Answer all the questions. Marks are allotted against each question.

Q.No. Question M.M.

1(a) Write note on any two of the followings [08]

a) Scale and sludge formation
b) Priming and foaming
c) Boiler corrosion

1(b) A water sample on analysis gave the following results [07]

\[
\begin{align*}
\text{Ca(HCO}_3\text{)}_2 &= 32.4; \text{Mg(HCO}_3\text{)}_2 &= 29.6; \text{CaSO}_4 &= 27.2; \text{MgSO}_4 &= 1.2; \text{FeSO}_4 &= 3.5; \\
\text{NaCl} &= 12.6 \text{ and Na}_2\text{SO}_4 = 2.4
\end{align*}
\]

a) Calculate temporary and permanent hardness in mg/L
b) Calculate the amount of lime and soda required to soften one litre of water.

[Atomic mass: Ca = 40; Mg = 24; S = 32; O = 16; C = 12; H = 1; Na = 23; Fe = 56; Cl = 35.5]

OR

1'(a) Explain Zeolite process of water softening. What are its advantages over lime soda process? [08]

1'(b) Describe various steps involved in the treatment of water for drinking purpose. What is break point chlorination? [07]

2(a) How coals are classified? Explain the significance of moisture and volatile matter in proximate analysis of coal. [08]

2(b) The composition of a coal sample was found to be as follows [07]

\[ C = 90\%; \quad H = 4.5\%; \quad S = 0.5\%; \quad N = 0.5\%; \quad O = 2\% \text{ and ash} = 2.5\% \]

Calculate Gross and Net calorific values by Dulong’s formula. Latent heat of steam = 587 cal/g

OR

2'(a) Describe Fischer-Tropsch method for the manufacture of synthetic petrol. [07]

2'(b) A petrol sample contains C = 78\% and H = 18\% by weight. Calculate minimum air required for complete combustion of one Kg of petrol [08]

3(a) Differentiate between chemical and electrochemical corrosion with examples. [07]

3(b) Describe the mechanism of electrochemical corrosion involving evolution of hydrogen. [08]

4(a) Differentiate between hydrodynamic and boundary lubrication mechanism. [07]

4(b) What are greases? What are the components of grease? Describe the function of each component. Describe the conditions where grease is used as lubricant. [08]
2013-14
B.TECH. (WINTER SEMESTER) EXAMINATION
(ELECTRICAL / MECHANICAL / CIVIL / CHEMICAL / ELECTRONICS / COMPUTER /
PETRO-CHEMICAL ENGINEERING)
APPLIED CHEMISTRY
AC-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. Questions M.M.
1(a) Describe the precipitation step of gravimetric analysis. Discuss the types of precipitates with their impurities. [05]
1(b) Discuss Beer’s Lambert Law and its deviation from linearity. Calculate the molar absorptivity of 0.05M colour solution to transmit 70% light using UV-visible spectrophotometer having a path length of 1.0 cm. [05]

OR

1(a)' What are the different types of titrations? Give one example of each type. What is the difference between iodimetric and iodometric titrations? [05]
1(b)' Define chromatography and give its applications. Explain size exclusion chromatography. [05]

2(a) What are the steps involved in the water treatment for municipal use. Explain sedimentation with coagulation. [03]
2(b) Describe the scale and sludge formation in boilers. Discuss any two methods of internal treatment of boiler feed water. [04]
2(c) What is break point chlorination and de-chlorination? [03]

OR

2'(a) Calculate temporary and permanent hardness and the amount of lime soda needed for softening 2,00,000 litres of water containing the following impurities: [05]
Ca(HCO₃)₂ = 8.1 ppm, Mg(HCO₃)₂ = 7.5 ppm, CaSO₄ = 13.6 ppm, MgSO₄ = 12 ppm, MgCl₂ = 2.0 ppm, NaCl = 4.7 ppm.

Atomic weights of Mg = 24, Ca = 40, Cl = 35.5, S = 32, O = 16, H = 1 and C = 12.

2' (b) Discuss Zeolite method of water softening.

3(a) Define higher and lower calorific value for a chemical fuel.
3(b) Differentiate between Proximate and Ultimate method of coal analysis.
3(c) Draw well labelled diagram of Bergius process for production of synthetic petrol.

OR

3(c)' Calculate the minimum amount of oxygen and air required in Kg for the complete combustion of 1 Kg of a coal sample containing 95% carbon and remaining incombustible matter. Calculate the w/w and v/v composition of dry flue gases.

4(a) Define lubricants and describe the mechanism of hydrodynamic lubrication.
4(b) Write short notes on any two of the following:
   (i) Silicone oil
   (ii) Compounded oil
   (iii) Cutting tool oil
4(c) Describe the types of greases and the conditions for their use.

5(a) Define corrosion and give its classification. Explain Pilling Bedworth rule.
5(b) Differentiate between:
   (i) Galvanizing and Tinning
   (ii) Electrochemical series and Galvanic series
5(c) Explain the important designing principles of corrosion control.

6(a) Define polymers and give their classification on the basis of origin, and chemical structure.
6(b) Explain the polymerization reaction of vinyl chloride by free radical mechanism.
6(c) Give the preparation, properties and uses of any two of the following:
   (i) Bakelite (ii) Buna S (iii) Nylon 6,6.
2013 – 2014
B.TECH/B.A.RCH. (WINTER SEMESTER) EXAMINATION
(ELECTRICAL / MECHANICAL / CIVIL / ELECTRONICS / COMPUTER / CHEMICAL / PETRO-CHEMICAL ENGINEERING)
(APPLIED MATHEMATICS – I)
(AM – 101)
Credits : 05
Duration: Three Hours

Maximum Marks: 60

Note: Answer all questions.

1. (a) Test for consistency the following system and solve if it is consistent:
   \[2x - 3y + 7z = 5; \quad 3x + y - 3z = 13; \quad 2x + 19y - 47z = 32.\]
   (b) Find the eigen values and eigenvectors of the matrix:
   \[
   \begin{bmatrix}
   -2 & 2 & -3 \\
   2 & 1 & -6 \\
   -1 & -2 & 0
   \end{bmatrix}
   \]
   OR
   (b’) Verify Caley-Hamilton theorem for the matrix
   \[
   A = \begin{bmatrix}
   2 & 1 & 1 \\
   0 & 1 & 0 \\
   1 & 1 & 2
   \end{bmatrix}
   \]

2. Answer any TWO of the following:
(a) In the parabola \( r = \frac{2a}{1 + \cos \theta} \), prove that
   (i) \( \phi = \frac{\pi}{2} - \frac{\theta}{2} \)
   (ii) \( p = a \sec \left( \frac{\theta}{2} \right) \).

(b) Show that the curvature at the point \( \left( \frac{3a}{2}, \frac{3a}{2} \right) \) on the Folium \( x^3 + y^3 = 3axy \) is \( \frac{8\sqrt{2}}{3a} \).
(c) Trace the curve \( y \left( x^2 + 4a^2 \right) = 8a^3 \) by describing its salient features.

3. (a) If \( y = \frac{\sin^{-1} x}{\sqrt{1-x^2}} \), prove that \( \left( 1-x^2 \right)y_{n+1} - (2n+1)xy_n - x^2y_{n-1} = 0. \)
(a') Expand \( \sin x \) in powers of \( x - \frac{\pi}{2} \) upto three non zero terms.

(b) (i) Test the convergence of the series:
\[
\frac{3}{5} x^2 + \frac{8}{10} x^3 + \frac{n^2 - 1}{n^2 + 1} x^n + \ldots
\]

(ii) Test for convergence the series whose general term is
\[
\sqrt[3]{(n^2 + 1)} - n.
\]

[6+6]

4. (a) Show that the intrinsic equation of the cycloid \( x = a (t + \sin t), y = a (1 - \cos t) \) is \( s = 4a \sin \psi \).

(b) Prove that the volume of the solid generated by the revolution of the curve
\[
y = \frac{a^3}{a^2 + x^2}
\]
about its asymptote is \( \frac{\pi a^3}{2} \).

OR

(b') Find the area of the surface formed by the revolution of \( x^2 + 4y^2 = 16 \) about its major axis.

[6+6]

5. (a) Solve any TWO of the following D.E.:

(i) \( (x^2 - ay) \frac{dx}{dx} = (ax - y^2) \frac{dy}{dx} \)

(ii) \( \frac{d^2 y}{dx^2} - 3 \frac{dy}{dx} + 2y = \sin 3x \)

(iii) \( x \frac{d^2 y}{dx^2} + 2 \frac{dy}{dx} = 6x \)

(b) A body executes damped forced vibrations given by the equation
\[
\frac{d^2 x}{dt^2} + 2k \frac{dx}{dt} + b^2 x = e^{-kt} \sin \omega t.
\]
Solve the equation for both cases when \( \omega^2 = b^2 - k^2 \) and \( \omega^2 \neq b^2 - k^2 \).
2013 – 2014
B.TECH./B.ARCH. WINTER (II SEMESTER) EXAMINATION
(ELECTRICAL / MECHANICAL / CIVIL / ELECTRONICS / COMPUTER / CHEMICAL / PETRO-CHEMICAL ENGINEERING)
MATHEMATICS – II
(AM – 112)
Credits : 04

Maximum Marks: 60

Note: Answer all questions. Programmable calculators are not allowed.

1. (a) If \( u = \log_e (x^3 + y^3 + z^3 - 3xyz) \), show that
\[
\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} + \frac{\partial^2 u}{\partial z^2} + 2 \frac{\partial^2 u}{\partial x \partial y} + 2 \frac{\partial^2 u}{\partial y \partial z} + 2 \frac{\partial^2 u}{\partial z \partial x} = \frac{9}{(x + y + z)^2}
\]

OR

(a') If \( u = f(r) \), where \( r^2 = x^2 + y^2 \), prove that \( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = f''(r) + \frac{1}{r} f'(r) \).

(b) If \( z = f(x, y) \) where \( x = e^u \cos v, y = e^u \sin v \), show that
\[
\left( \frac{\partial z}{\partial u} \right)^2 + \left( \frac{\partial z}{\partial v} \right)^2 = e^{2u} \left( \left( \frac{\partial z}{\partial x} \right)^2 + \left( \frac{\partial z}{\partial y} \right)^2 \right).
\]

(c) If \( u = x + 2y + z, v = x - 2y + 3z, w = 2xy - xz + 4yz - 2z^2 \), show that they are not independent. Find the relation among \( u, v \) and \( w \). [4+5+6]

2. (a) Find the first six terms of the expansion of the function \( f(x, y) = e^x \log_e (1 + y) \) in a Taylor series in the neighbourhood of the point \((0, 0)\).

(b) A balloon is in the form of right circular cylinder of radius 1.5m and length 4m and is surmounted by hemispherical ends. If the radius is increased by 0.01m and length by 0.05m, find the percentage change in the volume of balloon.

(c) Find the semi-vertical angle of the cone of maximum volume and of a given slant height.

OR

(c') Given that \( f(x, y, z) = \frac{5xyz}{x + 2y + 4z} \). Find the values of \( x, y, z \) for which the function \( f(x, y, z) \) is maximum, subject to the condition \( xyz = 8 \). [5+5+5]

3. (a) Find by double integration the area lying inside the circle \( r = a \sin \theta \) and outside the cardioid \( r = a (1 - \cos \theta) \). Contd.....2
(a') Evaluate the following integral by changing the order of integration
\[ \int_0^1 \int_0^{(2-x)} xy \, dy \, dx. \]

(b) Using the transformation \( x - y = u, x + y = v \), show that
\[ \iint_{R} \sin \left( \frac{x - y}{x + y} \right) \, dx \, dy = 0 \]
Where \( R \) is the area bounded by the coordinate planes and the line \( x + y = 1 \) in the first quadrant.

(c) Find by triple integration the volume of the solid enclosed by the ellipsoid \[ \frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1. \]

4. (a) Trace the conic:
\[ x^2 + y^2 - xy - 2x - 20y - 11 = 0. \]
Give its salient features.

(b) A circle of given radius passing through the focus of a conic intersects it in the points A, B, C and D; show that
\[ SA \cdot SB \cdot SC \cdot SD = \text{constant}. \]

OR

(b) In any conic, prove that the sum of the reciprocals of two perpendicular focal chords is constant.
2013-14
B.TECH. (WINTER SEMESTER) EXAMINATION
(Civil/ Chemical/ Computer/ Electrical/ Electronics/ Mechanical/ Petrochemical Engg.)
APPLIED PHYSICS-II
(AP- 102)

Maximum Marks: 60 Credits: 03 Duration: Three Hours

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

1(a) Define the terms; induced absorption, spontaneous emission, stimulated emission, population inversion-and spatial coherence. 5.0
1(b) Discuss construction and working of He-Ne laser with the help of suitable diagrams. What is advantage of this laser over ruby laser? 7.0

OR

1(b') What are the important characteristics of a laser light? Discuss working principle of ammonia maser and its one important application. 7.0

1(c) A ruby contains \(5.24 \times 10^{18}\) ions/m\(^3\) and emits laser pulses of wavelength 6943 Å. What is the minimum energy of a pulse? \((h=6.63 \times 10^{-34}\) J.s, \(c=3 \times 10^8\) m/s) 3.0

2(a) On what principle optical fiber works? Obtain an expression for angle of acceptance in terms of core and cladding refractive indices for a step index fiber also define numerical aperture. 6.0
2(b) Discuss superconductivity in mercury with the help of R vs. T diagram. What do you mean by critical magnetic field and critical temperature? 5.0
2(c) What are type-I and type-II superconductors? Why type-I superconductors are not useful for making electromagnets? 4.0

OR

2(c') Give an account of BCS theory of superconductivity 4.0

3(a) Differentiate with suitable examples between classical particles, bosons and fermions. Write energy distribution for ideal gas molecules and hence obtain their speed distribution. Plot this speed distribution and mark various speeds on this curve. 10.0

3(b) Show that average energy of an ideal gas molecule is independent of its mass. Find the average energy of hydrogen molecules at 27° C. (Assume mass of H\(_2\) molecule to be \(3.34 \times 10^{-27}\) kg and \(k_B = 1.38 \times 10^{-23}\) J/K) 5.0

OR

Contd......2
3'(a) What are distinguishable and indistinguishable particles? Show that probability of occupancy of a state by two bosons is twice that for two classical particles and that it is zero for two fermions.

3'(b) Discuss quantitatively free electrons in metals and obtain an expression for the number of their quantum states, \( g(\varepsilon) \text{d}\varepsilon \) and hence write and plot the expression for their energy distribution, \( n(\varepsilon) \text{d}\varepsilon \).

4(a) What do you mean by cross section of a nuclear reaction? On what factors does it depend? Mention its conventional and SI units. Obtain the expression for the fraction of surviving particles when a beam of particles is incident on a slab of absorber of thickness, \( x \).

4(b) Name various nuclear detectors you know and mention the principle involved in working of these detectors. Give an account of gas filled detectors and also draw the pulse height vs. voltage applied curve to discuss the working of this detector. Mark various regions of operation on this curve.

OR

4(b') What is a fusion nuclear reaction? Give two examples of fusion nuclear reactions. Describe fusion reactor and explain the terms, breakeven, ignition and confinement quality parameter. Mention essential requirements of a successful fusion reactor and briefly discuss as to why a fusion reactor is still a distant dream?
Maximum Marks: 60  
Credits: 04  
Duration: Three Hours

Answer all the questions. Assume suitable data if missing. Symbols used have their usual meanings.

1(a) Explain the terms: meta-stable states and population inversion. How the population inversion is achieved in a lasing device and why is it necessary for producing laser beam? Describe in brief the characteristics of laser light. [7.0]

OR

1(a') What do you understand by temporal and spatial coherence? With the help of a suitable energy level diagram, explain the principle and working of a three level laser. [7.0]

1(b) A typical He-Ne laser emits light of wavelength 632.8 nm. How many photons per second would be emitted by a 1.0 mW He-Ne laser? (Given: \( h = 6.63 \times 10^{-34} \) J.s and \( c = 3 \times 10^8 \) m/s.) [2.0]

1(e) What is meant by acceptance angle for an optical fiber? Obtain the relationship between acceptance angle and numerical aperture. Calculate the refractive indices of core and cladding of an optical fiber having numerical aperture 0.33 and the fractional difference of their indices as 0.02. [6.0]

2(a) With the help of a suitable diagram discuss the energy band formation in a semiconductor. Give two examples each of direct and indirect band gap semiconductors. [5.0]

OR

2(a') What is the significance of Fermi level in a semiconductor? Derive the expressions for the electron and hole concentrations in a semiconductor at equilibrium. [5.0]

2(b) The Hall coefficient and resistivity of a certain semiconductor are \( 3.22 \times 10^{-4} \) m\(^3\)/C and \( 8.50 \times 10^3 \) \( \Omega \cdot \) m respectively. Calculate the mobility and carrier concentration for the sample (Given: \( e = 1.6 \times 10^{-19} \) C). [3.0]

2(e) Explain the terms: i) critical temperature and ii) critical magnetic field in context of superconductors. Why are “high temperature” superconductors potentially of great practical importance? Across a certain Josephson junction a voltage of 5 \( \mu \)V is applied. Estimate the frequency of radiation emitted by this junction. (Assume \( h = 6.63 \times 10^{-34} \) J.s. and \( e = 1.6 \times 10^{-19} \) C) [7.0]

Contd. .......2
3(a) What is Compton effect? Plot the intensity variation of scattered photons for different angles of scattering in a Compton scattering experiment. How would you explain the presence of initial wavelength at every angle of scattering?
Find the energy of an X-ray photon in keV which can impart a maximum kinetic energy of $1.6 \times 10^{-15}$ J to an electron (Take rest mass energy of electron = 510 keV).

OR

3(a') Explain pair production and pair annihilation. Show that pair production cannot take place in free space.
A 1.0 MeV positron collides with an electron at rest and the two particles are annihilated. Two photons are produced; one moves in the same direction as the incident positron and the other moves in the opposite direction. Determine the energies of the two photons (Assume rest mass energy of an electron or a positron to be 0.51 MeV).

3(b) Discuss physical significance of a wave function? Describe quantitatively the problem of a particle confined in an infinite square potential well (box) and obtain the expressions for its energy and normalized wave function. Plot the wave functions and the probabilities for the two lowest quantum states.

4(a) What is Fermi–Dirac statistics? Discuss its salient features. Obtain an expression of the number of quantum states, $g(e)$, for free electrons in metals and hence deduce the formula for Fermi energy.
Estimate the average energy in eV of He molecules at 27 °C (Given: mass of a He molecule = $4.7 \times 10^{-27}$ kg and $k_B = 1.38 \times 10^{-23}$ J/K).

4(b) What do you mean by nuclear cross section? Mention its conventional unit.
The capture cross section, $\sigma_c$ of $^{59}$Co for neutrons of certain energy is 37 b. Determine the percentage of a beam of these neutrons that will penetrate a 1.0 mm thick sheet of $^{59}$Co. What is the mean free path of these neutrons in $^{59}$Co (Take density of $^{59}$Co = $8.9 \times 10^3$ kg/m$^3$ and mass of a $^{59}$Co atom = 59 a.m.u.).

4(c) Describe the working of a breeder reactor. Explain the terms- fertile materials, breeding reaction and doubling time and give examples of each.
1. Explain in brief the different classes of bricks, their characteristics and their usage. [5]

2. Differentiate between one and a half brick thick English and Flemish bond with the help of plans. [5]

3. What are different types of stones used in construction? What are the characteristics of good building stones? [5]

4. Draw one brick thick Rat Trap bond with the help of plans. [4]

5. Discuss defects in timber with neat sketches [4]

6. Differentiate between the followings (any TWO):
   a) Sapwood and Heartwood
   b) Rubble masonry and Ashlar Masonry
   c) Traditional brick and modular brick [6]

7. Explain any THREE of the following terms.
   a) Efflorescence
   b) Bullnose
   c) Dressing of stones
   d) Seasoning of timber [6]

8. Discuss any ONE of the following material with reference to their typology and their building applications:
   a) Glass
   b) Paints [5]
2013-14
B.ARC. (WINTER SEMESTER) EXAMINATION
ART AND GRAPHICS
AR 106
Credits: 03
Duration: Three Hours

Maximum Marks: 40

Present the graphics with proper colouring and rendering. At presentation of graphics and write-ups with proper examples and sketches carry additional weight-age thin maximum marks.

Design and present a composition of solids on a half imperial sheet with half inch margin all-round picking any four of the following elements:

- Cubes of dimension 10cm and 15cm
- Pyramids of square base size 5cm and 10cm with heights of 8cm and 12cm respectively
- Cylinders of radius 5cm and 8cm with heights equal to their diameter.
- Cones of dimensions as at iii) above.
- Spheres of diameter 4cm and 8cm.

Compose and present these solids in a monochromatic scheme by approximation to be seen in perspective with shade and shadow assuming light beam coming from top right corner at 45 degree angle.

Differentiate between any three of the following:
- Relief Sculpture and Round Sculpture
- Visual Texture and Tactile Texture
- Mural and Collage
- Functional Values and Emotional Values of Art

What is a good design? What are its four important attributes which also serve as evaluative considerations for design?

OR

What do you understand by plastic modulation and volume creation considering solids and voids to be important features of design

"Architecture is utilitarian art with function having paramount significance" — comment with proper example and sketches
2013-14
B.ARC.H. (WINTER SEMESTER) EXAMINATION
Architectural Drawing -II
AR 113

Maximum Marks: 40

Credits: 06

Duration: 3 Hours

Answer all the questions.
Assume suitable data if missing.
All dimensions are in mm.
Neat and good drafted drawings will be credited more.

Q.No. Question

1 Draw perspective view of the object shown in figure-1 (Eye level = 35 mm)

2 Draw siagrapy in front elevation of the object shown in figure -1 (Sun ray are inclined at <45° to ground level in elevation and at <45° to vertical plane in plan.)

OR

2' Draw siagrapy in plan of the object shown in figure -1 (Sun ray are inclined at <45° to ground level in elevation and at <45° to vertical plane in plan.)

FIGURE - 1
1. Derive anthropometrically the optimum size required for the following spaces showing necessary activities, furniture, required movement areas, etc.
   
a) Reception Lounge for a Hotel having sitting capacity 20 persons.
   
b) A toilet with all fixtures including bath tub.

Drawing required to a scale of (1:20)
   
i) Plan(s) with furniture layout.

OR

1' Design a kiosk for Nokia Mobile Phones for the advertisement of their products located in the atrium of a mall in your city.

Drawing required to a scale of (1:20)
   
i) Plan/Plans
   
ii) Elevation/View

2. You are appointed as an Architect to design a small Public Library in the Sir Syed Nagar, Aligarh. The design requirements include reading section, space for catalogues, Reception counter and book storage/racks etc.

Drawings required to a scale of (1:50)

i) Bubble diagram/Flow diagram (5)

ii) Plan/Plans (15)

iii) Elevation/View (10)
2014-15
B.TECH./B.Arch. (ALL BRANCHES) WINTER SEMESTER EXAMINATION
STRENGTH OF MATERIALS
CE-101

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. Question M.M.

1(a) Explain the following terms: (i) Strain hardening; (ii) Bulk modulus; (iii) Volumetric strain; (iv) Modulus of rigidity. [06]

1(b) A mild steel bar 25mm diameter and 250mm long is placed inside a brass tube, having an external diameter of 30mm and internal diameter of 25mm. The combination is then subjected to an axial load of 45 KN. Find (i) the stress in the tube and the rod, (ii) the shortening of the rod. [06]

OR

1'(a) Define Poisson’s ratio. A bar of 20mm diameter is subjected to a pull of 50KN which causes stress within elastic limit. The measured extension on a gauge length of 200mm is 0.1mm and the change in diameter is 0.0035mm. Calculate the Poisson’s Ratio, Modulus of Elasticity, Bulk Modulus and Modulus of Rigidity. [06]

1'(b) A steel bar 25mm diameter is loaded as shown in Fig.1. Determine the stresses in each part and the total elongation. Take $E = 210 \text{ GPa}$. [06]

![Fig.1](image)

2. The state of stress at a point in a stressed 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 the principal stresses in the material. Also, locate the planes of maximum shearing stress and calculate the normal and shearing stress on these planes. [12]

/end... 2
2. Draw the Mohr’s Circle for the state of stress shown in Fig. 2. Determinate (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.

Fig. 2

3. Draw the shear force and bending moment diagrams for the beam shown in Fig. 3. Also, locate the points of contra flexure in the beam if any.

Fig. 3

4(a) Enumerate the assumptions made in simple theory of bending and obtain the bending equation.

4(b) A rectangular beam 6 cm x 4 cm is 2m long and is simply supported at the ends. It carries a load 1kN at mid span. Determine the maximum bending stress induced in the beam.

4' Prove that for a solid circular section of diameter D (radius r), the shear stress at a distance of y from neutral axis is

\[ q = \frac{F}{3I} (r^2 - y^2) \]

where, F is the shear force at the section and I is the moment of inertia of cross-section.

5(a) Enumerate the assumptions made in the theory of pure torsion.

5(b) A hollow circular shaft, 12m long is required to transmit 15MW when running at a speed of 300 r.p.m. If the maximum shearing stress allowed in the shaft is 80MPa and the ratio of inner diameter to the outer diameter is 3/4, find the dimension of the shaft and also the angle of twist of one end of the shaft relative to the other. Modulus of rigidity of the material is 85GPa.
B.TECH. (WINTER SEMESTER) EXAMINATION
ELECTRONICS/COMPUTERS/ELECTRICAL/MECHANICAL/CIVIL/CHEMICAL/
PETROCHEMICAL/B. Arch
ENVIRONMENTAL STUDIES
CE111

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. | Question | M.M.
--- | --- | ---
1(a) | What are the major meteorological phenomena which influence the air quality? | [04]

OR

1'(a) | The following temperature profile data have been collected for a certain city:
Altitude, m 0 100 200 300 400 500 600
Temperature, °C 20 18 16 15 16 17 18
If the maximum daytime surface temperature is 22 °C, and the weather station anemometer at 10 m height shows winds averaging 4 m/s, what would be the ventilation coefficient? Assume stability class C and use the wind at the height halfway to the maximum mixing depth. The value of wind profile exponent for rough terrain for the above stability class may be taken as $p = 0.20$. What can you say about the air pollution potential of the city? | [04]

1(b) | List the main gaseous pollutants from industrial combustion processes where fossil fuels are used? What are the general approaches to control particulate emission? | [02]

1(c) | Consider a new 38% efficient, 600-MW power plant using sulphur emission control system. The coal to be burned contains 2% sulphur and has a heat content of 28 MJ/kg. The maximum permissible (NSPS) emission rate is 260 g SO₂/10⁶kJ. Find the allowable emission rate of SO₂ (kg/s) from the plant and the percent reduction in the emission control system that must be achieved. | [04]

2(a) | List the primary benefits of resource recovery in waste management? Write a brief note on the reuse and recycling opportunities for materials from MSW. | [04]

OR

2'(a) | What are the physical, chemical and biological properties of solid waste? Explain their significance in the development of a solid waste management system? | [04]
2(b) What are the essential components of a secure solid waste landfill? [02]

2(c) The chemical composition of the organic fraction of a residential MSW is given by the formula \([C_{760} \text{ H}_{1980} \text{ O}_{975} \text{ N}_{13} \text{ S}].\) Estimate the energy content of the residential MSW using the modified Dulong formula:

\[
\text{Energy content (kJ/kg)} = 2.3258 \left[145 \text{ C} + 610(\text{H}_2 - 1/8 \text{ O}_2) + 40 \text{ S} + 10 \text{ N}\right]
\]

In this formula C, H\(_2\), O\(_2\), S, and N represent the weight percent composition of the waste for carbon, hydrogen, oxygen, sulphur and nitrogen respectively.

3(a) A town of 30,000 persons contributes of 0.5 m\(^3\) of wastewater per person per day to the wastewater treatment plant. Design a circular primary sedimentation tank having surface overflow rate of 30 m\(^3\)/d. [5]

3(b) Briefly describe the attached growth and suspended growth systems employed in wastewater treatment plant. [5]

OR

3'(b) Describe the Activated Sludge Process for wastewater treatment. Design an aeration tanks for an activated sludge process having flow of 10,000 m\(^3\)/d for Food to Microorganism ratio 0.3. [5]

4(a) Describe the disinfection process for water treatment system. [4]

4(b) A mixture of domestic wastewater and river water has 5 day, 20°C BOD of 12 mg/L decay rate constant equal to 0.23/d. Calculate its ultimate and 20 day BOD values. Using Streeter-Phelps equation calculate the DO concentration in the stream after a time of travel of 0.3 day and 3 days. Assume: stream temperature 20°C, stream reaeration rate constant 0.6/d, saturation DO as 8.5 mg/L and initial deficit as 2 mg/L. [6]

5(a) What is food chain? Give the graphic representation of simple food web model. What are the different biotic and biotic components in pond ecosystem? [5]

5(b) Describe the various layers of atmosphere with the help of diagram. Discuss the significance of stratosphere layer. [5]

6(a) Describe the sources and significance of the CO and NO\(_x\). [5]

OR

6'(a) Write the short note on

i) Photochemical Smog

ii) Ozone Depletion

6(b) What are different physical, chemical and biological water quality parameters? What are endocrine disruptors? [5]
Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

1(a) What is a computer? List different components of a computer.
1(b) What is an operating system? Name five different operating systems.
1(c) Write short notes on RAM and ROM

OR

1(c') Write short notes on minicomputers and mainframe computers.

2(a) Draw a flowchart to find the largest of three numbers.
2(b) Briefly describe different types of expressions used in C programming.
2(c) Write the syntax of all conditional branching statements used in C programming.

OR

2'(a) Write an algorithm to find the factorial of a given number.
2'(b) Briefly describe different types of operators used in C programming.
2'(c) Write the syntax of all iterative statements used in C programming.

3(a) Define the following terms with example: keywords, identifiers, and variables.
3(b) What do you mean by data types? List different primitive data types of C language.
3(c) Explain the following networking devices: Hub, Bridge, and Router.

OR

3(c') Differentiate between LAN and WAN. Give two examples of network topology.

4(a) Write a program in C to calculate the roots of a quadratic equation.
4(b) Give the output of the following program with suitable reason:

```c
#include<conio.h>
#include<stdio.h>

void main()
{
    printf("%d",1<2<3<4);
    printf("%d",2<3<1<3);
    printf("%d",1<3<2<4);
    printf("%d",3<4<1<2);
}
```

4(c) Write a program in C to calculate the roots of a quadratic equation.

OR

4(c') Write a program in C to check whether a given year is a leap year or not.
B.TECH. (WINTER SEMESTER) EXAMINATION
(Civil/Electrical/Electronics/Computer/Mechanical/Petrochemical/Chemical)
BASICS OF ELECTRICAL & ELECTRONICS ENGINEERING
(EE –111)

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.
Part A (Q1&2) and Part B (Q3&4) are to be answered in separate copies.

PART A (To be answered in a separate copy)

1(a) What are different types of magnetic losses? How can they be minimized?  [05]

(b) Using the superposition theorem find the current flowing in the branch AB of the circuit shown in Figure 1.  [05]

(c) A 100 kVA, single phase 1100/220V, 60 Hz transformer has a high voltage resistance of 0.1 \( \Omega \) and a leakage reactance of 0.3 \( \Omega \). The low voltage winding resistance is 0.004 \( \Omega \) and the leakage reactance is 0.012 \( \Omega \). Determine the equivalent winding resistance and reactance referred to the high voltage side and the low voltage side.  [05]

1'(a) Differentiate between:

(i) Electrical and Magnetic circuits.  (ii) Average and RMS value of a sinusoid.  [05]

(b) Find the current through the 5\( \Omega \) resistor in the network of Figure 2 using Thevenin’s theorem.  [05]

(c) A single phase transformer working at unity power factor has an efficiency of 90% at both half load and at the full load of 500W. Determine the efficiency at 75% full load and the maximum efficiency.  [05]

\[ \text{contd...2} \]
2(a) Why is a single phase induction motor not self starting? Discuss working of a capacitor start capacitor run type single phase induction motor.

(b) Explain the working of a permanent magnet moving coil instrument with the help of a suitable diagram. Why this instrument is not suitable for measurement of ac quantities?

(c) Draw a power system network showing various transmission and distribution voltage levels. Why transmission is done at higher voltages over long distances?

PART-B (To be answered in a separate copy)

3 (a) Determine the current $I_D$ and diode voltage $V_D$ for the circuit in Figure 3 with $V_{DD} = 5V$ and $R = 1 \, \text{K}\Omega$. Assume that the diode has a current of 1mA at a voltage of 0.7V and that its voltage drop changes by 0.1V for every decade change in current.

(b) Explain the operation of a npn transistor in active mode of operation.

(c) A junction diode is operated in a circuit in which it is supplied with a constant current $I$. What is the effect on the forward voltage of the diode if an identical diode is connected in parallel. Assume $n=1$

OR

3'(a) With the help of input and output characteristics, explain the operation of common emitter configuration.

(b) A silicon diode with $n=1$ has $V = 0.7V$ at $i=1$ mA. Find the voltage drop at $i = 0.1$ mA and $i = 10$ mA.

(c) Assuming that the diodes in the circuit of Figure 4 are ideal, find the values of labelled voltages and currents.
4(a) Design the circuit of Figure 5 so that the transistor operates at $I_D = 0.4mA$ and $V_D = 0.5V$. The NMOS transistor has $V_T = 0.7V$, $k_n = 100\mu A/V^2$, $L = 1\mu m$ and $W = 32\mu m$.

\[
V_{DD} = +2.5 \, V \\
I_D \downarrow \uparrow R_D \downarrow V_D \\
I_D \downarrow \uparrow R_S \downarrow V_{SS} = -2.5 \, V
\]

Figure 5

(b) Derive the expression of differential gain of a single op amp based difference amplifier.

(c) Briefly explain the concept of virtual short in op amps.
Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.                  Question                                      M.M.      
1(a) Explain the concept of virtual short in an operational amplifier. [04]  
1(b) What are the ideal characteristics of an operational amplifier? [04]  
1(c) Design a differentiator to have a time constant of $10^{-2}$ sec and an input capacitance of 0.01 μF. What is the gain magnitude and phase of this circuit at $10^3$ rad/sec? [07]  

OR  

1'(a) Explain the terms open loop gain and closed loop gain of an operational amplifier. [04]  
1'(b) Draw the circuit of an inverting summing amplifier and write the expression of output voltage. [04]  
1'(c) Design a non-inverting amplifier with a gain of 2. At the maximum output voltage of 10 V the current in the voltage divider is to be 10 μA. [07]  

2(a) What is the significance of diode model? Draw the circuit of piecewise linear model. Also draw its characteristics. [07]  

OR  

2(a') Explain the phenomenon of Avalanche Breakdown and Zener Breakdown. [07]  

2(b) A zener diode exhibits a constant voltage of 5.6 V for current greater than five times the knee current. $I_k$ is specified to be 1 mA. The zener is to be used in the design of a shunt regulator fed from a 15 V supply. The load current varies over the range of 0 mA to 15 mA. Find a suitable value of $R$. [08]  

cont'd... 2
3(a) Give four applications of clipper and clamper circuits?

3(b) Why the input impedance of JFET is more than BJT?

3 (c) For a particular IC fabrication process, the transconductance parameters are Kn' = 50 μA / V² and Vt = 1 V. In an application in which VGS = VDS = V supply = 5V, a drain current of 0.8 mA is required for the device of minimum length of 2 μm. What value of channel width must the design used?

OR

3'(c) Using the appropriate diagram and id vs VDS characteristic curves, explain the operation of an N-channel enhancement type MOSFET.

4(a) Explain the Early Effect in a transistor.

4(b) Using the appropriate values of components draw the circuit of a BJT as an inverter and explain its operation.

4(c) Why collector current Ic is slightly less than the emitter current Ie for a transistor in active region?
1.(a) Read the passage carefully and answer the questions that follow: 4x3=12

The main menace to the modern human civilisation for the last few decades seems to be the almost ruinous arms race not between the great powers but between the decolonised and developing countries where most of the citizens are still languishing in abject poverty. Unless it is controlled and eventually stopped by the positive acts of statesmanship, there might be untold death and destruction. There is a growing apprehension among political scientists and intellectuals that if the world fails to address the problem life would have little chance to survive on this planet in any form in case of a clash.

War is perhaps man’s most mysterious invention; its criminal nature has become apparent quite late. The enigma of crime is that once it is invented and brought into operation, it becomes almost impossible to eliminate it even by the most severe mode of punishment. No sooner it is contained in one form than it makes its reappearance in another one. It is this vicious circle that has probably always eluded the wisdom of the legal scientists. It is tragic indeed that when there is so much unanimity about the imperial urgency of liquidating this threat and resolving disputes through peaceful means, a wide gulf divides the powerful countries and prevents a meeting of minds. The result is that neither side is ready to initiate for any arrangement which could minimise suspicion and fear. In such a situation of mutual distrust in international relations the objectives of diplomatic negotiations seem to hold little water.

The birth of the modern science had initially held the promise of mutual understanding of humanity. Today nations understand each other less than in the past despite not so frequent interactions. With the advancement of technology, resulting from human action, the distance among nations has increased more than ever in the past. The assumption that modern communication technology has eliminated space and time and has brought men close to each other is an illusion similar to the closeness of the reflection in the mirror to the observer.
(1) What is the potential threat that the author is suggesting?
(2) Explain the analogy used in the last paragraph,
(3) What do you understand by ‘vicious circle’? Explain with an example.
(4) What does the phrase ‘peaceful means’ imply?

B.a. Convert the following sentences into Passive Voice:
(1) Human knowledge is turning this planet into a small place.
(2) They should invite him on this auspicious occasion.
(3) In a just and free society the individual decides the course of his life according to his choice.
(4) State Governments have initiated many programmes in the last few years to improve the social condition of the people.

b. Correct the following sentences:
(1) A scientist observes carefully, applied logical thought to his observation and tried to find relationships in data.
(2) After read his work we came to know that the hotter a substance becomes, the faster the movement of the molecules.
(3) He did not drew any inference from the hypothesis.
(4) Scientists for ancient ages are interested in the composition of this universe.

UNIT-II

2.(a) Discuss the perception of the Time Traveller as the future of human civilization giving textual reference to support your answer.

OR

Present your own view of the world around you in the light of the observation made about man and his world in The Time Machine.

(b) What understanding have you developed about the social world of man in the backdrop of Orwell’s Animal Farm.

OR

Draw some parallels between Orwell’s projection of the behaviour of political power and your personal observation of the human world.

UNIT-III

3. Write a report on the General Election 2014 in India.

OR

Discuss the characteristics of the language of describing a process and also write as an example the process of getting railway reservation for your trip to Mumbai.
UNIT-IV

4. Read the following passage carefully. Make notes and write a précis of the same.

Biologists in Australia are deeply worried by the gradual death of a large number of world’s bird species due to noise and unprecedented production and construction activities that have resulted in the contamination of air and water. In the last few decades, they think, the situation has deteriorated beyond presumable recovery. The loss is so heavy that it might lead to extinction of many of them resulting in the desolation of the world of nature. The scientists have further observed that as man has increased exorbitantly the use of fertilizers to augment agricultural production intoxicating the sources of survival of the avian world, it has affected their fertility rate considerably. This phenomenon, the biologists think, is invariably related to the disturbance of the climatic forces and degradation of environment. They suggest that if serious measures are not taken by the world powers the future of even human survival is no more promising. But the experts also warn that the problem of nature and life can hardly be managed satisfactorily solely by political intervention, or legal mechanisms, rather it seems to have something to do with education which probably does not prepare us effectively to deal with such kind of problem.

Education is a product of social need. It is both a means as well as a condition. The first objective is well recognised but the second one is often misunderstood. The creation of the condition is not an automatic process, it requires human involvement which amounts to ecological responsibility. The worsening condition of our natural surroundings has perhaps it’s root in our defective and inadequate education that has made us more insensitive to the world around us.

UNIT-V

5. Write an essay on any one of the following topics in about 400 words:

(a) Language and the maturity of mind.
(b) Poverty of communication and uncertainty of social relations.
(c) Every development entails certain loss.
Q.No.                     Question                                                                                      M.M.
1(a)                     Precisely explain: Quasi-static process and Continuum.                                         [04]
1(b)                     The air pressure in a circular duct is to be measured using a manometer whose open arm is inclined 35° from the horizontal, as shown in Figure. The density of the liquid in the manometer is 0.81 kg/L, and the vertical distance between the fluid levels in the two arms of the manometer is 8 cm. Determine the gage pressure of air in the duct and the length of the fluid column in the inclined arm above the fluid level in the vertical arm. [04]
1(c)                     The resistance of the windings in a certain motor is found to be 80 ohms at room temperature (25°C). When operating at full load under steady state conditions, the motor is switched off and the resistance of the windings, immediately measured again, is found to be 93 ohms. The windings are made of copper whose resistance at temperature T°C is given by

\[ R_t = R_o[1 + 0.00393 T] \]

Where \( R_o \) is the resistance at 0°C. Find the temperature attained by the coil during full load. [04]

2                        An indicator spring is found to require an axial force of 60 N to shorten it by 1.0 mm. The spring is used in an indicator having a piston area of 4 cm² and a pencil mechanism which magnifies the motion of the indicator piston six-fold.

i) Calculate the spring number in N/m³.

ii) A single-cylinder, single-acting, 4-stroke gas engine of 150 mm bore develops an indicated power of 4.5 kW when running at 216 rev/min. Calculate the area of the indicator diagram that would be obtained using the above indicator, given that the length of the diagram is 0.1 times the length of the stroke of the engine. [12]

OR

Air at a temperature of 15°C passes through a heat exchanger at a velocity of 30 m/s [12]
where its temperature is raised to 800°C. It then enters a turbine with the same velocity of 30 m/s and expands until the temperature falls to 650°C. On leaving the turbine, the air is taken at a velocity of 60 m/s to a nozzle where it expands until the temperature has fallen to 500°C. If the air flow rate is 2 kg/s, calculate

i) the rate of heat transfer to the air in the heat exchanger

ii) the power output from the turbine assuming no heat loss

iii) the velocity at exit from the nozzle, assuming no heat loss.

Take the enthalpy of air as \( h = c_p T \), where \( c_p = 1.005 \) kJ/kg-K and \( T \) is the temperature.

3) Derive the expression for dryness fraction \( X = X_1, X_2 \) for separating and throttling calorimeter where \( X, X_1 \) and \( X_2 \) have their usual meanings.

A particular test on a separating and throttling calorimeter gave the following results:

Main pressure: \( 3.4 \times 10^6 \) N/m² gauge

Mass of water drained from the separator: 0.33 kg

Mass of steam condensed after passing through the throttle: 4.66 kg

Throttling calorimeter readings:

Pressure: 51 mm water gauge

Temperature: 145°C

Barometer reading: 746 mm mercury

Evaluate the dryness of the steam in the main and state, with reasons, whether the throttling calorimeter alone could have been used for this test.

OR

3'(a) The internal energy and the enthalpy of certain pure substances may be considered to be functions of temperature only. Further, over restricted ranges of conditions, the specific heats at constant volume and at constant pressure may be assumed to be constant. Show that for any process executed by a pure substance satisfying these conditions:

\[ \Delta u = C_v \Delta T \quad \text{and} \quad \Delta h = C_p \Delta T \]

3'(b) A rigid vessel contains 1 kg of a mixture of saturated water and saturated steam is at a pressure of 0.15 MPa. When the mixture is heated, the state passes through the critical point. Determine:

i) The volume of the vessel

ii) The mass of liquid and of vapour in the vessel initially
iii) The temperature of the mixture when the pressure has risen to 3 MPa

iv) The heat transfer required to produce the final state (iii)

4(a) Establish that out of all the heat engines working between the same two temperatures, a reversible one is the most efficient.

4(b) Exhaust steam from a process plant is to be used as the hot system for a heat engine. The steam is available at a pressure of $140 \times 10^3$ N/m$^2$ with a dryness fraction of 0.6. Heat transfer from the steam to the engine causes the steam to condense to saturated liquid at $140 \times 10^3$ N/m$^2$. River water is available at a mean temperature of 14$^\circ$C. Evaluate the maximum possible power which could be developed by the engine when the exhaust steam mass flow rate is 1800 kg/hr.

OR

4* An engine operating on the Carnot cycle employs 1 kg of water as the working fluid. The (constant) temperatures of the hot and the cold bodies are 200$^\circ$C and 40$^\circ$C respectively. In the cycle, state 1 corresponds to saturated liquid at 200$^\circ$C, state 2 to dry saturated vapour at 200$^\circ$C, state 3 to wet vapour, dryness 0.762 at 40$^\circ$C, and state 4 to wet vapour, dryness 0.229 at 40$^\circ$C. Evaluate the work done and the heat transfer in each process, the net work during the cycle and the efficiency.

5(a) Air at 15$^\circ$C flows over a hot plate of area $40 \times 80$ cm$^2$, with surface temperature of 150$^\circ$C having a thickness of 20 cm and thermal conductivity 43 W/m$^2$K. The heat transfer coefficient at the outer surface is 29 W/m$^2$K. If 582 W heat is lost by radiation from the outer surface, determine the inside surface temperature of the plate.

5(b) Define:
   i) Stefan Boltzman’s Law
   ii) Emissivity
   iii) Grey Body
B.TECH. (WINTER SEMESTER) EXAMINATION
MECHANICAL ENGINEERING
ENGINEERING GRAPHICS
ME-102

Maximum Marks: 40  Credits: 04  Duration: Three Hours

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

Q.No.  Question                                                                                                    M. M.  
1      A rectangular plot of land area 0.45 hectare is represented on a map by a similar rectangle of 5 square centimetres. Calculate the R.F. of scale of the map. Also draw a scale to read upto single metre from the map. The scale should be long enough to measure upto 400 metres. 1 hectare = 10000 square metres. [08]  
2      A straight line AB, 55 mm long makes an angle of 30° to the H.P. and 45° to the V.P. The end A is 12 mm in front of V.P. and 15 mm above H.P. Draw the projections of the line. [08]  

OR  

2'     Draw the projections of a rhombus having diagonals 100 mm 40 mm long. The bigger diagonal is inclined at 30° to H.P. with one of the end point in H.P. and the plan of the smaller diagonal is parallel to both the planes. [08]  

3      Fig. 1 shows a sketch of a casting. Draw the following views:  
(a) Top view  (b) Front view in direction of F  (c) Side view in direction of S.  

OR  

3'     Fig. 2 shows the pictorial view of an object. Using the first angle projection, draw  
(a) Top view  (b) Full sectional elevation in the direction of arrow. [12]  

4      Fig. 3 shows three views of an object. Draw its isometric view. [12]
Q. No.

1.(a) The frame $ACD$ is hinged at $A$ and $D$ and is supported by a cable that passes through a ring at $B$ and is attached to hooks at $G$ and $H$. Knowing that the tension in the cable is 1125 N, determine the moment about the diagonal $AD$ of the force exerted on the frame by portion $BH$ of the cable. (Figure-1) (06)

1.(b) The lever $BCD$ is hinged at $C$ and is attached to a control rod at $B$. If $P = 200$ N, determine (a) the tension in rod $AB$, (b) the reaction at $C$. (Figure-2) (06)

OR

1'.(a) Determine whether the 10-kg block shown is in equilibrium, and find the magnitude and direction of the friction force when $P = 40$ N and $\theta = 20^\circ$. (Figure-3) (06)

1'.(b) The bent rod $ABDE$ is supported by ball-and-socket joints at $A$ and $E$ and by the cable $DF$. If a 600-N load is applied at $C$ as shown, determine the tension in the cable. (Figure-4) (06)

2.(a) Determine the vertical force $P$ which must be applied at $G$ so that the linkage is in equilibrium for the position shown. (Figure-5) (06)

2.(b) Locate the centroid of the plane area shown. (Figure-6) (06)
2.(b') Determine the moments of inertia of the shaded area shown with respect to the x and y axes. (Figure-7)

3.(a) At the instant shown, slider block B is moving to the right with a constant acceleration, and its speed is 15.2 cm/s. Knowing that after slider block A has moved 25.4 cm to the right its velocity is 6 cm/s, determine (a) the accelerations of A and B, (b) the acceleration of portion D of the cable, (c) the velocity and the change in position of slider block B after 4 s. (Figure-8)

3.(b) The motion of a 4 kg block B in a horizontal plane is defined by the relations \( r = 3t^2 - t^3 \) and \( \theta = 2t^2 \), where \( r \) is expressed in meter, \( t \) in seconds, and \( \theta \) in radians. Determine the radial and transverse components of the force exerted on the block when (a) \( t = 0 \), (b) \( t = 1 \) s. (Figure-9)

OR

3.(b') A 1.5-kg collar is attached to a spring and slides without friction along a circular rod in a vertical plane. Knowing that the tension in the spring is 70 N and the speed of the collar is 3.8 m/s as it passes through point A, determine, at that instant, the radial and transverse components of acceleration of the collar. (Figure-10)

4.(a) A system consists of three particles A, B, and C. We know that \( m_A = 1 \) kg, \( m_B = 2 \) kg, and \( m_C = 3 \) kg and that the velocities of the particles expressed in m/s are, respectively, \( v_A = 3\hat{i} - 2\hat{j} + 4\hat{k} \), \( v_B = 4\hat{i} + 3\hat{j} \), and \( v_C = 2\hat{i} + 5\hat{j} - 3\hat{k} \). Determine the angular momentum \( \mathbf{H}_O \) of the system about O. (Figure-11)

4.(b) A 81.6 kg man and a 54.4 kg woman stand side by side at the same end of a 136 kg boat, ready to dive, each with a 4.87 m/s velocity relative to the boat. Determine the velocity of the boat after they have both dived, if the woman dives first. (Figure-12)

5.(a) The motion of an oscillating flywheel is defined by the relation \( \theta = \theta_0 e^{-3\pi t} \cos 4\pi t \), where \( \theta_0 \) and \( t \) are variables.

contd...
where \( \theta \) is expressed in radians and \( t \) in seconds. Knowing that \( \theta_0 = 0.5 \) rad, determine the angular coordinate, the angular velocity, and the angular acceleration of the flywheel when \( t = 0 \). (Figure-13)

**OR**

5.(a') The bent rod ABCD rotates about a line joining points A and D with a constant angular velocity of 75 rad/s. Knowing that at the instant considered the velocity of corner C is along y-direction, determine the velocity and acceleration of corner B. (Figure-14)

5.(b) The motion of rod AB is guided by pins attached at A and B which slide in the slots shown. At the instant shown, \( \theta = 30^\circ \) and the pin at A moves downward with a constant velocity of 225 mm/s. Determine (a) the angular velocity of the rod, (b) the velocity of the pin at end B. (Figure-15)
2013-14
B.TECH. (WINTER SEMESTER) EXAMINATION
ALL BRANCHES
APPLIED MECHANICS
ME - 111

Maximum Marks: 60  Credits: 04  Duration: Three Hours

Use separate answer book for section A and section B
Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Section A

1(a)  The frame ACD shown in Fig. 1 has a Boll and Socket joint at A and D and is supported by a cable that passes through a ring at B and is attached to hooks at G and H. Knowing that the tension in the cable is 450 N, determine the moment about the diagonal AD of the force exerted on the frame by portion BH of the cable.

OR

1'(a)  A 6.5 m ladder AB leans against a wall as shown in Fig. 2. Assuming that the coefficient of static friction i) \( \mu_s \) is zero at B and ii) \( \mu_s \) is the same at A and B. Determine the smallest value of \( \mu_s \) at A for which equilibrium is maintained.

1(b)  Knowing that the line of action of the force Q passes through point C (refer Fig. 3), derive an expression for the magnitude of Q required to maintain equilibrium.

Fig. 1
Fig. 2
Fig. 3

cont’d...
2  Attempt any two parts

2(a) Blocks A and B of mass 10 kg each, block C of mass 7 kg and block D of mass 8 kg are connected as shown in Fig. 4. Knowing that a downward force of magnitude 120 N is applied to block D, determine i) the acceleration of each block, ii) the tension in cord ABC. Neglect the weights of the pulleys and the effect of friction.

2(b) A thin circular rod is supported in a vertical plane by a bracket at A shown in Fig. 5. Attached to the bracket and loosely wound around the rod is a spring of constant $k = 50$ N/m and undeformed length equal to the arc of circle AB. A 250 gm collar C, not attached to the spring, can slide without friction along the rod. Knowing that the collar is released from rest when $\theta = 30^\circ$, determine i) the maximum height above point B reached by the collar, ii) the maximum speed of the collar.

2(c) Two hemispheres are held together by a cord as shown in Fig. 6, which maintains a spring under compression (the spring is not attached to the hemispheres). The potential energy of the compressed spring is 120 J and the assembly has an initial velocity $v_0$ of magnitude $v_0 = 10$ m/s. Knowing that the cord is cut when $\theta = 40^\circ$, causing the hemispheres to fly apart, determine the resulting velocity of each hemisphere.

3  Attempt any two parts

3(a) In the engine system shown in Fig. 7, the crank AB has a constant clockwise angular velocity of 2000 rpm. For the crank position indicated, determine i) the angular velocity of the connecting rod BD, ii) the velocity of the piston P.
3(b) Knowing that crank AB has a constant angular velocity of 160 rpm counter clockwise, determine the angular velocity of rod BD and the velocity of collar D when i) $\theta = 0^\circ$, ii) $\theta = 90^\circ$ (refer Fig. 8).

![Fig. 7](image)

![Fig. 8](image)

3(c) At the instant shown in Fig. 9 the angular velocity of links BE and CF is 6 rad/s counter clockwise and is decreasing at the rate of 12 rad/s$^2$. Knowing that the length of each link is 300 mm and weight of each link is 1 kg, determine i) the force P, ii) the corresponding force in each link. The mass of rod AD is 6 kg.

![Fig. 9](image)

**Section B**

(a) The state of stress at a point in a stressed material is given by $\sigma_x = 20$ MPa, $\sigma_y = 10$ MPa and $\tau_{xy} = 25$ MPa. Determine the direction and magnitude of the principal stresses in the material. Also, locate the planes of maximum shearing stress and calculate the normal and shearing stresses on these planes.

(b) A hollow circular shaft, 12m long is required to transmit 15MW when running at a speed contd...
of 300 rpm. If the maximum shearing stress allowed in the shaft is 80MPa and the ratio of inner diameter to the outer diameter is 3/4, find the dimension of the shaft and also the angle of twist of one end of the shaft relative to the other. Modulus of rigidity of the material is 85GPa.

OR

4'(a) A steel rod 20mm in diameter passes centrally through a steel tube of 25 mm internal diameter and 30 mm external diameter. The tube is 800mm long and is closed by rigid washers of negligible thickness which are fastened by nuts threaded on the rod. The nuts are tightened until the compressive load on the tube is 20 KN. Calculate the stresses in the tube and the rod.

4'(b) A brass bar, having cross-sectional area of 1000mm² is subjected to axial forces as shown in Fig.10. Find the total elongation of the bar. Take E = 1.05 x 10^5 N/mm².

\[ \text{Fig. 10} \]

5(a) Briefly explain the following terms:

(i) Strain hardening
(ii) Bulk Modulus
(iii) Isotropic

5(b) Draw BMD for the loaded beam shown in Fig.11. Also, locate the points of contra flexure, if any.

\[ \text{Fig. 11} \]