2013-14
B.TECH. FIRST YEAR (AUTUMN SEMESTER) EXAMINATION
(ELECT./MECH./CIVIL/CHEM./ELECTRONICS/COMPUTER/PETROCHEM. ENGG.)
APPLIED CHEMISTRY I
COURSE CODE AC-.101

Maximum Marks: 60  
Credits: 03  
Duration: Three Hours

*Answer all the questions.*

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<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
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<tr>
<td>1(a)</td>
<td>Describe various steps involved in gravimetric analysis.</td>
<td>[04]</td>
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<tr>
<td>(b)</td>
<td>Name different types of titrations with examples. Differentiate between primary and secondary standards.</td>
<td>[06]</td>
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OR

| 1'(a) | Define and classify Chromatography. Explain any one application of ion-exchange chromatography. | [04] |
| (b)   | Write Beer Lambert’s law and explain the terms involved in it. Draw a labelled diagram of a single beam spectrophotometer and discuss the functions of each component. | [06] |

| 2(a)  | Classify air pollutants on the basis of origin, chemical composition and state of matter and give their examples. | [05] |
| (b)   | Describe the sources and significance of sulphur dioxide in the atmosphere. | [05] |

| 3(a)  | Define heterogeneous system, phase, degree of freedom and component. | [04] |
| (b)   | Draw phase diagram of water system and discuss its important features. | [06] |

| 4(a)  | What is natural rubber? How is it obtained from rubber plant? | [05] |
| (b)   | Explain vulcanization of rubber. Describe advantages of vulcanized rubber over natural rubber. | [05] |

| 5(a)  | Describe addition and condensation polymerization reactions with examples. | [05] |
| (b)   | Differentiate between thermoplastics and thermosetting plastics. | [05] |

| 6     | Write short notes on any two of the followings. | [2×5] |
| a)    | Preparation and properties of polystyrene | |
| b)    | Biodegradable and non-biodegradable organic pollutants | |
| c)    | Invariant reactions | |
Maximum Marks: 60  
Credits: 04  
Duration: Three Hours

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

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<td>1(a)</td>
<td>Write the significance of von-Weimann ratio in precipitation and also highlight the favourable conditions for precipitation.</td>
<td>04</td>
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<tr>
<td>(b)</td>
<td>Give the principle of volumetric analysis. Describe the various types of titrations with the help of suitable example.</td>
<td>04</td>
</tr>
<tr>
<td>(c)</td>
<td>Differentiate between primary and secondary standard with the help of suitable examples.</td>
<td>02</td>
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**OR**

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<tr>
<td>1'(a)</td>
<td>State and explain the Beer-Lambert Law. Draw a labelled block diagram of Single Beam Spectrophotometer.</td>
<td>03</td>
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<tr>
<td>(b)</td>
<td>Distinguish between the followings:</td>
<td>04</td>
</tr>
<tr>
<td></td>
<td>i) Adsorption and Partition Chromatography</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii) Column and Planer Chromatography</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>A sample on spectrometric analysis showed an absorbance of 5 in a cuvette of path length 2 cm. Calculate the molar absorptivity if the concentration of sample solution is 0.2 g/L and molecular weight of the substance is 150.</td>
<td>03</td>
</tr>
</tbody>
</table>

2(a) Give the steps involved in municipal water treatment. Discuss the significance of sedimentation process.                                                                                             | 04   |

(b) Discuss the caustic embrittlement and methods for its prevention.                                                                                                                                | 03   |

(c) A sample of water was found to contain the following impurities in mg/L:                                                                                                                          | 03   |

Contd......2
Ca(HCO₃)₂=40.5; Mg(HCO₃)₂=36.5; MgSO₄=30.0; CaSO₄=6.8; NaCl=10.0; Fe₂O₃=5.0

Calculate the temporary, permanent and total hardness in degree Clark.
(Atomic Weights: Ca=40, Mg=24, Cl=35.5, S=32, O=16, C=12, H=1, Na=23 and Fe=56)

**OR**

2'(a) What are disinfectants? List the various types of disinfectants. Discuss the advantages and disadvantages of bleaching powder as disinfectant.
(b) Write the chemical reactions involved in determination of hardness causing impurities by Soap and EDTA methods.
(c) Discuss the advantages and disadvantages of any two of the followings:
   i) Lime-Soda process
   ii) Zeolite process
   iii) Ion Exchange process.

3(a) Calculate the minimum amount of air required for the complete combustion of 10 kg of carbon and also find out the composition of flue gases.
(b) Discuss the advantages and disadvantages of gaseous fuel. Give the composition, calorific value and uses of LPG.
(c) Describe the Fisher Tropsch process for the production of synthetic petrol.

4(a) Enlist the functions of the lubricants. Describe the mechanism of extreme-pressure lubrication.
(b) What are the various types of greases? Give the conditions of their use.
(c) Differentiate between the followings:
   i) Flash and fire points
   ii) Cloud and setting points

5(a) Explain dry corrosion. Discuss the mechanism of oxidation corrosion.
(b) Discuss the importance of design and material selection in controlling corrosion.
(c) Write short notes on any two of the followings:
i) Electrode potential
ii) Galvanic series
iii) Tinning

6(a) Explain condensation polymerization with the help of suitable example.

(b) Discuss briefly the process of vulcanization and its advantages.

(c) Give the preparation, properties and uses of PE or Bakelite.
1(a) For what values of the parameter $t$, the system of equations

\[ tx + y + z = 1, \quad x + ty + z = 1, \quad x + y + tz = -2 \]

fails to have a unique solution? Solve the system, if it is solvable for any of these values of $t$.

(b) Find the eigen values and the corresponding eigen vectors of the matrix

\[
\begin{bmatrix}
6 & -2 & 2 \\
-2 & 3 & -1 \\
2 & -1 & 3
\end{bmatrix}
\]

OR

(b') Find the characteristic equation of the matrix:

\[
A = \begin{bmatrix}
1 & 3 & 7 \\
4 & 2 & 3 \\
1 & 2 & 1
\end{bmatrix}
\]

Show that $A$ satisfies the characteristic equation and hence find the inverse of $A$.

2(a) In a parabola $r = \frac{2a}{1 + \cos \theta}$, prove that

(i) $\varphi = \frac{\pi}{2} - \frac{\theta}{2}$ and (ii) $p = a \sec \frac{\theta}{2}$.

(b) Trace the curve $(x^2 - 1)y^2 = x$ by discussing its salient features.

OR

Contd………2
(b’) Show that the asymptotes of the curve
\[(x^2 - y^2)(y^2 - 4x^2) + 6x^2 - 5x^2y - 2y^3 - x^2 + 3xy - 1 = 0\]
cut the curve in eight points which lie on the circle \[x^2 + y^2 = 1\].

3(a) If \[y = \frac{\sin^{-1}x}{\sqrt{1-x^2}}\], show that \[(1-x^2)y_{n+1} - (2n+1)xy_n - n^2y_{n-1} = 0\]. Hence find \(y_{n+1}\).

OR

(a’) Expand \(x^4 - 3x^3\) in powers of \(x - 2\) in Taylor’s series.

(b) (i) Test for convergence the series whose general term is \(\frac{3}{\sqrt{n^3 - 1}} - n\).
(ii) Test the convergence of the series
\[x + \frac{3}{5}x^2 + \frac{8}{10}x^3 + \frac{15}{17}x^4 + \cdots\], for \(x > 0\).

4(a) Show that the intrinsic equation of the parabola \(y^2 = 4ax\) is
\[s = a \cot \psi \cosec \psi + a \log(\cot \psi + \cosec \psi)\].

(b) Find the volume of the spindle shaped solid, generated by revolving the astroid \(x^{2/3} + y^{2/3} = a^{2/3}\) about the x-axis.

OR

(b’) The part of the parabola \(y^2 = 4ax\) cut off by the latus rectum, revolves about the tangent at vertex. Find the curved surface area of the reel thus generated.

5(a) Solve any two of the following differential equations:

(i) \[(x^3e^x - 2y^2)dx + 2xydy = 0\]
(ii) \[\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + 5y = e^{2x}\sin x\]
(iii) \[(x^2D^2 + 3xD + 5)y = 5(\log x)^2\]

(b) A body executes damped forced vibrations given by the equation:
\[\frac{d^2y}{dx^2} + 2k\frac{dy}{dx} + b^2x = e^{-kt}\sin \omega t\].

Solve the equation for both cases when \(\omega^2 \neq b^2 - k^2\), and when \(\omega^2 = b^2 - k^2\).
Maximum Marks: 60

1. (a) Write salient features and trace the conic
   \[ 16x^2 - 24xy + 9y^2 - 104x - 172y + 44 = 0 \]
   (b) Find the equation of the cone with vertex at the origin and passing through the curve \( x^2 + y^2 = 16, z = 3 \).

   OR

   (b') If PSP' and QSQ' are two perpendicular focal chords of a conic, prove that \( \frac{1}{PS \cdot PS'} + \frac{1}{QS \cdot SQ'} \) is constant.

2. (a) Show that for the surface
   \[ x^3y^3z^3 = C, \quad \frac{\partial^2 z}{\partial x \partial y} = -(x \log ex)^{-1} \] at the point \( x = y = z \).
   (b) If \( u = f(x, y) \) and \( x = r \cos \theta, \ y = r \sin \theta \) then,
   \[ \left( \frac{\partial u}{\partial x} \right)^2 + \left( \frac{\partial u}{\partial y} \right)^2 = \left( \frac{\partial u}{\partial r} \right)^2 + \frac{1}{r^2} \left( \frac{\partial u}{\partial \theta} \right)^2 \]

   OR

   (b') If \( u = \frac{x + y}{z}, \ v = \frac{y + z}{x}, \ w = \frac{y(x + y + z)}{xz} \), show that \( u, v, w \) are not independent and find the relation among them.

3. (a) Obtain Taylor’s expansion of the function \( f(x, y) = \tan^{-1} \left( \frac{y}{x} \right) \) about \((1, 1)\) upto
   and including the second degree terms.
   (b) Find the points on the surface \( z^2 = xy + 1 \) nearest to the origin.
4. (a) Find the volume of the cylinder \( x^2 + y^2 - ax = 0 \) bounded by the planes \( z = 0 \) and \( z = x \).

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

OR

(b') Find by double integration the area lying inside the circle \( r = a \sin \theta \) and outside the cardioid \( r = a \left(1 - \cos \theta \right) \).

5. (a) Given that \( f(x) = x + x^2 \) for \( -\pi \leq x \leq \pi \), find Fourier series expansion of \( f(x) \) and deduce that \( \frac{\pi^2}{6} = 1 + \frac{1}{2^2} + \frac{1}{3^2} + \frac{1}{4^2} \).

(b) Find the half-range cosine series for the function:

\[ f(x) = 2x - 1 \text{ for } 0 < x < 1. \]
1. (a) For what values of \( \lambda \) the following system of linear equations:
\[
\begin{align*}
  x + y + z &= 1, \\
  x + 2y + 4z &= \lambda, \\
  x + 4y + 10z &= \lambda^2
\end{align*}
\]
has a solution and solve them if possible. [5+5+5]

(b) Find the eigenvalues and eigen vectors of the matrix:
\[
\begin{bmatrix}
  2 & 2 & 1 \\
  1 & 3 & 1 \\
  1 & 2 & 2
\end{bmatrix}
\]

(c) Find the characteristic equation of the matrix:
\[
A = \begin{bmatrix}
  2 & 1 & 1 \\
  0 & 1 & 0 \\
  1 & 1 & 2
\end{bmatrix}
\]
and hence find the matrix represented by \( A^8 - 3A^7 + 7A^6 - 3A^5 + A^4 - 5A^3 + 9A^2 - A + 2I \)

OR

(c') State Cayley-Hamilton theorem and verify it for the matrix
\[
A = \begin{bmatrix}
  1 & -2 & 3 \\
  2 & 3 & -1 \\
  -3 & 1 & 2
\end{bmatrix}
\]
and hence obtain \( A^{-1} \).

2. (a) Trace the curve:
\[ y^2 (a+x) = (a-x) x^2 \]
by describing the salient features [5+5+5]

(b) If \( y = \sin (a \sin^{-1} x) \), prove that \((1-x^2) y_{n+2} - (2n+1) xy_{n+1} - (n^2 - a^2) y_n = 0\)

(c) If \( \log y = \tan^{-1} x \), find the coefficient of \( x^5 \) in the expansion of \( y \) by Maclaurin's series.

3. (a) Find the intrinsic equation of the semicubical parabola \( 3ay^2 = 2x^3 \). [7+8]

(b) Find the volume of the reel formed by the revolution of the cycloid \( x = a (\theta + \sin \theta), \ y = a (1- \cos \theta) \) about the tangent at the vertex.

OR

(b') The part of the parabola cut-off by the latus rectum revolves about the tangent at the vertex. Find the curved surface of the reel thus generated.
4. (a) Solve any three of the following:

(i) \[
\left[ y\left(1 + \frac{1}{x}\right) + \cos y \right] dx + \left[ x + \log x - x \sin y \right] dy = 0
\]

(ii) \[
\frac{d^2y}{dx^2} - 2 \frac{dy}{dx} + 5y = e^{2x} \sin x,
\]

(iii) \[
\frac{d^3y}{dx^2} + 4y = \sin^2 x + x^2 e^x,
\]

(iv) \[
x^2 \frac{d^2y}{dx^2} - x \frac{dy}{dx} - 3y = x^2 \log x.
\]

(b) Solve the following system of linear differential equations.

\[
\frac{dx}{dt} + 2x + 3y = 0,
\]

\[
\frac{dy}{dt} + 3x + 2y = 2e^{2t}.
\]

OR

(b') A body falling from rest is subjected to the force of gravity and an air-resistance proportional to the square of the velocity. If the resistance is equal to the weight of the body when the speed is \( b \). Show that the distance traveled by the body in \( t \) second is given by

\[
\frac{b^2}{g} \log \left( \cosh \frac{gt}{b} \right)
\]
2013-2014
B.TECH. AUTUMN (I SEMESTER) EXAMINATION
(ELECTRICAL / MECHANICAL / CIVIL / ELECTRONICS / COMPUTER / CHEMICAL /
PETRO-CHEMICAL ENGINEERING)
MATHEMATICS – II
(AM – 112)
Credits : 04

Maximum Marks: 60 Duration: Three Hours

Note: Answer ALL the questions.

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

(a') If \( z = x^2 + y^2 \), show that:
\[
\left( \frac{\partial z}{\partial x} - \frac{\partial z}{\partial y} \right)^2 = 4 \left( 1 - \frac{\partial z}{\partial x} \frac{\partial z}{\partial y} \right)
\]

(b) If \( x = r \sin \theta \cos \phi, \quad y = r \sin \theta \sin \phi, \quad z = r \cos \theta \), show that:
\[
\frac{\partial (x, y, z)}{\partial (r, \theta, \phi)} = r^2 \sin \theta
\]

(c) If \( z = f(x, y) \) and \( x = e^u + e^v \) and \( y = e^{-u} - e^v \), prove that:
\[
\frac{\partial z}{\partial x} - \frac{\partial z}{\partial y} = \frac{\partial z}{\partial x} + \frac{\partial z}{\partial y}
\]

2. (a) Expand \( f(x, y) = x^2y - 3y - 2 \) in powers of \((x - 1)\) and \((y + 2)\) using Taylor's theorem up to second degree terms.

(b) At a distance of 50 meters from the foot of a tower, the elevation of its top is \(30^\circ\). If the possible error in measuring the distance and the elevation are 2 cm and 0.05 degree respectively, find the approximate error in calculating the height.

OR

(b') Find the percentage error in the area of a rectangle when an error of +1 percent is made in measuring its length and breadth.

(c) In a triangle ABC, find the maximum value of \( \cos A \cos B \cos C \).

3. (a) Find the volume under the plane \( x + y + z = 6 \) and above the triangle in the xy-plane bounded by the lines \( 2x = 3y, \quad y = 0 \) and \( x = 3 \).

OR

(a') Evaluate the following integral by changing the order of integration:
\[
\int_0^2 \int_{\sqrt[3]{y^4 - a^2x^2}}^a \frac{y^2 \, dy \, dx}{\sqrt[3]{y^4 - a^2x^2}}
\]
(b) Evaluate, by using the transformation $x + y = u$, $y = uv$, the following integral:

$$\int_0^1 \int_0^{1-x} \frac{y}{e^{x+y}} dy dx$$

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

4. (a) Trace the conic:

$$x^2 + 24xy - 6y^2 + 28x + 36y + 16 = 0$$

Give its salient features.

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

$$\frac{1}{PS \cdot SP'} + \frac{1}{QS \cdot SQ'}$$

is constant.
2013-14
B.TECH. (AUTUMN SEMESTER) EXAMINATION
(Civil/Chemical/ Computer/ Electrical/ Electronics/ Mechanical/Petro-Chemical Engg.)
APPLIED PHYSICS-I
AP-101

Maximum Marks: 60
Credits: 03
Duration: Three Hours

Answer all the questions. Symbols used have their usual meaning.

1(a) Discuss direct and indirect band gap semiconductors with the help of E vs. k diagrams. [06]

1(b) What do you understand by intrinsic and extrinsic semiconductors? Draw energy bands for n and p-type semiconductors showing donor and acceptor levels. [05]

1(c) Ge is doped with $10^{18}$ Sb/cm$^3$ at 300 K, where is $E_F$ with respect to $E_i$? Also find minority carrier concentration. (Given: $k_B=1.38\times10^{-23}$ J/K, $n_i=2.5\times10^{13}$ cm$^{-3}$) [04]

OR

1(e') Write down expressions for $n_0$ and $p_0$ in terms of $n_i$. With the help of these expressions explain shifting of Fermi level with the doping concentrations. [04]

2(a) What are the postulates of special relativity? Derive formulae for relativistic length contraction and time dilation by using the Lorentz transformation and inverse Lorenz transformation respectively. [08]

2(b) Define ‘Poynting vector’ and write down Maxwell’s equation for electromagnetic waves. [04]

2(c) An electron with rest mass 0.511 MeV/c$^2$ and a photon with zero rest mass have momenta 2.000 MeV/c. Find the total energy of each. [03]

3(a) What do you mean by Compton effect? Obtain the expression for the Compton shift, i.e., $(\lambda' - \lambda) = (h/mc)(1 - \cos \theta)$. Plot the relative intensity versus wavelength graph for different angles of scattering observed in a Compton scattering experiment. [10]

3(b) What is pair production and pair annihilation? Mention essential conditions for pair production to occur. Show that pair production cannot take place in free place. [05]

OR

Contd.....2
3'(a) What is characteristic x-rays? Describe the construction of an x-ray tube and explain the production mechanism of continuous x-rays. How would you explain the presence of the minimum wavelength, \( \lambda_{\text{min}} \) in the continuous x-rays spectrum?

3'(b) An x-ray photon of initial frequency \(1.5 \times 10^{19}\) Hz emerges from a collision with an electron with a frequency of \(1.2 \times 10^{19}\) Hz. Find the kinetic energy imparted to the electron. (take \( h = 6.63 \times 10^{-34}\) J.s)

3'(c) State Heisenberg uncertainty principle. If uncertainty in the position of a particle is equal to its de-Broglie wavelength, show that the uncertainty in its velocity is equal its velocity.

4(a) Discuss the physical significance of a wave function and also mention the characteristics of a well behaved wave function. Establish the time dependent form of Schrödinger wave equation and hence obtain its steady state form.

4(b) Show that the expectation value, \( \langle x \rangle \) of the position of a particle trapped in a box \( L \) wide is \( L/2 \).

OR

4' What is tunnel effect? Obtain an expression for the approximate transmission probability, \( T \) of a particle of energy \( E \) incident on a barrier of height \( U \) such that \( E < U \)
2013-14
B.TECH. (AUTUMN SEMESTER) EXAMINATION
(Civil/Chemical/ Computer/ Electrical/ Electronics/ Mechanical/Petro-Chemical/Arch. Engg.)
APPLIED PHYSICS
AP-111

Maximum Marks: 60 Credits: 04 Duration: Three Hours

- Answer all the questions. Symbols used have their usual meaning.
- Some useful physical constants are given at the end of the question paper.

1(a) What is Hall effect? Obtain an expression for majority carrier concentration in terms of measurable parameters. Mention two important applications of Hall effect. [7.0]

OR

1(a') Starting with Fermi-Dirac distribution function and density of states in conduction band, derive an expression for equilibrium concentration of electrons ($n_0$). Also explain shifting of Fermi level with doping concentrations. [7.0]

1(b) Discuss Meissner effect with the help of suitable diagram. What are type-I and type-II superconductors? Why type-I superconductor is not useful for making electromagnet? [5.0]

1(c) A Si sample is doped with $5 \times 10^{17}$ cm$^{-3}$ donors and $2 \times 10^{17}$ cm$^{-3}$ acceptors. Find the position of the Fermi level with respect to $E_i$ at 300 K. [3.0]

2(a) Describe construction and working of He-Ne laser with the help of suitable diagrams. Mention one of the drawbacks of ruby laser. [6.0]

OR

2(a') What are the important characteristics of a laser? Discuss working principle of ammonia maser and its one important application. [06]

2(b) What is basic principle of e.m. wave propagation in an optical fiber? Obtain an expression for angle of acceptance in a step index optical fiber in terms of core and cladding refractive indices. [5.5]

2(c) A ruby laser emits 1.0 J pulses of light whose wavelength is 694.3 nm. What is the minimum number of Cr$^{3+}$ ions in the ruby? [3.5]

3(a) Explain Compton effect and deduce an expression for the change in wavelength of a [7.0]

Contd.......

2
photon scattered through an angle $\Phi$ by a particle of rest mass $m_0$.

Determine the energy of a photon if it is to have the momentum of a 10 MeV proton.

3(b) Define phase and group velocities. The phase velocity of ocean waves is $\sqrt{\frac{g\lambda}{2m}}$, where $g$ is the acceleration due to gravity. Find the group velocity of ocean waves.

3(c) Write down the time dependent form of the Schrödinger equation and hence obtain its steady state form.

Show that expectation value of the position of a particle trapped in a box $L$ wide is $L/2$.

4(a) Derive the expression for the molecular energy distribution for ideal gas molecules with energies between $\epsilon$ and $\epsilon + d\epsilon$ in a sample of the gas that contains $N$ molecules at absolute temperature $T$.

4(b) Write statistical distribution functions for classical and quantum mechanical particles.

Show that probability of occupancy of a quantum state by two bosons to be in the same state is twice that for two classical particles whereas it is zero for two fermions.

4(c) Define Q value and threshold energy of a nuclear reaction and obtain a mathematical relationship between these physical quantities for an endothermic nuclear reaction.

4(d) Draw a neat and labelled diagram of a gas filled detector and explain its working in different regions of operation.

---

**Some useful physical constants**

$h=6.63\times10^{-34} \text{ J.s}, \quad k_B=1.38\times10^{-23} \text{ J/K},$

$m_e=9.1\times10^{-31} \text{ kg}, \quad m_p=1.67\times10^{-27} \text{ kg}, \quad c=3\times10^8 \text{ m/s}$

$n_i(\text{Si})=1.5\times10^{16} \text{ m}^{-3} \quad q_e=1.6\times10^{19} \text{ C}$

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### B.Arch. (II SEMESTER) EXAMINATION
AR 103, Architectural Drawing-I
Credits: 4

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.**

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
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</table>
| 1     | Represent any two of the followings:-  
  a) Brick work (in box size 50 mm X 80 mm)  
  b) Plants in plan and elevation  
  c) Car in side elevation                                                                  | 5+5  |
| 2     | Draw orthographic projection of a hexagonal pyramid of base side 30mm & height 60mm resting on ground on one of its base edge in such a way that its central longitudinal axis is inclined at \(<45^0\) to ground level and edge touching ground is also inclined at \(<45^0\) to vertical plane. | 10   |
| OR    | Draw orthographic projection of a square prism of base side 30mm & height 60mm resting on ground on one of its base edge in such a way that its central longitudinal axis is inclined at \(<60^0\) to ground level and edge touching ground is inclined at \(<45^0\) to vertical plane. |      |
| 3     | Draw surface development of a sphere of diameter 60mm.                                                                                                                                                | 10   |
| 4     | Draw isometric view of the object shown in Figure -1                                                                                                                                                  | 10   |

Contd......2
FIGURE - 1
(All dimensions are in mm)
Maximum Marks:60  Credits:04  Duration: Three Hours

Note: (i) Answer all the questions.
(ii) Assume suitable data, if not given.

Q1(a). Briefly explain the following terms:
(i) Principle of superposition
(ii) Strain hardening

Q1(b). A steel rod of 20mm diameter passes centrally through a copper tube of 50mm external diameter and 40mm internal diameter. The tube is closed at each end by rigid plates of negligible thickness. The nuts are tightened on the projecting parts of the rod. If the temperature of the assembly is raised by 50°C, calculate the stresses developed in copper and steel. Take E for steel and copper as 200GN/m² and 100GN/m² and coefficient of thermal expansion for steel as 12 x 10⁻⁶ per °C and for copper as 18 x 10⁻⁶ per °C.

OR

Q1′(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.

Q1′(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 GPa.

Q2. 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.

OR

Q2′. In a certain material under load plane AB carries a tensile direct stress of 30MPa and a shear stress of 20MPa, while another plane BC carries a tensile direct stress of 20MPa and a shear stress. If the planes are inclined to one another at 30° and plane AC at right angles to plane AB carries a direct stress unknown in magnitude and nature (shown in Fig.2), find (a) the value of the shear stress on BC, (b) the magnitude and nature of the direct stress on AC, and (c) the principal stresses.
Q3. For the beam shown in Fig.3, draw the shear force and bending moment diagrams indicating the values at critical points. Also locate the point of contra flexure, if any. (12)

Q4(a). Enumerate the assumptions made in simple theory of bending. (03)

Q4(b). A beam of I-section 50cm deep and 20cm wide, has equal flanges 2cm thick and web 1cm thick. It carries at a cross-section a shear force of 200kN. Determine the shear stress distribution in the beam and the ratio of maximum shear to mean shear. (09)

OR

Q4'. 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. (12)

Q5. A solid aluminium shaft 100cm long and of 5cm diameter is to be replaced by a tubular steel shaft of the same length and the same outside diameter, so that either shaft could carry the same torque and have the same angle of twist over the total length. What must be the inner diameter of the tubular steel shaft? Modulus of rigidity of steel may be taken as 85GPa and that of Aluminium as 28GPa. (12)

FIGURES

![Figure 1](attachment:image1.png)

![Figure 2](attachment:image2.png)

![Figure 3](attachment:image3.png)
Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. | Question | M.M.
--- | --- | ---
1(a) | Draw the flow diagram of energy cycle and discuss the flow of energy in an ecosystem. | [05]
1(b) | Draw a flow diagram of carbon cycle and discuss the cycle in brief. | [05]
2(a) | Enlist the various segments of the environment and discuss any one in detail. | [05]
2(b) | Write short notes on any three of the following
   (i) Photochemical smog  
   (ii) Ozone Depletion  
   (iii) Biochemical Oxygen Demand  
   (iv) Gaseous analysis of $\text{SO}_2$ | [05]
3(a) | Describe briefly about the coagulation and flocculation process in water treatment. | [05]
3(b) | Design a sedimentation tank for a population of 10 thousand persons using 150 litres per day per person. | [05]
4(a) | A mixture of domestic wastewater and river water has a 5 day, $20^\circ\text{C}$ BOD of 15 mg/L. rate constant equal to 0.23/d. What will be its 3 day, $27^\circ\text{C}$ BOD? Using Streeter – Phelps equation plot the curve for DO concentration in the stream vs. time of travel in days. Assume: stream temperature $20^\circ\text{C}$, stream reaeration rate constant as 0.6/d, saturation DO as 8.0 mg/L and initial deficit as 2.0 mg/L. | [06]
4(b) What are low cost wastewater treatment systems?

5 (a) Define lapse rate and discuss their relationship with atmospheric stability.

5(b) Classify the particulate air pollutants.

OR

5'(b) Describe the working principle of centrifugal collector.

6(a) Describe the different functional elements of solid waste management.

OR

6'(a) How hazardous waste is classified? What are the different techniques adopted to manage hazardous waste?

6(b) Describe various disposal techniques for municipal solid waste and explain any one of them in detail.
1(a) A circuit consists of three branches connected in parallel across a 240V, 50 Hz supply. Branch 1 consists of 8 ohm resistor in series with a 200 μF capacitor, branch 2 consists of an inductor of 4Ω resistance and 20 mH inductance and branch 3 is a 10Ω resistor. Calculate,

1) The current in each branch.

2) The total current taken from the supply.

3) The overall power factor.

1(b) State Norton’s theorem and Thevenin’s theorem as applicable to a.c. circuit.

OR

1'(a) In the circuit of figure 1, determine the current through $Z_L$, using.

1) Thevenin’s theorem.

2) Norton’s theorem.

Figure 1
1'(b) Derive an expression that relates line and phase voltages for star connected load.

2(a) An iron magnetic circuit has a uniform cross sectional area of 5 cm$^2$ and a length of 25 cm. A coil of 120 turns is wound uniformly over the magnetic circuit. When the current in the coil is 1.5 A, the total flux is 0.3 mWb. For each value of current, calculate,
   1) The magnetizing force.
   2) The relative permeability of the iron.

2(b) A 40 kVA single phase transformer has iron losses of 800 W and copper losses of 1140 W when supplying its full load at unity power factor. Calculate the efficiency of the transformer at unity power factor at,
   1) Full load
   2) Half load

3(a) Define synchronous speed. A 6 pole alternator rotates at 1000 r.p.m. What is the frequency of the generated voltage?

3(b) Using suitable derivation explain how rotating magnetic field is produced in a three phase induction motor.

OR

3'(a) Explain why single phase induction motor is not self starting?

3'(b) Explain various methods to make the single phase induction motor self starting.

4(a) Explain the working of moving iron type instrument.

4(b) Describe the constructional details of single phase induction type energy meter.

OR

4'(a) Explain the working of PMMC type instrument. Why this is not suitable for AC measurement?

4'(b) Define in reference to measuring instrument,
   1) Deflecting torque
   2) Damping torque

5(a) Draw the layout of a power system indicating various voltage levels.

5(b) With the help of a suitable diagram explain the working of Nuclear power plant.
B.TECH/B.ARCH (AUTUMN SEMESTER) EXAMINATION
(Civil/Electrical/Electronics/Computer/Mechanical/Petrochemical/Chemical)
Basics of Electrical & Electronics Engineering
EE-111 (Part A & Part B)

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) For figure 1 given below, find the current through AB using superposition theorem. [05]

![ Circuit Diagram ]

1(b) An iron ring of 100 cm mean circumference is made from round iron of cross-section 10 cm². It’s relative permeability is 500. If a saw-cut 2 mm wide is made on it, determine the current required to produce a flux of 0.0012 Wb in the air gap. The number of turns is 200. [05]

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

OR

1(a) The load in each branch of a delta connected balanced three phase circuit consists of an inductance of 0.0318 H in series with a resistance of 10Ω. The balanced line voltage is 400 V at 50 Hz. Calculate the line current and the total power in the circuit. [05]

1(b) Explain how the effect of leakage flux in a transformer be represented by an equivalent leakage reactance. State the condition for maximum efficiency of a transformer. [05]

1(c) A 500 kVA single phase, 2000/200 V, 50 Hz transformer has a high voltage winding resistance of 0.2Ω and a leakage reactance of 0.4Ω. The low voltage winding resistance is 0.002Ω and the leakage reactance 0.008Ω. Find the equivalent winding impedance referred to the high voltage side and the low voltage side. [05]

2(a) Why is a single phase induction motor non self starting? Discuss working of a capacitor start capacitor run type single phase induction motor. [05]

Contd……2
2(b) With the help of a figure explain how power is measured using an electrodynamometer type wattmeter.

2(c) How are hydroelectric power plants classified? With the help of a figure explain a pumped storage hydroelectric power plant.

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

3(a) What are logic gates? Give circuit realization and truth table of OR, AND, NOT, NOR and NAND gates.

3(a') With the help of a neat diagram, explain the operation of a Bridge Rectifier. What is PIV for the diode used here.

3(b) Si- transistor with $\beta = 50$ is used in the circuit shown in Figure 2, determine (i) $I_{CQ}$ (ii) $V_{CEO}$ (iii) $I_{CST}$ (iv) $I_{BO}$

![Figure 2](image)

4(a) Explain the construction, working and characteristics of depletion mode MOSFET. Also explain the difference between enhancement and depletion MOSFET.

4(a') What are different characteristics of an ideal operational amplifier? Also explain the significance of virtual ground in an operational amplifier.

4(b) Design an operational amplifier circuit that will produce the output voltage $V_o = 0.5V_1 - 2V_2$. 

-------------------------------XXXXXXXXXXXXXXXXXXXXXXXXXX-------------------------------
UNIT - I

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

Unlike the scientist, the engineer is not free to select the problem which interests him, he must solve the problems as they arise, and his solutions must satisfy conflicting requirements. Efficiency costs money, safety adds complexity, performance increases weight. The engineering solution is the optimum solution, the most desirable end result taking into account many factors. It may be the cheapest for a given performance, the most reliable for a given weight, the simplest for a given safety, or the most efficient for a given cost. Engineering is optimizing.

To the engineer, efficiency means output divided by input. His job is to secure a maximum output for a given input or to secure a given output with a minimum input. The ratio may be expressed in terms of energy, materials, money, time or men. Most commonly the denominator is money, infact, most engineering problems are answered ultimately in dollars and cents. Efficient conversion is accomplished by using efficient methods, devices and personnel organizations.

The emphasis on efficiency leads to the large, complex operations which are characteristics of engineering. The processing of the new antibiotics and vaccines in the test-tube stage belongs in the field of biochemistry, but when great quantities must be produced at low cost, it becomes an engineering problem. It is the desire for efficiency and economy that differentiates ceramic engineering from the work of the potter, textile engineering from weaving, and agricultural engineering from farming.

(i) Identify the disciplines being compared in the passage.
(ii) What is meant by the expression ‘Engineering is optimizing’.
(iii) What is the rationale for efficiency?
(iv) Discuss how engineering problems arise.
(v) Make the following words negative – efficient, interest.

(b) Write a summary of the passage given above.
UNIT - II

2. (a) Elaborate in your works; The Time Traveller’s journey to the year 802701 AD.

OR

(a') Discuss the world of the Marlocks.

2. (b) Discuss the ‘Battle of the Windmill’.

OR

(b') Describe Old Major’s dream.

UNIT - III

3. Write the process of booking/purchasing an airline ticket via internet.

OR

3'. Write a report on your experience of the 1st Semester that you are completing at Zakir Husain College of Engineering and Technology, A.M.U.

UNIT - IV

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

A degree never came with the promise of a job. Now a study shows that 47% of graduates are not employable in any sector. Their poor English and cognitive skills are to be blamed. While one of two pass-outs will easily show off their theoretical skills, the number fails to just a quarter when knowledge must be applied.

In case of computer science/IT, 90% engineers do not know basic theoretical concepts used in computer programming, according to the latest Computer Programming Learning Levels, Engineering Graduates, 2013 report. The pan-India study examines the capability of engineering students in computer programming at the end of their undergraduate education. "Computer Programming skill is the key foundational skill required by the IT industry and also covered by academic curriculum. Yet, we find only 14.97% of IT specialization students can write a simple program, while 70% of them show theoretical understanding. Clearly, the problem is rote learning. This needs to be fixed," said Varun Aggarwal, co-Founder and CTO, of the company that carried out the study.

The Computer Programming Learning Levels, Engineering Graduates Annual Report, 2013 draws inference from data from more than 55,000 engineering students across India from over 250 engineering colleges. Since the advent of the software industry in India, there has been a constant requirement of sector specific talent for the IT industry. Computer programming and algorithm design are the most common denominators required vitaly amongst IT professionals. However, 50% to 60% of CS/IT engineers do not understand subtleties of programming concepts, while more than 80% are unable to apply them to real-world situations. Only 14.97% of the engineers are able to do application of programming constructs, which are of routine use in the industry, the study noted.

"When we look at advanced areas of programming like algorithm design such as complexity theory, around 50% CS/IT engineering students do not know basic terminologies and definitions in these areas. In terms of complexity theory and application based knowledge of CS/IT engineering students, the percentage drops to a dismal 13.65," the report said.
UNIT – V

5. (a) Complete the following by choosing the appropriate words from the given list:

The researcher in the field of economics who investigates the phenomenon of ______, which leads emerging countries to rely almost exclusively on the export of raw materials for their foreign ______, often finds that for this reason and also to satisfy the growing demands caused by ______, both the ______ of crops and breeders of animals tend to over ______ the land.

[exchange, over population, industrialization, cultivators, cultivate]

(b) Write an essay on any ONE of the following topics in about 400 words:

(i) Technology and adolescent trends.

(ii) My favorite sport.
B.TECH. (AUTUMN SEMESTER) EXAMINATION
CIVIL/CHEMICAL/COMPUTERS/ELECTRICAL/ELECTRONICS/
MECHANICAL/PETRO-CHEMICAL
THERMAL SCIENCES
ME101

Maximum Marks: 60  Credits: 04  Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.
Use of Steam Tables is permissible.

Q.No.  Question  M.M.

1(a) Find pressures (absolute) \( p_1, p_2 \) and \( p_3 \) if \( p_{\text{atm}} = 740 \) mm of Hg in the figure given below.

1(b) For a system to be in thermodynamic equilibrium, do the temperature and pressure have to be the same everywhere?

1(c) What are the different types of systems? Give an example for each type.

2(a) Apply SFEE to adiabatic nozzle and hence define stagnation enthalpy.

Contd......2
2(b) A gas flows steadily through a rotary compressor. The gas enters the compressor at a temperature of 16 °C, a pressure of $100 \times 10^3$ N/m$^2$ and an enthalpy of $391.2 \times 10^3$ J/kg. The gas leaves the compressor at a temperature of 245 °C, a pressure of $600 \times 10^3$ N/m$^2$ and an enthalpy of $534.5 \times 10^3$ J/kg. There is no net heat transfer to or from the gas as it flows through the compressor.

(i) Evaluate the external work done per unit mass of gas assuming the gas velocities at entry and exit to be negligible.

(ii) Evaluate the external work done per unit mass of gas when the gas velocity at entry is 80 m/s and that at exit is 160 m/s.

OR

2'(a) With the help of sketches, precisely describe the working of a 4-stroke IC engine.

2'(b) A piston-cylinder device shown in the figure contains 50 kg of water at 250 kPa and 25 °C. The cross-sectional area of the piston is 0.1 m$^2$. Heat is now transferred to the water, causing part of it to evaporate and expand. When the volume reaches 0.2 m$^2$, the piston reaches a linear spring whose spring constant is 100 kN/m. More heat is transferred to the water until the piston rises 20 cm more. Show the process on a $P$-$V$ diagram and determine

(i) The final pressure and temperature

(ii) The work done during this process.

3 A refrigerant is at a pressure of 0.745 MN/m$^2$ and has a temperature of 45 °C. It is cooled at constant pressure until it becomes liquid at saturation temperature. It is then throttled down to a pressure of 0.219 MN/m$^2$. Determine

(i) the heat transfer during the constant pressure cooling process per kilogram of refrigerant

(ii) the quality of the refrigerant after throttling

Use the data given below:

<table>
<thead>
<tr>
<th>Pressure MN/m$^2$</th>
<th>Saturation temperature °C</th>
<th>Specific enthalpy (kJ/kg)</th>
<th>Superheated by 20 K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$h_f$</td>
<td>$h_{fg}$</td>
</tr>
<tr>
<td>0.219</td>
<td>-10</td>
<td>26.9</td>
<td>183.2</td>
</tr>
<tr>
<td>0.745</td>
<td>30</td>
<td>64.6</td>
<td>199.6</td>
</tr>
</tbody>
</table>
3'(a) Draw $p\sim v$ diagram for a pure substance that contracts on freezing (normal behaviour), marking clearly all salient points and boundaries.

3'(b) The properties of a certain fluid are related as follows

$$ u = 196 + 0.718T $$
$$ pv = 0.287(T + 273) $$

where $u$ is the specific internal energy (kJ/kg), $T$ is in °C, $p$ is pressure (kN/m²) and $v$ is specific volume (m³/kg). For this fluid, find $C_v$ and $C_p$.

4 A vapour-compression refrigerator uses methyl-chloride as the working fluid. The fluid flows steadily into the compressor at a pressure of $119 \times 10^3$ N/m² and is delivered to the condenser as dry saturated vapour at a pressure of $653 \times 10^3$ N/m². The fluid leaves the condenser as saturated liquid at a pressure of $653 \times 10^3$ N/m² and after expansion in the throttle valve to pressure of $119 \times 10^3$ N/m², it flows through the evaporator and thence back into the compressor again. The compression process may be assumed to be reversible and adiabatic and the throttling process to be adiabatic. Changes in kinetic energy and in elevation are negligible.

(a) Evaluate the dryness fraction of the fluid entering the compressor and hence the shaft work done per unit mass of refrigerant.

(b) Evaluate the dryness fraction of the fluid after the throttling process.

(c) Evaluate the heat transfer per unit mass to the refrigerant in the evaporator.

(d) Evaluate the coefficient of performance of the refrigerator and compare it with the value for a reversed Carnot cycle operating between the given temperature limits.

Use the data for methyl-chloride given below:

<table>
<thead>
<tr>
<th>Pressure N/m²</th>
<th>Saturation temperature °C</th>
<th>Specific enthalpy kJ/kg</th>
<th>Specific entropy kJ/kg-K</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Saturated liquid</td>
<td>Saturated vapour</td>
</tr>
<tr>
<td>$119 \times 10^3$</td>
<td>-20</td>
<td>30.1</td>
<td>455.2</td>
</tr>
<tr>
<td>$653 \times 10^3$</td>
<td>30</td>
<td>108.6</td>
<td>478.7</td>
</tr>
</tbody>
</table>

OR

Contd......4
4'(a) Establish the relation \( S_2 - S_1 = \int_1^2 \left( \frac{dQ}{T} \right) \) and hence deduce the principle of increase of entropy.

4'(b) Prove that a PMM2 does not exist.

5(a) A composite wall is made up of an external surface of brick 110 mm thick, inside which is a layer of fibreglass 75 mm thick. The fibreglass is faced internally by an insulating board 25 mm thick. The thermal conductivities for the three materials are 0.6 (brick), 0.04 (fibreglass) and 0.06 (insulating board) W/m-K. The inside and outside air heat transfer coefficients are 2.5 W/m\(^2\)-K and 3.1 W/m\(^2\)-K. Determine the heat lost per hour through such a wall which is 6 m high and 10 m long. Take the internal and external ambient temperatures as 27 °C and 10 °C respectively.

5(b) Define, absorptivity, emissivity, grey body and Kirchoff's identity.
Q.No. | Question                                                                                                                                                                                                 | M.M.
---|---
1  | Construct a diagonal scale to measure kilometres, hectometres and decametres to a scale 1:50000 and measure on it a length of 9 kilometres, 6 hectometres and 5 decametres. | [10]
2  | The plan of a line CD is 35mm long and inclined at 30° to the V.P. The line is 50mm long. The end C is 10mm above of H.P. and 15mm in front of V.P. Draw the projections of the line. Find its true inclination with the V.P., H.P. and P.P. | [10]
2' | Draw the projections of a pentagonal plane of side 30mm resting on H.P. on one of its edge. Its surface is inclined at 30 degrees to the H.P. and the resting edge is making an angle of 45 degrees with the V.P. | [10]
3  | Draw the plan and the elevation of the object shown in figure 1. Give all its dimensions.                                                                                                                                                               | [10]
3' | Draw the half sectional elevation and the plan of the bushed bearing shown in figure 2, showing the dimensions.                                                                                                                                       | [10]
The front view of an object is given in figure 3. Draw its isometric projection.
A 110 N force acting in a vertical plane parallel to the \( yz \) plane is applied to the 220 mm long horizontal handle \( AB \) of a socket wrench. Replace the force with an equivalent force couple system at the origin \( O \) of the coordinate system. (Figure-1)

The rectangular plate shown weighs 300 N and is held in the position shown (Figure-2) by hinges at \( A \) and \( B \) and by cable \( EF \). Assuming that the hinge at \( B \) does not exert any axial thrust, determine (a) the tension in the cable, (b) the reactions at \( A \) and \( B \).

**OR**

Gear \( C \) is rigidly attached to arm \( AB \). If the forces and couple shown (Figure-3) can be reduced to a single equivalent force at \( A \), determine the equivalent force and the magnitude of the couple \( M \).

Knowing that \( P = 100 \) N, determine the range of values of \( \theta \) for which equilibrium of the 7.5 kg block is maintained. (Figure-4)

The mechanism shown (Figure-5) is acted upon by the force \( P \); derive an expression for the magnitude of the force \( Q \) required for equilibrium.
2.(b) Determine the moment of inertia and radius of gyration of the shaded area shown in Figure-6 with respect to the x axes.

OR

2.(b') Locate the centroid of the plane area shown. (Figure-7)

3.(a) The system shown (Figure-8), consisting of a 20 kg collar A and a 10 kg counterweight B, is at rest when a constant 500 N force is applied to collar A. Determine the velocity of A just before it hits the support at C.

3.(b) A 1.5 kg collar is attached to a spring and slides without friction along a circular rod in a horizontal plane (Figure-9). The spring has an undeformed length of 150 mm and a constant $k = 400 \text{ N/m}$. Knowing that the collar is in equilibrium at A and is given a slight push to get it moving, determine the velocity of the collar (a) as it passes through B, (b) as it passes through C.

OR

3.(b') A homeowner uses a snowblower to clear his driveway (Figure-10). Knowing that the snow is discharged at an average angle of 40° with the horizontal, determine the initial velocity $v_0$ of the snow.

4.(a) A system consists of three particles $A$, $B$, and $C$ (Figure-11). We know that $m_A = 3 \text{ kg}$, $m_B = 2 \text{ kg}$, and $m_C = 4 \text{ kg}$ and that the velocities of the particles expressed in m/s are, respectively, $v_A = 4i + 2j + 2k$, $v_B = 4i + 3j$, and $v_C = -2i + 4j + 2k$. Determine the angular momentum $H_0$ of the system about $O$.

4.(b) Two hemispheres are held together by a cord which maintains a spring under compression (the spring is not attached to the hemispheres) (Figure-12). The potential energy of the compressed spring is 120 J and the assembly has an initial velocity $v_0$ of magnitude $v_0 = 8 \text{ m/s}$. Knowing that the cord is severed when $\theta = 30^\circ$, causing the hemispheres to fly apart, determine the resulting velocity of each hemisphere.

Contd......3
(a) Small wheels have been attached to the ends of rod $AB$ and roll freely along the surfaces shown (Figure-13). Knowing that wheel $A$ moves to the left with a constant velocity of 1.5 m/s, determine (a) the angular velocity of the rod (b) the velocity of end $B$ of the rod.

OR

(b) In the position shown (Figure-14), bar $AB$ has an angular velocity of 4 rad /s clockwise. Determine the angular velocity of bars $BD$ and $DE$.

(b) An automobile travels to the left at a constant speed of 77.4 km/h (Figure-15). Knowing that the diameter of the wheel is 560 mm, determine the acceleration (a) of point $B$, (b) of point $C$, (c) of point $D$.

FIGURE ENCLOSED

Contd.....4
Q. No. 1. Two tape spools shown in Fig. 1 are attached to an axle supported by bearings at A and D. The radius of spool B is 30 mm and the radius of spool C is 40 mm. Knowing that $T_B = 80$ N and that the system rotates at a constant rate, determine the reactions at A and D. Assume that the bearing at A does not exert any axial thrust and neglect the weights of the spools and axle.

Fig. 1

OR

1'(a) Wire is being drawn at a constant rate from a spool by applying a vertical force $P$ to the wire as shown in Fig. 2. The spool and the wire wrapped on the spool have a combined weight of 20 N. Knowing that the coefficients of friction at both A and B are $\mu_s = 0.40$ and $\mu_k = 0.30$, determine the required magnitude of the force $P$.

Fig. 2
1(b) For the linkage shown in Fig. 3, determine the couple $M$ required for equilibrium when $l = 1.8 \text{ m}$, $Q = 40 \text{ N}$, and $\theta = 65^\circ$.

![Fig. 3]

2(a) Water flows from a drain spout with an initial velocity of $0.75 \text{ m/s}$ at an angle of $15^\circ$ with the horizontal (Fig. 4). Determine the range of values of the distance $d$ for which the water will enter the trough $BC$.

![Fig. 4]

2(b) A 4 kg collar $C$ as shown in Fig. 5 slides on a horizontal rod between spring $A$ and $B$. If the collar is pushed to the right until spring $B$ is compressed 50 mm and released, determine the distance through which the collar will travel, assuming (a) no friction between the collar and the rod, (b) a coefficient of friction $\mu_s = 0.35$.

![Fig. 5]

OR
2(a) The masses of blocks A, B, and C shown in Fig. 6 are $m_A = 4$ kg, $m_B = 10$ kg, and $m_C = 2$ kg. Knowing that $P = 0$ and neglecting the masses of the pulleys and the effect of friction, determine (a) the acceleration of each block, (b) the tension in the chord.

![Fig. 6](image)

2(b) A system shown in Fig. 7 consists of three particles A, B and C. We know that $m_A = 3$ kg, $m_B = 2$ kg, and $m_C = 4$ kg and that the velocities of the particles expressed in m/s are, respectively, $v_A = 4i + 2j + 2k$, $v_B = 4i + 3j$, and $v_C = -2i + 4j + 2k$. Determine the angular momentum $H_0$ of the system about O.

![Fig. 7](image)

3(a) Two blocks and a pulley are connected by inextensible cords as shown in Fig. 8. The pulley has an initial angular velocity of 0.8 rad/s counter clockwise and a constant angular acceleration of 1.8 rad/s² clockwise. After 5 seconds of motion, determine the velocity and position of (a) block A, (b) block B.

![Fig. 8](image)

Contd.....4
3(b) Small wheels have been attached to the ends of rod AB and roll freely along the surface shown in Fig. 9. Knowing that wheel A moves to the left with a constant velocity of 1.5 m/s, determine (a) the angular velocity of the rod. (b) the velocity of end B of the rod.

4(a) Draw the stress-strain curve for mild steel and show the different points on it.

4(b) In a statically determinate structure (Fig. 10), determine the final stresses in each bar. Given:

\[ \alpha_{te} = \alpha_s = 12 \times 10^{-6} ^\circ C \]

\[ E_s = 2E_{te} = 2 \times 10^5 \text{ N/mm}^2 \]

\[ A_{te} = A_{te} = 2A_s = 12000 \text{ mm}^2 \]

\[ L_{te} = L_{te} - L_s = 1000 \text{ mm} \]

Applied load = 800 N (compressive)

Temperature is increased by 40°C.

4'(b) Determine the final stresses for the structure as shown in Fig. 11.

Temperature decreases by 40°C.

\[ \alpha_{te} = \alpha_s = 12 \times 10^{-6} ^\circ C \]

\[ E_s = 2E_{te} = 2 \times 10^5 \text{ N/mm}^2 \]

\[ L_{te} = L_{te} - L_s = 1000 \text{ mm} \]
$A_{cu1} = A_{cu2} = 2A_s = 12000\text{mm}^2$

$P =$ Applied load at fixed ends is 800 N (compressive)

5 Determine the SF and BM (Fig. 12) and draw SFD and BMD. [12]

$3\text{KN}$

$8\text{KN}$

$3\text{KN}$

Fig. 12

OR

5' Determine the bending stresses for the beam as shown in Fig. 12 and Fig. 13. Draw the bending stress diagram also. [12]