OLD COURSE

B.E. (1 YEAR) EXAMINATION
(ELECTRICAL / MECHANICAL / CIVIL)
MATHEMATICS – II
(FAM – 102)

Maximum Marks: 100

Note: Answer all questions.

1. (a) If \( u = x \frac{x}{y} + y \frac{x}{y} \), prove that
\[
x^2 \frac{\partial^2 u}{\partial x^2} + 2xy \frac{\partial^2 u}{\partial x \partial y} - y^2 \frac{\partial^2 u}{\partial y^2} = 0.
\]

(b) Show that for the surface \( x^2 y^2 z^2 = C \),
\[
\frac{\partial^2 z}{\partial x \partial y} = \left( x \log x \right)'
\]
at the point \( x = y = z \).

(c) If \( u = f(r, s, t) \) and \( r = \frac{x}{y}, s = \frac{y}{z}, t = \frac{z}{x} \), prove that
\[
x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} + z \frac{\partial u}{\partial z} = 0.
\]

OR

(c') If \( u = \sin^{-1} x + \sin^{-1} y \) and \( v = x \sqrt{1 - y^2} + y \sqrt{1 - x^2} \), are \( u \) and \( v \) functionally related? If so, then find the relationship between \( u \) and \( v \).

2. (a) Expand \( f(x, y) = e^x \tan^{-1} y \) in the neighbourhood of \((1, 1)\) up to the term of second degree.

(b) At a distance of 50 meter from the foot of a tower, the elevation of its top is 30°. If the possible errors in measuring the distance and the elevation are 2 cm and 0.05 degree respectively, find the approximate error in the calculated height.

(c) Prove that the rectangular solid of maximum volume which can be inscribed in a sphere is cube.

OR

(c') Given \( f(x, y, z) = 5xyz / (x + 2y + 4z) \), find the values of \( x, y, z \) for which \( f(x, y, z) \) is a maximum subject to the condition \( xyz = 8 \).

[8+6+6]

Contd. . . . .

Duration: Three Hours
3. (a) A line makes angle $\alpha$, $\beta$, $\gamma$, $\delta$ with four diagonals of a cube. Prove that 
\[ \cos^2\alpha + \cos^2\beta + \cos^2\gamma + \cos^2\delta = \frac{4}{3}. \]

(b) Show that the equation of the right circular cylinder described on the circle through the point A (1, 0, 0), B (0, 1, 0) and C (0, 0, 1) as the guiding curve is 
\[ x^2 + y^2 + z^2 - yz - zx - xy = 1. \]

OR

(b') Find the equation of the right circular cone with vertex at origin, semivertical angle $60^\circ$ and the axis \[ \frac{x}{3} = \frac{y}{-4} = \frac{z}{5}. \]

4. (a) Evaluate the following integral by changing the order of integration 
\[ \int_0^1 \int_x^{\sqrt{x^2 + y^2}} \frac{x \, dy \, dx}{\sqrt{x^2 + y^2}}. \]

OR

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

(b) Find the volume cut from the sphere $x^2 + y^2 + z^2 = a^2$ by the cone $x^2 + y^2 = z^2$. [10+10]

5. (a) Find the Fourier series for the function $f(x) = x + x^2$ in the interval $-\pi < x < \pi$.

OR

(a') Find the Fourier series of the function $f(x) = x^2$, $-\pi < x < \pi$ and deduce the relations 
\[ \frac{\pi^2}{6} = 1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} + \ldots \]
\[ \frac{\pi^2}{12} = 1 - \frac{1}{2^2} + \frac{1}{3^2} - \frac{1}{4^2} + \ldots \]
\[ \frac{\pi^2}{8} = 1 + \frac{1}{3^2} + \frac{1}{5^2} + \frac{1}{7^2} + \ldots \]

(b) Test the convergence of the following series:

(i) \[ 1 + \frac{1}{2} + \frac{2}{5} x + \left( \frac{3}{4} \right)^2 x^2 + \left( \frac{4}{5} \right)^3 x^3 + \ldots \]

(ii) \[ 1 + 3x + 5x^2 + 7x^3 + \ldots \] [10+10]
2014-15
B.E. (EVENING) WINTER SEMESTER EXAMINATION
ELECTRICAL/CIVIL & MECHANICAL ENGG.
APPLIED PHYSICS
EAP111

Maximum Marks: 60
Credits: 04
Duration: Three Hours

NOTE: Answer ALL the questions. Notations used have their usual meanings.

1(a) Explain n and p-type semiconductors. Show that the effective mass of an electron under
the influence of an external electric field moving in an energy band is given by
\[ m^* = \frac{k^2}{\frac{\partial^2 E}{\partial k^2}} \]

OR

1(a') Define mobility of charge carriers and derive the expression for conductivity of an
intrinsic semiconductor.

1(b) What is Hall effect? The Hall coefficient \( R_H \) and resistivity of a semiconductor are
3.52×10^-4 m^2/C and 8.25×10^3 Ω·m respectively. Calculate the mobility and concentration
of its charge carriers. Also specify the type of charge carriers.

2(a) Give the principle of an optical fibre. Obtain an expression for the acceptance angle and
numerical aperture of the fibre.

2(b) Explain the cause of signal distortion and transmission losses in multimode step index
optical fibre.

2(c) The refractive indices of the core and cladding of an optical fibre are 1.572 and 1.472
respectively. Calculate its angle of acceptance and numerical aperture.

3(a) What do you mean by population inversion? Explain the Einstein's coefficients for
induced absorption, spontaneous emission, and stimulated emission.

3(b) With the help of neat diagrams explain principle, construction and working of a three
level laser. Mention one of the drawbacks of this laser.

OR

3(b') Discuss the applications of a laser in holography, industrial and communications.

3(c) A certain ruby laser emits 1.00 J pulses of light whose wavelength is 6940 Å. What is the
minimum number of Cr^3+ ions in the ruby?

Continued.....2
4(a) What is Compton's effect? Derive an expression for Compton shift, 
\[ \lambda' - \lambda = \frac{h}{m_e c} (1 - \cos \phi). \]  

4(b) What is the minimum wavelength and corresponding frequency of x-rays produced in a tube maintained at 13.26 kV. [4.0]

OR

4'(a) Explain pair production and pair annihilation. Show that pair production cannot take place in free space. [6.0]

4'(b) What is uncertainty principle? Obtain qualitatively, the uncertainty relation \( \Delta x \Delta p \geq \hbar/2 \). [4.0]

5(a) What is the physical significance of a wave function? Obtain the time dependent form of the Schrödinger equation. [7.0]

5(b) Find the probability that a particle trapped in a box \( l \) wide can be found between 0.45L and 0.55L for the ground state. [3.0]

6(a) Write statistical distribution functions for classical and quantum mechanical particles. [2.0]

6(b) Derive an expression for the molecular energy distribution, \( n(\epsilon)d\epsilon \) for ideal gas molecules having energy in the energy interval \( \epsilon \) and \( \epsilon + d\epsilon \) for a gas sample that contains \( N \) molecules at any temperature \( T \). [5.0]

6(c) Find the most probable and rms speeds of oxygen molecules at 20 °C. [3.0]

OR

6'(a) Show that average molecular energy of an ideal gas is given by \( \bar{\epsilon} = (3/2)kT \). [3.0]

6'(b) State Dulong-Petit's law and mention its drawbacks. Discuss quantitatively the Einstein's explanation on the specific heat of solids. [7.0]

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**SOME USEFUL PHYSICAL CONSTANTS**

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

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

\[ m_e = 9.1 \times 10^{-31} \text{ kg}, \quad m_p = 1.67 \times 10^{-27} \text{ kg}, \quad c = 3 \times 10^8 \text{ m/s} \]
### Question Bank

**Maximum Marks: 60**

**Credits: 04**

**Duration: Three Hours**

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

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Discuss the objectives of conducting ecological studies and their benefits.</td>
<td>5</td>
</tr>
<tr>
<td>1'(a)</td>
<td>Differentiate between abiotic and biotic environment with proper classification.</td>
<td>5</td>
</tr>
<tr>
<td>1(b)</td>
<td>What is photochemical smog? Write down different reactions involved in photochemical smog.</td>
<td>5</td>
</tr>
<tr>
<td>2(a)</td>
<td>What are the deleterious effects produced on the human body when exposed to high levels of Air Pollution.</td>
<td>5</td>
</tr>
<tr>
<td>2(b)</td>
<td>Enumerate various constituents of Air and discuss the role played by them in sustaining life on earth.</td>
<td>5</td>
</tr>
<tr>
<td>3(a)</td>
<td>Explain the procedure of preparation of N/50 H₂SO₄ standard solution from commercially available concentrated H₂SO₄ with 96% purity.</td>
<td>5</td>
</tr>
<tr>
<td>3(b)</td>
<td>A water sample contains 44 mg/l of calcium ions and 19 mg/l of magnesium ions. Calculate the hardness expressed as mg/l of CaCO₃.</td>
<td>5</td>
</tr>
<tr>
<td>3'(b)</td>
<td>A 100 ml sample of water is titrated with 0.02 N H₂SO₄. The initial pH is 9.5 and 6.2 ml of acid is used to reach the pH 8.3. An additional 9.8 ml of acid is used to reach the pH 4.5. Determine the Phenolphthalein alkalinity and Methyl orange alkalinity in mg/l as CaCO₃.</td>
<td>5</td>
</tr>
<tr>
<td>4(a)</td>
<td>Design a sedimentation tank for a population of 10 thousand persons using 150 liters per day per person. Assume SUR=30m/day</td>
<td>5</td>
</tr>
</tbody>
</table>

**Contd...**
4(b) Briefly discuss the water treatment system for surface water source. Briefly describe its each unit.

5(a) Differentiate between Biochemical Oxygen Demand and Chemical Oxygen Demand. The BOD₄ of wastewater is determined to be 200 mg/L at 27°C. The k²₇ value is known to be 0.3/day. What would be the BOD₇, BOD₂₀, and Ultimate BOD if the test were run at 20°C?

5(b) What are attached and suspended growth system in biological wastewater treatment?

OR

5'(b) What are low cost wastewater treatment system?

6(a) What are the principle functional elements of solid waste management? How solid waste is characterized on its physical and chemical properties?

6(b) Describe the Aerobic Composting Process. Discuss the parameters which effects the process.
1. (a) Read the passage and answer the questions that follow:  

Teotihuacan is the largest and most impressive urban archaeological site of ancient America, covering an area of roughly 20 square kilometers. The city was at one time thought to be the religious center of the Toltecs but is now believed to be a creation of an earlier civilization about whose origins little is known. The earliest artifacts from Teotihuacan date from over 2,000 years ago, but the period of greatest expansion dates from 200 CE to 600 CE. At its peak the city is estimated to have had a population of up to 200,000 inhabitants, with residential areas extending throughout the built-up area. Judging by the regionally dispersed finds of the rain god Tlaloc, or “thin orange war” pottery, and the characteristic architectural forms, the influence of Teotihuacan was widespread. It is not clear what caused the city’s decline and eventual abandonment, but the evidence points to overpopulation, a depletion of resources, and the possible sacking by adversaries.

The primary axis of the city was the Avenue of the Dead, which extends for 2.5 kilometers through the center of the urban area, starting in the north at the Moon Plaza and continuing beyond the Great Compound complexes to the south. The avenue divided Teotihuacan into two sections with apartment compounds arranged on either side, often symmetrically, suggesting a highly planned layout from the earliest phases of construction.

The vast Pyramid of the Sun, located in the middle of the central zone, is the tallest and most dominant structure of Teotihuacan, with a height of 65 meters and a base covering approximately 1.8 acres. At one time the edifice was surmounted by a temple. A cave located underneath the pyramid and possibly used for ritual activities hints at its religious importance. The Pyramids of the Moon and Feathered Serpent are other notable ceremonial sites nearby.

A particular feature of the architecture of many of the pyramidal platforms at this site is the series of sloping apron walls known as talud, interspersed with vertical panels tableros — producing a step-like appearance. Originally all such structure would have been covered with a layer of stucco and then painted, often with pictures of animals and mythological creatures.

(i) What are the causes of decline of Teotihuacan, as mentioned in the passage?
(ii) Which of the sentences below expresses the essential information in the highlighted sentence in the passage?
(a) A feature of the pyramidal architecture is the many platforms that make up the steps.
(b) The sloping walls of the pyramid have occasional vertical panels, which gives the appearance of steps.
(c) The architectural features known as taluds and tableros are a particular feature of the many pyramidal platforms.
(d) A series of sloping walls combined with vertical panels produces the appearance of steps that form the pyramidal platforms.

(iii) All of the following are mentioned as having been found in Teotihuacan area EXCEPT
(a) market streets
(b) religious artifacts

Contd.....2
(c) Ceremonial structures
(d) Residential districts
(iv) Change the following into verb forms:
   Civilization, deploration, expansion, abandonment
(v) Change the following into noun forms:
   Extend, continue, Residential, Possibly
1. (b) Write a summary of the passage given above.

UNIT – II

2. Discuss the seven commandments and the way they change during the course of
   the novel, ‘Animal Farm’

   OR

   In Animal Farm, Squealer is used as a propagandist by Napoleon. Give at least 3
   instances to show bow.

3. Describe the lifestyle of the Morlocks and their attitude towards the Eloi in The
   Time Machine.

   OR

   How does the Time Traveller interpret all that he has seen of the future through
   his voyage, in The Time Machine.

UNIT – III

4. Attempt any one of the following:
   Write a report on a recently concluded workshop on ‘Managing Water
   Pollution’.

   OR

   Write the process of placing an order for a copy of The Animal Farm from an
   online shopping website.

UNIT – IV

5. Read the passage give below and (i) make notes of it in the proper format;
   (ii) Write a précis of the same.

   A recent survey found that nine out of ten drivers admit to having felt intense
   anger toward other drivers at some time. “Road rage” seems to be on the rise, and
   several explanations for this have been presented. First, there are more cars today
   competing for road space. People also are far more subject to time constraints. A
   person who must meet a time deadline, but is caught in a tangle of traffic, may feel
   increasingly frustrated. Soon this stress may result in an outburst of road rage.
   Range anywhere from pounding on the car horn to getting out of the car and
   attacking another driver.

   Of the three major responses to stress which have evolved – flight, flight, or
   freeze – only one is available to the driver who is suddenly caught behind a dawdler
   in the last lane. This car itself prohibits the driver from fleeing the situation or
   freezing in one place. The only stress response left is fight.

   Another explanation may be that people are not as courteous as they used to be.
   A person who is worried about getting to work on time, having a report ready for the
   afternoon mail, and running into the boss while coming into the office late may
   forget how to be polite. Other drivers become the enemy and the car, a weapon.

   UNIY – V

6. Write an essay of at least 250 words on any one of the following topics:
   (a) A few great changes of the twentieth century.

   OR

   (b) Poverty and Unemployment Two major issues of our country.

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2014-2015
B. E. II SEMESTER EXAMINATION
(CIVIL/ELECTRICAL/MECHANICAL)
APPLIED MECHANICS
(EME111)

Maximum Marks: 60
Duration: Three Hours

NOTE: Answer all the questions, symbols have their usual meaning.
Assume suitable data if missing.

SECTION A

1(a). A 110-N force acting in a vertical plane parallel to the y-z plane is applied to the 220-
mm long horizontal handle AB of a socket wrench. Replace the force with an equivalent
force couple system at the origin O of the coordinate system. (Figure 1)

1(b). Denoting by \( \mu \), the coefficient of static friction between the block attached to rod ACE
and the horizontal surface, derive expressions in terms of \( P \), \( \mu \), and \( \theta \) for the largest and
smallest force \( Q \) for which equilibrium is maintained. (Figure 2)

Figure 1

Figure 2
2. A 30 g bullet is fired with a horizontal velocity of 150 m/s through a 3 kg block B and becomes embedded in carrier C which has a mass of 30 kg. After the impact, block B slides 0.5 m on C before coming to rest relative to the carrier. Knowing the coefficient of kinetic friction between B and C is 0.2, determine (a) the velocity of the bullet immediately after passing through B, (b) the final velocity of the carrier. (Figure 3)

OR

2'. An 18 kg and a 12 kg cannonball are chained together and fired horizontally with a velocity of 165 m/s from the top of a 15-m wall. The chain breaks during the flight of the cannonballs and the 12-kg cannonball strikes the ground at t=1.5s, at a distance of 240 m from the foot of the wall, and 7 m to the right of the line of fire. Determine the position of the other cannonball at that instant. Neglect the resistance of the air. (Figure 4)

3(a). In an engine system shown, a=100 mm and b=60 mm. Knowing that crank AB rotates with a constant angular velocity of 1000 rpm clockwise, determine the velocity of the piston P and the angular velocity of the connecting rod when (a) \( \theta = 0 \) (b) \( \theta = 90^\circ \). (Figure 5)

OR

3(a'). In the position shown, bar DCE has a constant angular velocity of 10 rad/s clockwise. Knowing that d=500 mm, determine (a) the angular velocity of bar FBD, (b) the velocity of point E. (Figure 6)
3(b). Race car A is traveling on a straight portion of the track while race car B is traveling on a circular portion of the track. At the instant shown, the speed of A is increasing at the rate of 10 m/s², and the speed of B is decreasing at the rate of 6 m/s². For the position shown, determine (a) the velocity of B relative to A, (b) the acceleration of B relative to A. (Figure 7)

SECTION B

4(a). (i) Explain the following terms: Volumetric strain; Toughness; Determinate and indeterminate structures.

(ii) A bar of 10mm diameter is subjected to a pull of 50kN which causes stress within elastic limit. The measured extension over a gauge length of 20cm is 0.12mm and change in diameter is 0.0036mm. Calculate the Poisson's ratio and the value of modulus of elasticity 'E' and bulk modulus 'K'.

4(b). The state of stress at a point in a stress material is given by $\sigma_x = 20 \text{MPa}$, $\sigma_y = 10 \text{MPa}$ and $\tau_{xy} = 25 \text{MPa}$. Determine the direction and magnitude of principal stresses in the material. Also locate the planes of maximum shear stress and calculate the normal and shear stress on these planes.
4(b). At a point in a stressed material, the principal stresses are 120MPa (tensile) and 60MPa (compressive). Find the resultant stress and its direction on a plane inclined at 45° to the axis of 120MPa stress by Mohr's circle diagram. Also determine the maximum intensity of shear stress in the material.

5(a). Draw the shear force and bending moment diagram for the beam shown in figure below.

\[ \text{3kN} \quad \text{1kN/m} \quad \text{2.5kN} \]

5(b). Prove that for a solid circular section of diameter \(D\) (radius \(r\)), the shear stress \(q\) at a distance of \(y\) from neutral axis is

\[ q = \frac{F}{2I} (r^2 - y^2) \]

Where, \(F\) is shear force at the section and \(I\) is moment of inertia of the section.