower plant? Explain the environmental impact of hydropower plant. 09
- 7(c). How wind power could be exploited? Show that an hour with an average velocity produce more power than an hour with different wind velocity. 08
- 7(d). What factors are considered for the selection of site of a WECS? Explain the effect of turbulence. 09
- 8(a). How geothermal energy resource systems are classified? Explain with schematic diagram. 08
- 8(b). Explain with neat sketch the closed cycle OTEC system for power generator. 09
- 8(c). How energy can be extracted from waves? Explain any one method. 10
- 8(d). What are the factors that should be considered for selection of a wind energy collector system? Why wind energy storage systems are necessary? 08

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