2015 – 2016
B.E. (II SEMESTER) EXAMINATION
(CIVIL / ELECTRICAL / MECHANICAL ENGINEERING)

MATHEMATICS – II
(EAM – 112)

Maximum Marks: 60

Duration: Three Hours

Note: Answer all the questions.

1. (a) If \( V = \left( x^2 + y^2 + z^2 \right)^{\frac{1}{2}} \), show that \( \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = 0 \). [05]

(b) If \( z = f(x, y) \), where \( x = e^u \cos v, y = e^u \sin v \), show that 

\[
\left( \frac{\partial z}{\partial x} \right)^2 + \left( \frac{\partial z}{\partial y} \right)^2 = e^{2u} \left( \left( \frac{\partial z}{\partial u} \right)^2 + \left( \frac{\partial z}{\partial v} \right)^2 \right)
\]

OR

(b') If \( x + y = 2e^\theta \cos \phi \) and \( x - y = 2ie^\theta \sin \phi \) where \( i = \sqrt{-1} \), show that 

\[
\frac{\partial^2 v}{\partial \theta^2} + \frac{\partial^2 v}{\partial \phi^2} = 4xy \frac{\partial^2 v}{\partial x \partial y}.
\]

(c) If \( u = \frac{x}{\sqrt{1-r^2}}, v = \frac{y}{\sqrt{1-r^2}}, w = \frac{z}{\sqrt{1-r^2}} \) where \( r^2 = x^2 + y^2 + z^2 \), show that 

\[
\frac{\partial (u, v, w)}{\partial (x, y, z)} = \frac{1}{(1-r^2)^{\frac{5}{2}}}.
\]

2. (a) Expand \( x^y \) in powers of \((x - 1)\) and \((y - 1)\) upto the third degree terms. [05]

(b) The period of simple pendulum is \( T = 2\pi \sqrt{\frac{l}{g}} \). Find the maximum error in \( T \) due to possible errors upto 1% in \( l \) and 2.5% in \( g \). [05]

OR

(b') At a distance of 50 meters from the foot of a tower, the elevation of its top is 30°. If the possible errors in measuring the distance and elevation are 2 cm and 0.05 degree respectively final the approximate error in the calculate height. [05]

(c) Show that the volume of the greatest rectangular parallelepiped the can be inscribed in the ellipsoid \( \frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1 \) is \( \frac{8abc}{3\sqrt{3}} \). [05]

Contd.....2
3. (a) Find the volume under the plane \( z = x + y \) and above the area cut from the first quadrant by the ellipse \( 4x^2 + 9y^2 = 36 \).  

OR  

(a') Find by double integration the area lying inside the cardioid \( r = 1 + \cos \theta \) and outside the parabola \( r (1 + \cos \theta) = 1 \).

(b) Evaluate

\[
\int_0^1 \int_x^1 \frac{x}{\sqrt{x^2 + y^2}} \, dy \, dx
\]

by changing the order of integration.

(c) Find by triple integration the volume cut off from the cylinder \( x^2 + y^2 = ax \) by the planes \( z = mx \) and \( z = nx \).

4. (a) Trace any one of the following conics:

(i) \( 14x^2 - 4xy + 11y^2 - 44x - 58y + 71 = 0 \)

(ii) \( x^2 - 3xy + y^2 + 10x - 10y + 21 = 0 \).

(b) A circle passing through the focus of a conic whose latus rectum is \( 2 \ell \) meets the conic in four points whose distances from the focus are \( r_1, r_2, r_3 \) and \( r_4 \); prove that

\[
\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + \frac{1}{r_4} = \frac{2}{\ell}.
\]
NOTE: Answer ALL the questions. Notations used have their usual meanings.

1(a) On the basis of band diagram, distinguish between metals, semiconductors and insulators. Also explain the intrinsic and extrinsic semiconductors with two examples of each. [7.0]

OR

1(a') What is doping? Derive the expression for the number of electrons per unit volume in the conduction band at equilibrium in a semiconductor. [7.0]

1(c) The electron and hole mobilities in a Si sample are 0.135 and 0.048 m²/V-s respectively. Determine the conductivity of intrinsic Si at 300 K if the intrinsic carrier concentration is $1.5 \times 10^{16}$ atoms/m³. The sample is then doped with $10^{23}$ phosphorus atoms/m³. Determine the equilibrium hole concentration and conductivity of the doped sample. [3.0]

2(a) Explain the terms numerical aperture and acceptance angle in an optical fiber. Distinguish between step index and graded index optical fibers. [5.0]

2(b) Explain the advantages of an optical fibre communication system over the conventional ones. [3.0]

2(c) The refractive indices of core and cladding materials of a step index fibre are 1.48 and 1.45 respectively. Calculate (i) numerical aperture, (ii) acceptance angle at the core and cladding interface and (iii) fractional refractive indices change. [2.0]

3(a) What are the important characteristics of a laser light? With the help of suitable diagrams, describe principle, construction and working of a four level laser. Mention three advantages of a semiconductor laser. [7.0]

3(b) Discuss the applications of a laser in engineering and biomedical science. [3.0]

OR

3(b') A laser beam has a wavelength of $8 \times 10^{-7}$ m and an aperture 5 mm. The laser beam is sent to moon whose distance is $4 \times 10^{5}$ km from the earth. Calculate the angular spread and axial spread of the beam. [3.0]
What are x-rays? Mention some of their properties.

Define phase and group velocities. Calculate the phase and group velocities of an electron whose de Broglie wavelength is 2.0 pm.

What is Compton effect? In a Compton scattering experiment, a photon of wavelength 55.8 pm is scattered by an electron through 46°. Find the wavelength of the scattered photon.

What do you mean by Duane-Hunt limit? Find the shortest wavelength present in the radiation from an x-ray machine whose accelerating potential is 50 kV.

What do you understand by a ‘well-behaved wave function’? Establish time dependent form of Schrödinger equation.

Solve the time independent form of Schrödinger equation for a particle confined in a box L wide for its normalized wave function and hence calculate the expectation value of its position in the box.

What is the significance of statistical mechanics? Differentiate clearly between various types of statistical distributions.

How does the classical physics fail to explain the specific heats of solids? Discuss the Einstein modification and hence obtain the modified formula on specific heats of solids.

Write Maxwell-Boltzmann energy distribution, \( n(\varepsilon) \)d\( \varepsilon \) for ideal gas molecules and hence show that the average molecular energy in an ideal gas is \( \frac{3}{2} k_B T \).

---

**SOME USEFUL PHYSICAL CONSTANTS**

\[ h = 6.63 \times 10^{-34} \text{ J.s}, \quad k_B = 1.38 \times 10^{-23} \text{ J/K} \]

\[ n_i(\text{Si}) = 1.5 \times 10^{16} \text{ m}^{-3}, \quad q_e = 1.6 \times 10^{-19} \text{ C} \]

\[ m_e = 9.1 \times 10^{-31} \text{ kg}, \quad m_p = 1.671 \times 10^{-27} \text{ kg}, \quad c = 3 \times 10^8 \text{ m/s} \]
2015-16
B.E. (WINTER SEMESTER) EXAMINATION
CIVIL/ELECTRICAL/MECHANICAL
ENVIRONMENTAL STUDIES
ECE 111

Maximum Marks: 60 
Credits: 04 
Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. 

1(a) Discuss the objectives of conducting ecological studies and their benefits. [05]

OR

1'(a) Differentiate between food chain and food web in detail with the help of suitable examples [05]

1(b) Differentiate between abiotic and biotic environment with proper classification. [05]

2. (a) Briefly describe the impact of discharge of wastewater on streams. [02]

2 (b) A wastewater treatment plant discharges its effluent to a river. The flow of wastewater was 10,000 m³/d, BOD₅ of 45 mg/L, D.O. 2.0 mg/L and temperature 24° C. The properties of river water (just before the pint of discharge of wastewater) was flow = 0.45 m³/s, BOD₅ = 3.0 mg/L, D.O. = 7.5 mg/L and temperature 21° C. Assume complete mixing of wastewater occurs with the river water and the mixture moves with a uniform velocity of 0.4 m/s. Determine the minimum dissolved oxygen concentration in river and find its distance from the point of discharge of wastewater. Assume k₁ = 0.23 d⁻¹ at 20° C and k₂ = 0.40 d⁻¹ at 20° C. [08]

OR

2'(a) Design a sedimentation tank for a flow of 20 MLD assuming SOR as 25 m³/m².d. [05]

Design both rectangular and circular sections.

2'(b) What is disinfection process? Write different chemical equations involved with chlorine and nitrogen compounds. Describe break point chlorination. [05]

Contd.....2.
3 (a) What are the objectives of sewage treatment? Draw a flowsheet used for the treatment of municipal wastewater.

3 (b) Describe the working of activated sludge process.

3 (b') Design a grit channel for a flow of 10 MLD assume horizontal velocity as 0.3 m/s and settling velocity as 0.02 m/s

4 (a) Enumerate and discuss various types of plumes with the help of neat sketches. Also, discuss the effects of these plume behaviour on dispersion of air pollutants

4 (b) What are the different particulate control devices? Discuss the working of gravitational settling chamber with diagram?

5 (a) How solid waste is characterized? Discuss the different functional elements of solid waste management?

5 (b) How landfilling is done for solid waste? What is the waste to energy concept in incineration and pyrolysis process for solid waste?

6 (a) How air pollutants are classified?

6 (b) What is the importance of oxides of carbon? What are their health and environmental effects?

OR

6' (b) Enumerate and discuss various types of plumes with the help of neat sketches. Also, discuss the effects of these plume behaviour on dispersion of air pollutants
UNIT – I

1. (a) Read the passage and answer the questions that follow: [5x2=10]

Jacob Epstein’s sculptures were the focus of much controversy during the sculptor’s lifetime. Epstein was born in the United States of Russian-Jewish immigrants in 1880. He moved to Paris in his youth and later to England, where he eventually settled and obtained British citizenship in 1907. His first major public commission, on a building in London, offended public taste because of the expressive distortion and nudity of the figures. In 1937, the Rhodesian government, which at that time owned the building, actually mutilated the sculptures to make them conform to public notions of decency. Many of another’s monumental carvings received equally adverse criticism.

While the general public denounced his work, many artists and critics praised it. They admired in particular the diversity of his work; and noted the influence on it of primitive and ancient sculptural motifs from Africa and the Pacific. Today, Epstein’s work has received the recognition it deserves, and Epstein is considered one of the major sculptors of the twentieth century.

1. The author’s attitude towards Epstein’s work is:
   (a) critical  (b) derisive
   (c) amusing  (d) admiring

2. Which of the following can be said to be a probable important influence on Epstein’s work?
   (a) public tastes  (b) African carvings
   (c) Russian painting (d) the Rhodesian government

3. In today’s time, a newly erected Epstein sculpture would probably
   (a) be mutilated  (b) confirm to public opinions
   (c) be well received  (d) be expressive

4. Change the following into noun forms:
   Settled, offend.

5. Change the following into adjectives:
   Controversy, distort
   (b) Write a summary of the passage given above in approximately 65 words. [10]

UNIT – II

2. (a) What are the events that the Animal Farm goes through after the pigs come into absolute power? [05]

   OR

Discuss the two battles of the windmills. What was the difference between the two?

(b) What are the things that the time traveler sees in the Palace of Green Porcelain? [05]

   OR

Discuss the living style of the Elois. Why were they scared of the Mortocks? (The Time Machine)

UNIT – III

3. Attempt any one of the following:
   Write the process of paying electricity bill through a website. [10]

Contd.....2
OR
Write a report on a recently concluded symposium entitled 'Waste Disposal and a Better Future'.

UNIT - IV

4. Read the passage given below and:
   (i) Make notes of it in proper format.
   (ii) Write a précis of the same.

**Cellular Slime Molds**

Cellular slime molds are extraordinary life forms that exhibit features of both fungi and protozoa, although often classed for convenience with fungi. At one time they were regarded as organisms of ambiguous taxonomic status, but more recent analysis of DNA sequences has shown that slime molds should be regarded as inhabiting their own separate kingdom. Their uniqueness lies in their unusual life cycle, which alternates between a feeding stage in which the organism is essentially unicellular and a reproductive stage in which the organism adopts a multicellular structure. At the first stage they are free-living, separate amoebae, usually inhabiting the forest floor and ingesting bacteria found in rotted wood, dung, or damp soil. But their food supplies are relatively easily exhausted since the cells' movements are restricted and their food requirements rather large.

When the cells become starved of nutrition, the organism initiates a new genetic program that permits the cells to eventually find a new, food-rich environment. At this point, the single-celled amoebae combine together to form what will eventually become a multicellular creature. The mechanism by which the individual members become a single entity is essentially chemical in nature. At first, a few of the amoebae start to produce periodic chemical pulses that are detected, amplified, and relayed to the surrounding members, which then move toward the pulse origin. In time, these cells form many streams of cells, which then come together to form a single hemispherical mass. This mass sticks together through the secretion of adhesion molecules.

UNIT - V

5. Write an essay of about 250 words on anyone of the following topics:
   (a) The Internet has made the world smaller.
       OR
   (b) Using waste material to make a better world.
       OR
   (c) Science in the Service of the mankind.

*****
Q.No. 1. **Do any two questions:**

(a) Two transmission belts pass over a double-sheaved pulley that is attached to an axle supported by bearings at A and D as shown in Figure 1. The radius of the inner sheave is 125 mm and the radius of the outer sheave is 250 mm. Knowing that when the system is at rest, the tension is 90 N in both portions of belt B and 150 N in both portions of belt C, determine the reactions at A and D. Assume that the bearing at D does not exert any axial thrust.

(b) The coefficients of friction are $\mu_s = 0.40$ and $\mu_k = 0.30$ between all surfaces of contact for Figures 2. Determine the force P for which motion of the 30-kg block is impending if cable AB (a) is attached as shown, (b) is removed.
A vertical force $P$ of magnitude 150 N is applied to the linkage at B as shown in figure 3. The constant of the spring is 2000N/m, and the spring is unstretched when AB and BC are horizontal. Neglecting the weight of the linkage, determine the value of $\theta$ corresponding to equilibrium.

2 (a) The rotation of rod OA (shown in figure 4) about O is defined by the relation $\theta = 0.5e^{-0.8t} \sin 3\pi t$, where $\theta$ and $t$ are expressed in radians and seconds, respectively. Collar B slides along the rod so that its distance from O is $r = 1 + 2t - 6t^2 + 8t^3$, where $r$ and $t$ are expressed in feet and seconds, respectively. When $t = 0.5$ s, determine (a) the velocity of the collar, (b) the acceleration of the collar, (c) the acceleration of the collar relative to the rod.

2 (b) Three spheres, each of mass $m$, can slide freely on a frictionless, horizontal surface. Spheres A and B are attached to an inextensible, inelastic cord of length $l$ and are at rest in the position shown in figure 5 when sphere B is struck squarely by sphere C, which is moving to the right with a velocity $v_0$. Knowing that the cord is slack when sphere B is struck by sphere C and assuming perfectly elastic impact between B and C, determine the velocity of each sphere immediately after the cord becomes taut.
Two small disks A and B, of mass 3 kg and 1.5 kg, respectively, may slide on a horizontal, frictionless surface (figure 6). They are connected by a cord, 600 mm, long, and spin counter-clockwise about their mass center G at the rate of 10 rad/s. At \( r=0 \), the coordinates of G are \( x_0 = 0 \), \( y_0 = 2 \) m and its velocity is \( \bar{v}_0 = (1.2 m/s)i + (0.96 m/s)j \). Shortly thereafter, the cord breaks; disk A is then observed to move along a path parallel to the y axis and disk B along a path which intersects the x axis at a distance \( b = 7.5 \) m from O. Determine (a) the velocities of A and B after the cord breaks, (b) the distance \( a \) from the y-axis to the path of A.

![Figure 6](image)

3. (a) The disk shown in figure 7 has a constant angular velocity of 500 rpm counter-clockwise. Knowing that rod BD is 250 mm long, determine the acceleration of collar D when (a) \( \theta = 90^\circ \), (b) \( \theta = 180^\circ \).

3. (b) A uniform slender rod of length \( L = 1 \) m and mass \( M = 2 \) kg hangs freely from a hinge at A (figure 8). If a force P of magnitude 8 N is applied at B horizontally to the left (\( h = L \)), determine (a) the angular acceleration of the rod, (b) the components of the reaction at A.

Contd...... 4
4 (a) A steel bar 25 mm diameter is loaded as shown in figure 9. Determine the stresses in each part and total elongation. Take \( E = 210 \text{ GPa} \).

4 (b) Calculate the values and draw the diagrams for shearing force and bending moment for the following beam shown in figure 10.
5 (a) A 4m long beam with rectangular section of 10 cm deep is simply supported at the ends. If it is loaded with a uniformly distributed load of 4 KN/m throughout the span and concentrated load $P = 2$ KN placed at a distance of 1.5m from the left end. Determine the maximum bending stress in the beam.

OR

5 (a') A shaft has to transmit 105 KW at 160 rpm. If the shear stress is not to exceed 65 N/mm$^2$ and the twist in a length of 3.5 m must not exceed 10, find a suitable diameter. Take $G$ or $C = 8 \times 10^4$ N/mm$^2$.

5 (b) The principal stresses at a point in a strained material are 126 MPa tensile and 63 MPa tensile, the third principal stress being zero. Using Mohr's Circle determine the magnitude and direction of resultant stress on a plane inclined at 30° to the direction of the smaller principal stress and perpendicular to the plane across which the stress is zero. Also find the maximum obliquity of the resultant stress and its magnitude.

OR

5 (b') For the state of stress given below, determine (i) the normal and shear stresses on the plane $AC$; (ii) resultant stress on the planes of maximum shear stress; and (iii) principal stresses and principal planes.

![Figure 11](image)