2014-15

B.TECH. (WINTER II SEMESTER) EXAMINATION
(APPLIED CHEMISTRY II)
(AC-102)

Maximum Marks: 60
Credits: 03
Duration: Three Hours

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

Q.No. Question M.M.
1(a) Write notes on any two of the followings:
a) Scale and sludge formation
b) Phosphate conditioning
c) Caustic embrittlement [08]

1(b) A water sample on analysis gave the following results in mg/L

\[
\begin{align*}
\text{Ca(HCO}_3\text{)}_2 &= 16.2; \\
\text{Mg(HCO}_3\text{)}_2 &= 14.8; \\
\text{CaSO}_4 &= 13.6; \\
\text{MgSO}_4 &= 1.2; \\
\text{FeSO}_4 &= 1.5; \\
\text{NaCl} &= 5.6 \\
\text{Fe}_2\text{O}_3 &= 2.1
\end{align*}
\]

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

a) Calculate temporary and permanent hardness in mg/L

b) Calculate the amount of lime and soda required to soften one litre of water.

1'(a) Describe ion-exchange process for the preparation of demineralized water. What are its advantages over Zeolite process? [08]

1'(b) Describe various steps involved in the treatment of water for drinking purpose. [10]

2(a) Define a fuel and give its classification. Discuss the characteristics of good quality coal. [08]

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

\[
\begin{align*}
\text{C} &= 80\%; \\
\text{H} &= 12\%; \\
\text{S} &= 3\%; \\
\text{N} &= 2\%; \\
\text{O} &= 2\% \\
\text{and remaining ash}
\end{align*}
\]

Calculate Gross and Net calorific values by Dulong’s formula. Latent heat of steam

contd... 2
= 587 cal/g

OR

2'(a) Describe Fischer-Tropsch method for the manufacture of synthetic petrol. [10]

2'(b) Distinguish between proximate and ultimate analysis of coal. [04]

2'(c) What is LPG? Give the composition, calorific value and uses of LPG. [04]

3 (a) Describe the significance of electrochemical series. How it differs from galvanic series? [06]

3 (b) Explain with the help of suitable example the mechanism of electrochemical corrosion involving absorption of oxygen. [06]

4 (a) Define flash point, aniline point, cloud point and saponification value. [04]

4(b) What are greases? What are the components of a grease? Discuss the conditions where grease is used as lubricant. [08]
2014-15
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.  
All questions carry equal marks.

Question                   M.M.

1(a) Define analyte, titrant and titration. Give the basic requirements of titrimetric method. [4]
(b) What is Von Weimann ratio? Describe the favourable conditions for precipitation. [4]
(c) With suitable chemical equations, explain the followings:
    (i) Precipitation titrations  
    (ii) Iodometry

OR

1'(a) Define Bear and Lambert's Law and discuss the terms involved. Explain its deviation from linearity. [4]
1'(b) Explain the principle of chromatography. Differentiate between adsorption and ion-exchange chromatography. [4]
1'(c) Draw a block diagram of a single beam UV-Visible spectrophotometer. [2]

2(a) Give chemical equation for the followings:
    (i) Removal of temporary Mg hardness by addition of lime
    (ii) Regeneration of exhausted anion and cation exchange resin
    (iii) Avoidance of scale formation by calgon conditioning
    (iv) Removal of permanent Ca hardness by addition of soda
    (v) Reaction of soap with temporary Ca-hardness

(b) Calculate the quantity of lime and soda required for softening 60,000 litres of water containing following impurities in mg/L:
    CO₂ = 20; Mg(HCO₃)₂ = 25; Ca(HCO₃)₂ = 20; HCl = 8.4; Al₂(SO₄)₃ = 40; MgCl₂ = 12.
    (Atomic weight of C = 12, O = 16, Mg = 24, H = 1, Ca = 40, Cl = 35.5, Al = 27, S = 32)

OR

contd...
2. (a) List the requirements of water for municipal and industrial use.

(b) What are the requirements of a good disinfectant. Explain the mechanism of disinfection by bleaching powder.

(c) Differentiate between scale and sludge. Describe the various causes of scale formation.

3. (a) Give reasons for the followings:
   (i) Net calorific value is less than gross calorific value
   (ii) Gaseous fuels are more advantageous than solid fuels

(b) Discuss the importance of proximate analysis of coal.

(c) A sample of coal was found to contain the following constituents: C =81%; O= 8%; S=1%; H =5%; N=1%; ash = 40%. Calculate the minimum amount of air required for complete combustion of 1 Kg of the coal. Also calculate the percentage composition by weight of the dry products of combustion.

4. (a) Define lubricants. Mention the important functions of lubricants.

(b) What do you understand by consistency and drop point of a grease? Explain their importance.

(c) Write a note on the selection of lubricants for:
   (i) Internal combustion engines and
   (ii) Transformers

5. (a) Explain the mechanism of wet corrosion by evolution of hydrogen.

(b) Explain the effect of the followings on the rate of corrosion:
   (i) Humidity of air
   (ii) Purity of metal
   (iii) Overvoltage
   (iv) Solubility of the corrosion product

(c) Give an account of corrosion control by cathodic protection.

6. (a) Give the preparation, properties and uses of any two of the followings:
   (i) PTFE
   (ii) Buna N
   (iii) Polyessters

(b) Define polymerization. Differentiate between addition and condensation polymerization.
2014 – 2015
B.TECH. (WINTER SEMESTER) EXAMINATION
ALL BRANCHES
APPLIED MATHEMATICS – II (OLD COURSE)
(AM – 102)
Credits : 04

Maximum Marks: 60
Duration: Three Hours

Note: Answer all questions.
Use of Programmable calculator is not allowed.

1. (a) Write salient features and trace the conic

\[ 36x^2 + 24xy + 29y^2 - 72x + 126y + 81 = 0 \]

(b) If PSP' and QSQ' are two perpendicular focal chords of a conic, prove that

\[ \frac{1}{PS \cdot SP'} + \frac{1}{QS \cdot QS'} \]

is constant.

OR

(b') Find the equation of right circular cylinder whose guiding circle is

\[ x^2 + y^2 + z^2 = 9, \quad x - y + z = 3. \]

[6,6]

2. (a) If \( u = \sin^{-1}\left(\frac{x^2 + y^2}{x + y}\right) \), show that \( x \frac{\partial u}{\partial x} + y \frac{\partial u}{\partial y} = \tan u \).

(b) If \( V = f(\gamma), \gamma^2 = x^2 + y^2 + z^2 \), prove that

\[ \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} + \frac{d^2 V}{d\gamma^2} + \frac{2}{\gamma} \frac{dV}{d\gamma}. \]

OR

(b') If \( u = xyz, \quad V = x^2 + y^2 + z^2, \quad w = x + y + z \), find

\[ \frac{\partial (x, y, z)}{\partial (u, v, w)}. \]

[6,6]

3. (a) Expand \( e^x \cos y \) near the point \( \left(1, \frac{\pi}{4}\right) \) by Taylor's theorem upto two terms.

(b) Locate the stationary points of \( x^4 + y^4 - 2x^2 + 4xy - 2y^2 \) and determine their nature.

[6,6]

4. (a) Evaluate \( \iint_R xy \, dx \, dy \) where \( R \) is the quadrant of the circle \( x^2 + y^2 = a^2 \) where \( x \geq 0, \quad y \geq 0. \)

Contd…..2
(b) Find the volume bounded by $4z = 16 - 4x^2 - y^2$ and the plane $z = 0$.

(e) Evaluate

$$
\int_{0}^{\infty} \int_{0}^{y} \frac{dx \, dy}{\sqrt{x^2 + y^2}}
$$

by changing the order of integration.

5. (a) Find the Fourier series expansion of the periodic function

$$
f(x) = |x|, \text{ for } -\pi < x < \pi.
$$

(b) Find the Fourier series to represent $f(x)$ where

$$
f(x) = x \text{ for } 0 < x < 1
$$

$$
= 0 \text{ for } 1 < x < 2.
$$
2014-2015
B.TECH./B.ARCH. WINTER SEMESTER EXAMINATION
(ELECTRICAL/MECHANICAL/CIVIL/ELECTRONICS/COMPUTER/
CHEMICAL/PETRO-CHEMICAL ENGINEERING)
MATHEMATICS – I
(AM – 111)
CREDITS 04

Max Marks: 60
Duration: Three Hours

Note:
(i) Answer all questions as directed.
(ii) All questions carry equal marks.

1. (a) For what value of x is the rank of the matrix
\[
\begin{bmatrix}
4-x & 2\sqrt{5} & 0 \\
2\sqrt{5} & 4-x & \sqrt{5} \\
0 & \sqrt{5} & 4-x
\end{bmatrix}
\]
less than 3?

Also, find the rank of the matrix
\[
\begin{bmatrix}
2 & 3 & 4 & 5 \\
3 & 4 & 5 & 6 \\
4 & 5 & 6 & 7 \\
9 & 10 & 11 & 12
\end{bmatrix}
\]

(b) Investigate for what values of a, b the equations
\[x + y + z = 6, \quad x + 2y + 3z = 10\]
and \[x + 2y + az = b\] have (i) no solution, (ii) a unique solution, (iii) an infinite number of solutions.

(c) Find the characteristic roots (eigen values) of the matrix \[
\begin{bmatrix}
1 & 4 \\
2 & 3
\end{bmatrix}
\]
and verify Cayley-Hamilton theorem for this matrix. Find the inverse of the matrix A and also express \[A^5 - 4A^4 - 7A^3 + 11A^2 - A - 10I\] as a linear polynomial in A.

OR

(c') Determine the eigenvalues and the corresponding eigenvectors of the matrix
\[
\begin{bmatrix}
6 & -2 & 2 \\
-2 & 3 & -1 \\
2 & -1 & 3
\end{bmatrix}
\]

2. (a) Show that eight points of intersection of the curve
\[x^4 - 5x^2y^2 + 4y^4 + x^2 - y^2 + x + y + 1 = 0\]
and its asymptotes lie on a rectangular hyperbola.

OR

(a') Trace the curve \[y(a^2 + x^2) = a^2x\] giving its salient features.

(b) If \[y = (\sin^{-1} x)^2\], show that
\[(1-x^2)y''+2(2n+1)xy''-n^2y = 0\]
and find \((y_n)\).

(c) Expand \log x\ in powers of \((x-1)\) by Taylor's theorem and hence find the value of \[5,5,5\]
\[
\log 1.1
\]

Contd......2
3. (a) Prove that the intrinsic equation of the cardioid $r = a(1 + \cos \theta)$ is $s = 4a \sin \frac{1}{3} \psi$.

OR

(a') Find the length of an arch of the cycloid $x = a(t - \sin t)$, $y = a(1 - \cos t)$.

(b) Find the volume of the solid generated by the revolution of the loop of the curve $y^2 = x^2(a - x)/(a + x)$ about the $x$-axis.

(c) Find the surface of the solid generated by the revolution of the astroid $[4,6,5]$ $x^{2/3} + y^{2/3} = a^{2/3}$ about the axis of $x$.

4. (a) (i) Show that the following equation is exact and solve it.
$$ (e^y + 1)\cos x \, dx + e^y \sin x \, dy = 0 $$

(ii) The roots of the auxiliary equation of a linear differential equation $f(D)y = 0$
$$ \left(D = \frac{d}{dx}\right) \text{ are } 2, 3, 3, 3, \pm \sqrt{5}, \pm \sqrt{5}, 3 \pm 2i. \text{ What will be the solution of this differential equation.} $$

OR

(a') If $D$ denotes $\frac{d}{dx}$, evaluate any two of the following:

(i) $\frac{1}{D^4 - 1} (x \sin x)$

(ii) $\frac{1}{D^3 - D^2 - 6D} (1 + x^2)$

(iii) $\frac{1}{D^2 + 4D + 3} e^x$

(b) Solve the following system of simultaneous differential equation:
$$ \frac{dx}{dt} - \frac{dy}{dt} + 2y = \cos 2t, \quad \frac{dx}{dt} + \frac{dy}{dt} - 2x = \sin 2t. $$

(c) Uranium disintegrates at a rate proportional to the amount then present at any $[5,5,5]$ instant. If $M_1$ and $M_2$ grams of Uranium are present at times $T_1$ and $T_2$ respectively, show that half life of Uranium is
$$ \frac{(T_2 - T_1) \log 2}{\log (M_1/M_2)}.$$

*****
Maximum Marks: 60
Duration: Three Hours

1. (a) If \( \cos u = \frac{x + y}{\sqrt{x} + \sqrt{y}} \), prove that
\[
\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y} + \frac{1}{2} \cot u = 0.
\]

(b) If \( u = f(x^2 + 2yz, y^2 + 2zx) \), prove that
\[
(y^2 - zx)\frac{\partial u}{\partial x} + (x^2 - yz)\frac{\partial u}{\partial y} + (z^2 - xy)\frac{\partial u}{\partial z} = 0.
\]

OR

(b') Use transformation \( u = x - ct, v = x + ct \) to transform the equation
\[
\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}.
\]
Hence show that its general solution is of the form \( y = f(x - ct) + g(x + ct) \).

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

2. (a) Expand \( \tan^{-1}(y/x) \) in the neighbourhood of \((1, 1)\) by Taylor's theorem upto the term of second degree.

(b) The diameter and altitude of a can in the shape of a right circular cylinder are measured as 4cm and 6cm respectively. The possible error in each measurement is 0.1cm. Find approximately the maximum possible errors in the values computed for the volume and lateral surface.

OR

(b') Locate the stationary points of \( x^4 + y^4 - 2x^2 + 4xy - 2y^2 \) and determine their nature at the point \((\sqrt{2}, -\sqrt{2})\) and \((-\sqrt{2}, \sqrt{2})\).
(c) Find the dimensions of the largest rectangular parallelepiped that has three faces in the coordinate planes and one vertex in the plane:

\[
\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1.
\]

3. (a) Evaluate \(\iint \sqrt{a^2 - x^2 - y^2} \, dx \, dy\) over the semi circle \(x^2 + y^2 = ax\) in the positive quadrant.

(b) Find the area included between the curve \(r = a(\sec \theta + \cos \theta)\) and its asymptote.

(c) Use polar coordinates, find the volume of the solid region under the surface \(z = 3 - x^2 - 2y^2\) for \(x^2 + y^2 \leq 1\).

OR

(c’) Find by triple integration the volume of the paraboloid of revolution \(x^2 + y^2 = 4z\) cut off by the plane \(z = 4\).

4. (a) Discuss the salient features and trace the conic

\[8x^2 - 4xy + 5y^2 - 16x - 14y + 17 = 0.\]

(b) A point moves so that the sum of its distances from two fixed points S, S’ is constant and equal to \(2a\). Show that P lies on the conic.

\[\frac{a(1-e^2)}{r} = 1 - e \cos \theta,\] referred to S as pole and SS’ as the initial line, the SS’ being equal to ae.

OR

(b’) PSP’ and QSQ’ are two perpendicular focal chords of a conic; prove that

\[\frac{1}{SP \cdot SP'} + \frac{1}{SQ \cdot SQ'}\]

is constant.
2014-15
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

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

1(a) What do you mean by induced absorption, spontaneous emission, stimulated emission, population inversion and optical pumping? [5.0]

1(b) Discuss construction and working of Ruby laser with the help of suitable diagrams. What is the major drawback of this laser? [6.0]

OR

1(b') What are the important characteristics of a laser? Discuss two applications based on any two characteristics of lasers. [6.0]

1(c) A typical ruby laser emits radiation of 6943 Å because of transition between the energy levels of Cr$^{3+}$ ions. If ruby is 5 cm long and 1 cm in diameter contains $10^{20}$ Cr$^{3+}$ ions/cm$^3$, What is the maximum energy of the pulse emitted by the laser? If pulse lasts for $5\times10^{-9}$ sec., what is the average power of the laser during the pulse? (h=$6.63\times10^{-34}$ J.s, c=$3\times10^8$ m/s) [4.0]

2(a) What is essential difference between superconductor and an ideal conductor? Define critical temperature and critical magnetic field with the help of suitable diagrams. [6.0]

2(b) What is the basic principal of fiber optic communication? Draw cross sectional view of an optical fiber. Depending upon core and cladding materials, categorize optical fibers. [5.0]

OR

2(b') What are the advantages of communication with optical fibers as compared to conventional systems? [5.0]

2(c) The actual energy gap at 0 K in lead is 2.73$\times10^{-3}$ eV. What is the predicted critical temperature ($T_c$) from BCS theory? Radiation of what minimum energy could break apart Cooper pairs in lead at 0K? ($k_B$=$1.38\times10^{-23}$ J/K) [4.0]
3(a) What is statistical mechanics? Differentiate clearly between Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distribution functions. Obtain an expression for energy distribution of ideal gas molecules, $n(e)de$ and plot this distribution as well.

3(b) Using speed distribution of ideal gas molecules show that the expression for most probable speed is given by \[ v_p = (2kT/m)^{1/2} \]  

OR

3'(a) What is Dulong Petit law on specific heats of solids? Mention its limitations. Discuss Einstein's modification of specific heats of solid and show that Einstein's result reduces to classical result at higher temperatures.

3'(b) Obtain an expression for the number of quantum states, $g(e)de$ of free electrons in metals and hence derive the formula for Fermi energy.

4(a) What do you understand by Q-value and threshold energy of a nuclear reaction? Show that the threshold energy, $E_{th}$ of an endoergic nuclear reaction is given by, \[ E_{th} = (-Q) \left( 1 + m_e / M_X \right) \]

4(b) What is nuclear cross section? On what factors does it depend? What are its conventional and SI units. Derive the expression for the fraction of surviving particles when a beam of particles is incident on a slab of absorber of thickness, $x$.

OR

4(b') Outline the general principle involved in working of nuclear detectors. Write the names of various nuclear detectors you know and give a complete account of a scintillation detector coupled with photomultiplier tube.
B.TECH. (WINTER SEMESTER) EXAMINATION
(Civil/ Chemical/ Computer/ Electrical/ Electronics/ Mechanical/ Petrochemical Engg.)
APPLIED PHYSICS
(AP- 111)

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 intrinsic and extrinsic semiconductors with the help of energy band diagram. Drive an expression for the hole concentration in an intrinsic semiconductor using Fermi-Dirac distribution function.

OR

1(a') (i) With the help of a suitable example discuss the energy band formation in semiconductors.
(ii) Show that for a p-type semiconductor, the Hall coefficient $R_H$ is given by $R_H = I/pe$. Give any two applications of Hall effect.

1(b) The electron and hole mobilities in silicon (Si) sample are 0.135 and 0.048 m²/V-s, respectively. Determine the conductivity of the intrinsic Si at 300 K. The sample is then doped with $10^{23}$ phosphorous atoms/m³. Calculate the hole concentration and conductivity in the doped sample.

2(a) Define acceptance angle and numerical aperture of an optical fibre? Explain the difference between step index and graded index fibres.

2(b) Write four advantages of optical fibre over the conventional method of communication.

2(c) An optical fibre has a numerical aperture of 0.20 and a cladding refractive index of 1.59. Find the acceptance angle for the fibre in water which has a refractive index of 1.33.

3(a) What do you mean by a laser? With the help of suitable diagrams, explain the principle and working of a semiconductor laser. Mention merits, demerits and uses of a semiconductor laser.

3(b) Explain the role of the active medium in a gas laser. Briefly mention the applications of laser in medical sciences and fusion reactor.

OR

3(b') A laser beam has a wavelength of 7000 Å and an aperture of 6 mm. The beam is sent to moon which is at a distance of $4 \times 10^5$ Km from the earth. Calculate the angular and axial spread of the beam.

Continued......2
4 Explain the terms-phase velocity and group velocity. Obtain the expression for group velocity, \( v_g = \frac{d\omega}{dk} \) and show that the group velocity, \( v_g \) associated with a moving particle is always equal to the velocity of the particle, \( v \).

Find the shortest wavelength present in the radiation from an x-ray machine whose accelerating potential is 50,000 V.

5 What do you mean by a well behaved wave function? Set-up the time dependent form of Schrödinger equation for matter waves and hence obtain its steady state (time independent) form.

6 Discuss the physical significance of Fermi energy. Use the expression for number of quantum states, \( g(\epsilon)\,d\epsilon \) of free electrons in metals to obtain an expression for Fermi energy. Show that average electron energy at 0 K is \( \frac{3}{5} \varepsilon_F \).

**OR**

6'(a) Obtain classical result on specific heats of solids at constant volume and give its limitations.

Discuss Einstein's explanation of specific heats of solids and show that this result reduces to classical result at higher temperatures.

6'(b) The Fermi energy in silver is 5.51 eV. Estimate the average energy of free electrons in silver at 0 K. What temperature is necessary for the ideal gas molecules to acquire this value of average energy?

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**Some useful physical constants**

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

\( m_e = 9.1 \times 10^{-31} \text{ kg} \), \( m_p = 1.67 \times 10^{-27} \text{ kg} \), \( c = 3 \times 10^8 \text{ m/s} \)

\( n_i (\text{Si}) = 1.5 \times 10^{16} \text{ m}^{-3} \), \( q_e = 1.6 \times 10^{-19} \text{ C} \), 1 amu = 1.66 \times 10^{-27} \text{ kg} \)
1. Explain in brief the different classes of bricks, their characteristics and their usage. [6]

OR

1’ What are the different tools used in the masonry work? Explain in brief.

2. Discuss defects in timber with neat sketches [6]

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

4. Explain any TWO of the following terms.
   a) Efflorescence
   b) Dressing of stones
   c) Seasoning of timber
   d) Quoins [6]

5. Differentiate between one and a half brick thick English and Flemish bond with the help of plans. [8]

6. Discuss any TWO of the following material with reference to their typology and their building applications:
   a) Tiles
   b) Glass
   c) Stones [8]
Design and present a composition of planes on a half imperial sheet with half inch margin all-round picking any four of the following elements:

i) Squares of dimension(s) 10 cm and 15 cm.
ii) Right Angled Triangles of size 5 cm & 8 cm and 8 cm & 12 cm.
iii) Circles of radius 5 cm and 8 cm.
iv) Rectangles of size 5 cm x 8 cm and 4 cm x 6 cm.
v) Two Quadrilaterals of any size and shape other than square and rectangle.

Compose and present these planes in a monochromatic scheme with partial overlap of planes.

Differentiate between any three of the following:

i) Scale and Proportions.
ii) Additive Forms and Subtractive Forms.
iii) Tint of Hue and Tone of Hue.
iv) Tactile Texture and Visual Texture.

What do you understand by Aesthetics? What do you consider to be chic design and how does it differ from a good design?

OR

What are the various ways a design creation by surface division?

How do Colours and Textures impart emotional values to Art and Architecture
B.A.R.C.H. (II SEMESTER) EXAMINATION
AR 113, Architectural Drawing -II
Credits: 6

Maximum Marks: 40

Duration: 3 Hours

Answer all the questions.
Suitable assume any missing data.
All dimensions are in mm.
Neat and good drafted drawings will be credited more.

Q. 1 Draw angular perspective view of the object shown in figure-1. (Eye level =70mm)

Q. 2 Draw siagraphy in plan and elevation of the object shown in figure-1. (Sun rays are inclines at 45° in plan and elevation)

OR

Q. 2' Draw siagraphy in plan and elevation of the object shown in figure-2. (Sun rays are inclines at 45° in plan and elevation)

(All Dimensions are in mm)

FIGURE - 1
1. Derive anthropometrically the optimum size required for the following spaces showing necessary activities, furniture, required movement areas, etc.
   a) Dining area for 8-10 persons
   b) A double occupancy hostel room with an attached toilet
   Drawing required to a scale of (1:20)
   i) Plan(s) with furniture layout.

   OR

1\textsuperscript{st} Design a semi-permanent structure for a Nescafe outlet located in the premise of Maulana Azad Library, Aligarh Muslim University, Aligarh.
   Drawing required to a scale of (1:20)
   i) Plan/Plans
   ii) Elevation/View

2. Aligarh Muslim University wants to build a sub post office in front of University Polytechnic (Boys). You are appointed as an Architect to design this sub post office to cater the needs of the people. The design requirements include a verandah, a room for sitting 3-4 persons, space for storage, toilet and pantry.

   Drawings required to a scale of (1:50)
   i) Viva
   ii) Plan/Plans
   iii) Elevation/View

   (5)
   (15)
   (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

1(a) 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 45kN. Find (i) the stress in the tube and the rod, (ii) the shortening of the rod. Take $E_s = 210$ GPa and $E_b = 80$ GPa.

1(b) Explain the following terms:
   (i) Thermal stresses; (ii) Elasticity; (iii) Strain Hardening; (iv) Toughness and (v) Volumetric strain.

OR

1'(a) Prove that the total extension of a uniformly tapering rod of diameters $D_1$ and $D_2$, when the rod is subjected to an axial load $P$ is given by

$$dL = \frac{4PL}{\pi E D_1 D_2}$$

where $L = $ Total length of the rod

1'(b) A brass bar, having cross-sectional area of 1000mm$^2$, is subjected to axial forces as shown in Fig.1. Find the total elongation of the bar. Take $E = 1.05 \times 10^5$ N/mm$^2$

![Fig.1]

2 In two dimensional problem, the stresses at a point are $\sigma_x = 100$ MPa, $\sigma_y = 60$ MPa. If the principal stress is limited to 150 MPa, find out the value of shear stress $\tau_{max}$. Also find the inclination of the principal plane and magnitude of the maximum shear stress.

OR

2' At a point in a strained 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.

---

Concl. 2.
3. Draw the shear force and bending moment diagrams for the beam shown in Fig.2. Also, locate the points of contra flexure in the beam if any.

Fig.2

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

4(b) A cantilever of length 2m fails when a load of 2kN is applied at the free end. If the section of the beam is 40 mm x 60 mm, find the stress at the failure.

OR

4' A beam of I-section 50 cm deep and 19 cm wide, has flanges 2.5 cm thick and web 1.5 cm thick. It carries a shearing force of 400 kN at a section. Calculate the maximum intensity of shear stress in the section, assuming the moment of inertia to be 64,500 cm$^4$. Also calculate the total shear force carried by the web and sketch the shear stress distribution across the section.

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

5(b) A solid steel shaft is to transmit 75 KW at 200 rpm. Taking allowable shear stress as 70MPa, find suitable diameter of the shaft, if the maximum torque transmitted in each revolution exceeds the mean by 30%. Also find the outer diameter of the shaft if inside diameter is 0.7 of the outside diameter, which can replace the solid shaft.
2014-15
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.

<table>
<thead>
<tr>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a) The temperature of an air parcel at 500 min 25°C. If this is moved upward, what would be its temperature if the conditions are</td>
<td></td>
</tr>
<tr>
<td>i) Subadiabatic</td>
<td>4</td>
</tr>
<tr>
<td>ii) Superadiabatic</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td></td>
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<tr>
<td>1'(a) Enumerate the methods used for the control of gaseous pollutants, explain any one of them in detail with the help of neat diagram.</td>
<td>4</td>
</tr>
<tr>
<td>1(b) A power plant burns 5.45 tonnes of coal per hour and discharges the combustion products through a stack that has an effective height of 75m. The coal has a sulphur content of 4.2 percent, and the wind velocity at the top of the stack is 6.0 m/s. The atmospheric conditions are moderately to slightly stable. Determine the maximum ground level concentration of SO₂ and the distance from the stack at which maximum occurs. (use the attached figures)</td>
<td>6</td>
</tr>
<tr>
<td>2(a) Define e-waste, what are the hazardous compounds that e-waste consist of?</td>
<td>2</td>
</tr>
<tr>
<td>2(b) What are the sources of municipal solid waste?</td>
<td>2</td>
</tr>
<tr>
<td>2(c) Discuss in brief the environmental impact of solid waste disposal on land.</td>
<td>2</td>
</tr>
<tr>
<td>2(d) Discuss in brief any two of the following</td>
<td>4</td>
</tr>
<tr>
<td>i) Windrow composting</td>
<td></td>
</tr>
<tr>
<td>ii) In Vessel composting</td>
<td></td>
</tr>
</tbody>
</table>

contd...
iii) Anaerobic digestion
iv) Vermi Composting

3. Write short notes on any FOUR of the following:
   (a) Mechanism of Photo-chemical Smog
   (b) Diagrammatic representation of carbon cycle
   (c) Green-House Effect
   (d) Terrestrial food chain
   (e) Role of stratosphere
   (f) Classification of air pollutants

4.(a) Differentiate between Chemical Oxygen Demand and Biochemical Oxygen Demand. For a BOD Test 6 mL of wastewater sample was diluted to 300 mL in a standard BOD bottle. Initial DO in the bottle was determined to be 8.5 mg/L. DO after 5 days at 20°C was found to be 5 mg/L. Determine BOD5 of wastewater.

4(b) Describe the analysis and measurement of any one of the gaseous pollutants.

OR

4'(b) Briefly explain physical, chemical and biological water quality parameters.

5(a) A mixture of industrial wastewater and river water has a 5 day, 20°C BOD of 20 mg/L decay rate constant equal to 0.23/d. Calculate its ultimate and 20 day BOD values. What will be its 3 day, 27°C BOD? Using Streeter – Phelps equation calculate the DO concentration in the stream after a time of travel of 7 days. Assume: stream temperature 20°C, stream reaeration rate constant as 0.6/d, saturation DO as 8.5 mg/L and initial deficit as 1.8 mg/L.

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

6(a) Briefly discuss the water treatment system for surface water source.

6(b) Design a sedimentation tank for a population of 5 thousand persons using 150 litres of water per day per person. Assume SOR = 30m/day.

Prove that for particle to reach the bottom of the tank its settling velocity must be equal to or greater than SOR
Q.No.       Question                                      M.M.   
1(a) Describe any THREE of the following;     [02*3]   
   a. Microcomputer                            
   b. Minicomputer                             
   c. Mainframe Computer                       
   d. Supercomputer                            
1(b) What is the role of an operating system? Name five different operating systems. Name few available editors in windows xp.  [04]   
2(a) What do you mean by algorithms? Write an algorithm to find factorial of a number.  [04]   
2(b) Draw a flowchart to find the sum of digits of a three digit number.  [03]   
2(c) Briefly describe different primitive data types in C.  [03]   
                              OR                                             
2(c') Describe the terms with suitable example: constants, keywords, identifiers, and variables.  [03]   
3(a) List different types of operators in C, also mention their symbolic representation.  [04]   
                             OR                                              
3(a') Represent the working of switch case using flow diagram. What will be the output when you execute the following C code?  [04]
#include<stdio.h>

void main(){
    int check=2;
    switch(check){
    case 1: printf("Friday");
    case 2: printf("Saturday");
    case 3: printf("Sunday");
    default: printf("Monday");
    }
}

3(b) Write the structure of a C program.
3(c) Write complete structure of a switch case in C.

4(a) Write a program in C to reverse a string without using library function.
4(b) Differentiate between LAN and WAN. Give two examples of network topology.
4(c) Describe different storage classes in C.

OR

4'(a) Write a function in C to calculate $X^Y$.
4'(b) Write syntax for if-else, for, while, and do-while statements.
4'(c) Differentiate between break and continue statements.
PART A (To be answered in a separate copy)

1(a) Distinguish between the following:
   (i) Power factor and Form factor
   (ii) Active Power and Reactive Power.

   [04]

(b) Find the current through 10 Ω resistor in Figure 1 using Thevenin's theorem.

   [05]

(c) An inductor has a core built up of stamping of the shape shown in Figure 2, the coil being on the centre limb. There is a 1mm air gap in the centre limb which has a cross sectional area of 4 cm². All the other paths in the core have a cross sectional area of 2 cm². The mean path lengths of the magnetic flux in each portion of the core are as shown. If the relative permeability of the iron is 800, find the current needed in the coil of 500 turns to produce a total flux in the air gap of 0.8 mWb.

   [06]

OR

1'(a) Using phasor diagram, obtain the relationship for line and phase current for delta connected system.

   [05]

(b) Find the current through the capacitor of −j5 Ω reactance in Figure 3 using Superposition theorem.

   [05]

(c) A 100 kVA, 50 Hz, 440V/1100 V single phase transformer has an efficiency of 98.5% when supplying full load current at 0.8 power factor lagging and an efficiency at 99% when supplying half full load at unity power factor. Find the core loss and copper loss corresponding to full load.

   [05]

2.(a) Derive E.M.F equation for an alternator. Also write the modified equation incorporating winding factor.

   [05]
(b) Describe with a neat diagram the functioning of induction type single phase energy meter.

(c) Discuss the classification of Hydro-electric plants. Also draw a neat diagram of Pumped storage Plant.

Figure 1

Figure 2

Figure 3

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

3. (a) What is the significance of diode model? Draw the equivalent circuits and characteristics of a PN junction diode for piecewise linear model, constant voltage drop model and ideal diode model.

(b) (i) Why collector current IC in a transistor is slightly less than the emitter current IE for a transistor in active region. (ii) Why Base current in a transistor is usually much smaller than IEB or IEC in active region?

(c) At what forward voltage does a diode for which η = 2 conduct a current equal to 1000 Ie? In terms of Ie, what current flows in the same diode when its forward voltage is 0.7 volt?

4. (a) Draw the construction of P-Channel Enhancement MOSFET. What is inversion layer and how it is created in P-Channel Enhancement MOSFET?

(b) In CE configuration Si transistor circuit, the collector supply voltage is 10V. When a resistor Rc = 1kΩ is connected in the collector circuit, the voltage drop across it 0.5V. For α = 0.98, determine the base current IB and emitter current IE. Draw the DC load line and determine the Q-point.

(c) Draw the circuit for opamp based Subtractor circuit and find its output voltage.

OR

4."(a) Define the term threshold voltage VT in P-Channel Enhancement MOSFET.

(b) What is Zener breakdown? What is the difference between Avalanche and Zener Breakdown?

(c) An op-amp based inverting integrator is measured at 1 kHz to have a voltage gain of -100 V/V. At what frequency is its gain reduced to -1 V/V? What is the integrator time constant?
Q.No. | Question | M.M.
--- | --- | ---
1(a) | Considering an op-amp to be ideal, determine the expressions of closed loop gain & input resistance for inverting and non-inverting amplifier configuration. | [08]
1(b) | With the help of a detailed diagram, explain the principle of operation of Cathode Ray Tube (CRT). | [07]

2(a) | A silicon junction 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. | [05]
2(b) | What are clampsers. With the help of a circuit diagram, explain the operation of positive clamer. | [05]
2(c) | With the help of a circuit diagram, explain the operation of a bridge rectifier. Also determine its Peak Inverse Voltage (PIV). | [05]

OR

2'(a) | With the help of a circuit diagram, explain how zener diodes can be used as voltage regulators. | [05]
2'(b) | What are clippers. With the help of a circuit diagram, explain the working of combinational clipper. | [05]
2'(c) | The circuit in Fig. 1 utilizes three identical diodes having \( n = 1 \) and \( I_r = 10^{-14} \) A. Find the value of current \( I \) required to obtain an output voltage \( V_o = 2V \). | [05]
3 (a) Design the circuit of Fig.2 so that the transistor operates at $I_D = 0.4 \text{ mA}$ and $V_D = 0.5 \text{ V}$. The NMOS transistor has $V_t = 0.7 \text{ V}$, $k_n = 100 \text{ uA/V}^2$, $L = 1 \text{ um}$ and $W = 32 \text{ um}$.

3(b) With the help of $I_D$ vs $V_{DS}$ and $I_D$ vs $V_{GS}$ characteristic curves, explain the operation of a depletion type NMOS.

OR

Cont'd... 3
(a) Design the circuit of Fig. 3 to obtain a current $I_D$ of 80 $\mu$A. Find the value required for $R$ and dc voltage $V_D$. Let the NMOS transistor have $V_t$ of 0.6V, $k_n$ of 200 $\mu$A/V$^2$, channel length $L$ of 0.8um and channel width $W$ of 4 um.

![Fig. 3](image)

(b) With the help of a device structure, explain the physical operation of n-channel JFET.

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

4(b) Determine all the node voltages and branch currents for the circuit shown in Fig. 4. Assume that $\beta$ is specified to be 100.

![Fig. 4](image)

4(c) Briefly describe how a Bipolar Junction Transistor can be used as a switch.
B.TECH/B. ARCHITECTURE WINTER (II SEMESTER) EXAMINATION
(ELECT/MECH./CIVIL/CHM./ELECTRONICS/COMPUTER/
PETRO-CHEMICAL ENGINEERING)
ENGLISH
(EN – 101)
CREDITS 04

Max Marks: 60
Duration: Three Hours

Note: Answer all questions.

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

In the eleventh century, people noticed that if a small hole were put in one wall of a darkened room, then light coming through the aperture would make a picture of the scene outside on the opposite wall of the room. A room like this was called a camera obscura. Artists later used a box to create a camera obscura, with a lens in its opening to make the picture clearer. But it was not possible to preserve the image that was produced in the box.

In 1727, Johann Heinrich Schulze mixed chalk, silver, and nitric acid in a bottle. He found that when the mixture was subjected to light, it became darker. In 1826, Joseph Nicéphore Niépce put some paper dipped in a light-sensitive chemical into his camera obscura, which he left exposed in a window. The result was probably the first permanent photographic image. The image Niépce made was a negative, a picture in which all the white parts are black and all the black parts are white. Later, Louis Daguerre found a way to reverse the black and white parts to make positive prints. But when he looked at the pictures in the light, the chemicals continued to react and the pictures went dark. In 1837, he found a way to fix the image. These images are known as daguerreotypes.

Many developments of photographic equipment were made in the nineteenth century. Glass plates coated with light-sensitive chemicals were used to produce clear, sharp, positive prints on paper. In the 1870s, George Eastman proposed using rolls of paper film, coated with chemicals, to replace glass plates. Then, in 1888, Eastman began manufacturing the Kodak® camera, the first “modern” lightweight camera that people could carry and use.

During the twentieth century, any technological improvements were made. One of the most important was color film. Color film is made from layers of chemicals that are sensitive to red, green, and blue light, from which all other colors can be made. Despite the fact that the space age has witnessed the creation of an array of technological marvels, until recently even the ability to take photographs of distant galaxies from above the Earth’s atmosphere via orbiting satellites was grounded in the basic principles of photography that Niépce used when he took his first fuzzy negative pictures.

(i) What did the very first camera obscura look like?
(ii) What was the problem that Daguerre encountered?
(iii) According to the passage, George Eastman built a camera that
(a) used chemically coated glass plates
(b) produced light sensitive prints

Contd......2
(c) used chemicals to produce clear, sharp and positive prints.
(d) was portable.

(iv) Which of the sentences below express the essential information in the highlighted sentence in the passage?
(a) The layers of chemicals that make up colour film are sensitive to all colours that can be made.
(b) Colour films use chemicals that are sensitive to red, green, and blue light.
(c) Red, green and blue light are the essential colours from which all colours can be chemically made.
(d) The layers of chemicals on color film are sensitive to red, green, and blue light that, combined, can make all colours.

(v) Change the following sentences into passive voice:
(a) Louis Daguerre found away to reverse the black and white parts to make positive prints.
(b) Glass plates coated with light-sensitive chemicals were used to produce clear, sharp, positive prints.

1. (b) Write a summary of the above passage. [10]

UNIT – II

2. The animals rebelled against Jones because he made them work hard and exploited them. How is all of this ironic in the light of the end of the novel, “Animal Farm”.

OR

Compare and Contrast Napoleon and Snowball’s leadership.

3. Discuss the roles played by the Elois and the Marlocks in their social setup as depicted in ‘The Time Machine’. [05]

OR

Discuss the significance of the Palace of Green Porcelain in the novel ‘The Time Machine’.

UNIT – III

4. Attempt any one of the following: [10]

Write a report on a recently concluded Seminar on ‘Recent Advancements in Engineering’.

OR

Write the process of buying a railway ticket from Bangalore to Delhi through the Indian Railways portal.

Contd……3
5. Read the passage given below and (i) Make notes of it in the proper format; (ii) Write a précis of the same.

For a fossil to be found, a complicated series of steps must occur in sequence. The first is that the animal [or plant] must be buried quickly. Animals that die on the plains or in the mountains are soon found by scavengers, such as hyenas or ceratosaurs, and rapidly reduced to bone chips. Most animals that are fossilized are caught in a flash flood, or die in or near a river and are buried in a sand bar, or are caught in a sandstorm. If the current in the river is fairly strong, even those few animals that die in the water are soon torn apart and their bones scattered over acres of river bottom. It is estimated that perhaps one animal in a thousand is fossilized, likely a generous estimate.

The second condition necessary for an animal to be fossilized is that it must be buried in a depositional area: that is, more and more layers of mud or gravel must be laid down over it. If the area is subject to erosion – and nearly all land surfaces are – the fossil will soon be washed out and destroyed.

The third step is that this depositional area must at some time become an erosional area, so that wind and water wear it down and uncover the buried remains.

The fourth step necessary for the recovery of a fossil is that when the fossil is uncovered, someone knowledgeable has to walk along that ridge, or study the face of that cliff, and locate the fossil and recover it. The time frame for this recovery varies, but it is necessarily short. The fossil is protected, but also invisible, until it is exposed. As soon as it is exposed, wind and water attack it, and they can destroy it quickly. The best fossils are found when someone spots an exposed bone that turns out to be part of a buried skeleton and is therefore still well preserved. Many fine fossils have been washed away because no one happened to see them when they were first exposed, or the people who saw them didn’t realize what they were seeing.

UNIT – V

6. Write an essay on any one of the following topics in 300 words.
   (a) Companies should employ their workers for their entire lives. Comment.

   OR

   (b) A few problems of the community that need immediate attention.

   ****
1(a) Define State, Quasi-static process & Quasi-equilibrium states. [3]

1(b) The temperature T on a thermometric scale is defined in terms of a property X by the relation:

\[ T = a \ln X + b \]

where a and b are constants. The values of X are found to be 1.83 at ice point and 6.78 at steam point. The temperatures at these points are assigned numbers 0 and 100 respectively. Find out the temperature corresponding to a reading of X = 2.45 on the temperature scale. [3]

1(c) Calculate a formula for manometer reading \( h_2 \) for a situation shown in the figure in terms of known values of \( h, h_3, \rho_1, \rho_2 \) and \( \rho_c \). [6]

2(a) What are the modes of energy transfer across the boundary of a closed system? [2]

2(b) An insulated room is heated by burning candles. Is this a heat or work interaction? Take the entire room, including the candles, as the system. [2]

2(c) Water is being heated in a closed pan on top of a burner while being stirred by a paddle wheel. During the process, 30 kJ of heat is transferred to the water, and 5 kJ of heat is lost to the surrounding air. The paddle-wheel work amounts to 500 N \cdot m. Determine the final energy of the system if its initial energy is 10 kJ. [4]
2(d) A gasoline engine has a specific fuel consumption of 0.3 kg/kWh. The stream of air and gasoline vapour, in the ratio 14:1 by mass, enters the engine at a temperature of 30 °C and leaves as combustion products at a temperature of 790 °C. The net heat transfer rate from the fuel-air stream to the jacket cooling water and to the surroundings is $35 \times 10^3$ J/s. The shaft power delivered by the engine is 26 kW. Evaluate the increase in the specific enthalpy of the fuel-air stream assuming the changes in kinetic energy and in elevation to be negligible.

OR

2'(a) A fluid is confined in a cylinder by a spring-loaded, frictionless piston so that the pressure in the fluid is a linear function of the volume ($p = a + bV$). The internal energy of the fluid is given by the following equation:

$$U = 34 + 3.15pV,$$

where $U$ is in kJ, $p$ in kPa, and $V$ in m$^3$. If the fluid changes from an initial state of 170 kPa, 0.03 m$^3$ to a final state of 400 kPa, 0.06 m$^3$, with no work other than that done on the piston, find the direction and magnitude of the work and heat transfer.

2'(b) Air at a temperature of 15 °C passes through a heat exchanger at a velocity of 30 m/s 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 $\Delta h = c_p \Delta T$, where $c_p$ is the specific heat equal to 1.005 kJ/kg-K.

3(a) With the help of pressure-enthalpy diagram, precisely discuss the use of throttling calorimeter for measuring the dryness fraction of slightly wet steam. Also, specify the limitation of throttling calorimeter.

3(b) The properties of a certain gas are related by

$$\rho v = 310(T + 273)$$

and

$$u = u_0 + 0.84T$$

where $\rho$ is in N/m$^2$, $v$ in m$^3$/kg, $T$ in °C and $u$ in kJ/kg.

A cylinder fitted with a piston contains 0.02 m$^3$ of this gas at a pressure of $350 \times 10^3$ N/m$^2$ and a temperature of 80 °C. As the gas expands to a lower pressure the work done by the gas is 2900 N-m and the heat transfer from the gas is $1.9 \times 10^3$ J.

i) Determine the temperature of the gas after expansion.

ii) If the gas undergoes an adiabatic process between the same end states, evaluate the work done by the gas in this case.

OR
3' Show that in an adiabatic nozzle, stagnation enthalpy remains constant.
   i) Steam enters a convergent-divergent nozzle with a velocity of 60 m/s, with a pressure $800 \times 10^3$ N/m$^2$ and with 79.6 K superheat. The steam leaves the exit section of the nozzle at a pressure of $160 \times 10^3$ N/m$^2$ with a dryness of 0.96. The cross sectional area of the exit section is 12 cm$^2$. The flow is adiabatic. Determine the steam velocity at the exit section and the steam mass flow rate.
   ii) The exhaust steam from the nozzle flows into a condenser and flows out as water at a temperature of 95°C and negligible velocity. The cooling water enters the condenser at a temperature of 10°C and leaves at a temperature of 25°C; determine its mass flow rate. [12]

4(a) Prove that solid friction is irreversible. [4]

4(b) Establish Clausius inequality. [4]

4(c) A heat engine is used to drive a heat pump. The heat transfers from the heat engine and from the heat pump are used to heat the water circulating through the radiators of a building. The efficiency of the heat engine is 27% and the coefficient of performance of the heat pump is 4. Evaluate the ratio of the heat transfer to the circulating water to the heat transfer to the heat engine. [4]

OR

4' A heat engine operates steadily on the following cycle. Saturated water at a temperature of 200°C is pumped into a boiler and leaves as dry-saturated steam at a temperature of 200°C. After adiabatic expansion through a turbine to a pressure of $100 \times 10^3$ N/m$^2$ the dryness fraction is 0.90. The exhaust steam from the turbine passes to a condenser and is partially condensed, leaving at a pressure of $100 \times 10^3$ N/m$^2$ with a dryness fraction of 0.15. The wet steam leaving the condenser is then compressed adiabatically in the feed pump before re-entering the boiler as saturated water at a temperature of 200°C.
   i) Determine the specific entropy values around the cycle.
   ii) State whether the turbine and pump processes are reversible or irreversible, give reasons.
   iii) Evaluate the heat transfer per unit mass of steam in each component, and determine the efficiency of the heat engine. [12]

5(a) Show Diesel, Brayton and Rankine cycles on Pressure-Volume (p-v) and Temperature-Entropy (T-s) diagrams. [6]

5(b) An inventor claims to have designed a heat engine which has an efficiency of 38% when using the exhaust gas from the engine, at a temperature of 145°C, as the high temperature system. Examine the validity of this claim. [6]
1. The distance between two stations A and B is 100 kilometres and its equivalent distance on railway map measures 2.5 centimetres. What is the R.F.? Draw a diagonal scale showing single kilometres and indicate a distance of 577 kilometres on the scale.

2. The top view of a straight line AB 72 mm long, measures 62 mm while length of its front view is 49 mm. Its end A is in V.P. and 12 mm above the H.P. Draw the projections of the straight line and determine its inclinations with H.P. and V.P.

OR

2'. Draw the projections of a pentagonal plane, side 25 mm, resting in the H.P. on one of its edges. The plane of pentagon is inclined at 45° to the H.P. and the perpendicular from the mid-point of the resting edge, makes an angle of 30° with the V.P.

3. Figure 1 shows a sketch of an assembling block. Draw the following views:
   (i) Front view  (ii) Top view and (iii) Side view

OR

3'. Figure 2 shows casting of an object with quarter portion removed. Draw the following views:
   (i) Half sectional elevation, (ii) Half sectional side view, and (iii) Top view.
4. Figure 3 shows two views of an object. Draw the isometric projection of the given object.

Fig. 1

Fig. 2

Contd...
Answer any two of the following.

(a) Two forces P and Q are applied as shown in figure 1(a) to an aircraft connection. Knowing that the connection is in equilibrium and that \( P = 500 \) N and \( Q = 650 \) N, determine the magnitudes of the forces exerted on the rods A and B. [06]

(b) The lever BCD is hinged at C as shown in figure 1(b) and attached to a control rod at B. Determine the maximum force P which can be safely applied at D if the maximum allowable value of the reaction at C is 1000 N. [06]

(c) Two 10° wedges of negligible weight are used to move and position the 163 kg block. Knowing that the coefficient of static friction at all surfaces of contact is 0.25, determine the smallest force P that should be applied as shown in figure 1(c) to one of the edges. [06]

Answer any two of the following.

(a) For the plane area shown in figure 2(a), determine [06]
   - the first moments with respect to the x and y axes.
   - the location of the centroid.

(b) Determine the moment of inertia of the shaded area, shown in figure 2(b), with respect to each of the coordinate axes. [06]

(c) A thin semicircular plate, shown in figure 2(c), has a mass m. Determine the mass moment of inertia of plate, with respect to (i) the centroidal axis BB (ii) the centroidal axis CC that is perpendicular to the plate. [06]

Answer any two of the following.

(a) A homeowner uses a snowblower, shown in figure 3(a) to clear his driveway. Knowing that the snow is discharged at an average angle of 40° with the horizontal, determine the initial velocity \( v_0 \) of the snow. [06]
3(b) Knowing that at the instant block A, shown in figure 3(b), has a velocity of 200 mm/s and an acceleration of 150 mm/s² both directed down the incline, determine (a) the velocity of block B, (b) the acceleration of block B.

3(c) The three blocks shown in figure 3(c), move with constant velocities. Find the velocity of each block, knowing that the relative velocity of A with respect to C is 300 mm/s upward and that the relative velocity of B with respect to A is 200 mm/s downward.

**Answer the following.**

4(a) A spring AB of constant k, shown in figure 4(a) is attached to a support at A and to a collar of mass m. The unstretched length of the spring is l. Knowing that the collar is released from rest at x=x₀ and neglecting friction between the collar and the horizontal rod, determine the magnitude of the velocity of the collar as it passes through point C.

4(b) The 15 kg block B, figure 4(b) is supported by the 25 kg block B is supported by the 25 kg block A and is attached to a cord to which a 225 N horizontal force is applied as shown. Neglecting friction, determine (a) the acceleration of block A, (b) the acceleration of block B relative to A.

**Answer any two of the following.**

5(a) Block A, figure 5(a) has a mass of 30 kg and block B a mass of 15 kg. The coefficients of friction between all plane surfaces of contact are μk = 0.15 and μk = 0.10. Knowing that $\theta = 30^\circ$ and that the magnitude of the force P applied to block A is 250 N, determine (a) the acceleration of block A, (b) the tension in the cord.

5(b) A 6 kg block B rests, as shown in figure 5(b) on the upper surface of a 15 kg wedge A. Neglecting friction, determine immediately after the system is released from rest (a) the acceleration of A, (b) the acceleration of B relative to A.

5(c) The two blocks shown 5(c) are originally at rest. Neglecting the masses of the pulleys and the effect of friction in the pulleys and between block A and the horizontal surface, determine (i) the acceleration of each block, (ii) the tension in the cable.
1a. The bent rod ABED is supported by bearings at C and D and by wire AH. Knowing that portion AB of the rod is 250 mm long, determine (a) the tension in wire AH, (b) the reactions at C and D. Assume that the bearing at D does not exert any axial thrust. (Figure 1)

1b. Denoting by $\mu_s$ the coefficient of static friction between collar C and the vertical rod, derive an expression for the magnitude of the largest couple $M$ for which equilibrium is maintained in the position shown. Explain what happens if $\mu_s \geq \tan \theta$. Use principle of virtual work. (Figure 2)
2a. A projectile is fired from Point A with an initial velocity \( v_0 \). (a) Show that the radius of curvature of the trajectory of the projectile reaches its minimum value at the highest Point B of the trajectory. (b) Denoting by \( \theta \) the angle formed by the trajectory and the horizontal at a given Point C, show that the radius of curvature of the trajectory at C is \( \rho = \frac{\rho_{\text{min}}}{\cos^3 \theta} \). (Figure 3)

![Figure 3]

2b. Four small disks A, B, C, and D can slide freely on a frictionless horizontal surface. Disks B, C, and D are connected by light rods and are at rest in the position shown when disk B is struck squarely by disk A, which is moving to the right with a velocity \( v_0 = 12 \hat{i} \) (m/s). The masses of the disks are \( m_A = m_B = m_C = 7.5 \) kg, and \( m_D = 15 \) kg. Knowing that the velocities of the disks immediately after the impact are \( v_A = v_B = 2.5 \hat{i} \) (m/s), \( v_C = -v_C \hat{i} \) and \( v_D = v_D \hat{i} \), determine (a) the speeds \( v_C \) and \( v_D \), (b) the fraction of the initial kinetic energy of the system which is dissipated during the collision. (Figure 4)

![Figure 4]

2b’. Three small spheres A, B, and C, each of mass \( m \), are connected to a small ring D of negligible mass by means of three inextensible, inelastic cords of length \( l \). The spheres can slide freely on a frictionless horizontal surface and are rotating initially at a speed \( v_0 \) about ring D which is at rest. Suddenly the cord CD breaks. After the other two cords have again become taut, determine (a) the speed of ring D, (b) the relative speed
at which spheres $A$ and $B$ rotate about $D$, (c) the fraction of the original energy of spheres $A$ and $B$ which is dissipated when cords $AD$ and $BD$ again became taut. (Figure 5)

![Figure 5](image)

3a. Knowing that at the instant shown the angular velocity of rod $AB$ is 15 rad/s clockwise, determine (a) the angular velocity of rod $BD$, (b) the velocity of the midpoint of rod $BD$. (Figure 6)

![Figure 6](image)

3b. A uniform slender rod of length $L = 1$ m and mass $m = 2$ kg hangs freely from a hinge at $A$. If a force $P$ of magnitude $8$ N is applied at $B$ horizontally to the left. Determine (a) the distance $h$ for which the horizontal component of the reaction at $A$ is zero, (b) the corresponding angular acceleration of the rod. (Figure 7)

![Figure 7](image)

3b'. A 15-kg slender rod $AB$ is 2.5 m long and is pivoted about a point $O$ which is 0.5 m from end $B$. The other end is pressed against a spring of constant $k = 300$ kN/m until the spring is compressed 40 mm. The rod is then in a horizontal position. If the rod is released from this position, determine its angular velocity and the reaction at the pivot $O$ as the rod passes through a vertical position. (Figure 8)
4a. (i) Explain the following terms: Strain hardening; Principle of superposition; Isotropic and Homogeneous materials.

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

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<table>
<thead>
<tr>
<th>40kN</th>
<th>20kN</th>
<th>10kN</th>
<th>30kN</th>
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<tr>
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<td>40cm</td>
<td>20cm</td>
<td></td>
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4(b). The intensity of resultant stress on a plane AB, as shown in figure, at a point in a material under stress is $80\, \text{MPa}$ (tensile) inclined at 30 degree to the normal to that plane. The normal component of stress on another plane BC at right angles to plane AB is $60\, \text{MPa}$. Determine (i) Resultant stress on the plane BC, (ii) The principal stresses and the principal planes and (iii) The maximum shear stress and its place.
4(b'). The principal stresses at a point in a strained material are 126MPa tensile and 63MPa tensile, the third principal stress is being zero. Using Mohr's circle, find the magnitude and direction of resultant stress on a plane inclined at 30 degree to the direction of 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.

5(a). Draw the bending moment diagram for the following beam shown in figure. Also find the maximum bending moment.

5(b). For a solid circular shaft diameter 'D' and length 'L', derive the equation of torsion, if it is subjected to torque 'T'.

OR

5(b'). A hollow shaft of diameter ratio 3:5 is required to transmit 800KWa at 110rpm, the maximum torque being 20% greater than mean torque. The shear stress is not to exceed 63MPa and the twist in a length of 3m is not exceeding 1.4 degree. Calculate the external and internal diameter of the shaft. Take C = 84GPa

\[ \frac{2}{R} = \frac{C_0}{c} = \frac{T}{J} \]