ਆਈ.ਕੇ. ਗੁਜਰਾਲ ਪੰਜਾਬ ਟੈਕਨੀਕਲ ਯੂਨੀਵਰਸਿਟੀ
(ਅਕਾਦਮਿਕ ਵਿਭਾਗ)

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ਡਾਇਰੈਕਟਰ / ਪ੍ਰਿੰਸੀਪਲ / ਫੈਕਲਟੀ ਇੰਚਾਰਜ
ਸਮੂਹ ਖੇਤਰੀ ਕੈਂਪਸ ਅਤੇ ਐਫੀਲੇਟਿਡ ਕਾਲਜ
ਆਈ.ਕੇ.ਗੁਜਰਾਲ ਪੰਜਾਬ ਟੈਕਨੀਕਲ ਯੂਨੀਵਰਸਿਟੀ।

ਵਿਸ਼ਾ :- ਬੀ.ਟੈਕ. ਸਮੈਸਟਰ ਪਹਿਲਾ ਅਤੇ ਦੂਜਾ ਬੈਚ 2018 ਦੇ ਮਾਡਲ ਪ੍ਰਸ਼ਨ ਪੱਤਰ ਸਮੇਤ ਉੱਤਰ ਕੁੰਜੀਆਂ ਭੇਜਣ ਸਬੰਧੀ।

ਉਪਰੋਕਤ ਵਿਸ਼ੇ ਦੇ ਸਬੰਧ ਵਿੱਚ ਆਪ ਜੀ ਨੂੰ ਬੀ.ਟੈਕ. ਸਮੈਸਟਰ ਪਹਿਲਾ ਅਤੇ ਦੂਜਾ ਬੈਚ 2018 ਦੇ ਮਾਡਲ ਪ੍ਰਸ਼ਨ ਪੱਤਰ ਸਮੇਤ ਉੱਤਰ ਕੁੰਜੀਆਂ ਇਸ ਪੱਤਰ ਨਾਲ ਨੱਥੀ ਕਰਕੇ ਭੇਜੀਆਂ ਜਾਂਦੀਆਂ ਹਨ। ਆਪ ਜੀ ਨੂੰ ਬੇਨਤੀ ਕੀਤੀ ਜਾਂਦੀ ਹੈ ਕਿ ਇਹ ਮਾਡਲ ਪ੍ਰਸ਼ਨ ਪੱਤਰ ਸਮੇਤ ਉੱਤਰ ਕੁੰਜੀਆਂ ਸਬੰਧਤ ਵਿਦਿਆਰਥੀਆਂ ਅਤੇ ਅਧਿਆਪਕਾਂ ਤੱਕ ਪੁੱਜਦੇ ਕੀਤੇ ਜਾਣ ਤਾਂ ਜ਼ੋ ਸਬੰਧਤ ਵਿਦਿਆਰਥੀ ਇਮਿਤਹਾਨਾਂ ਦੀ ਤਿਆਰੀ ਸੁਚੱਜੇ ਢੰਗ ਨਾਲ ਕਰ ਸਕਣ। ਇਸ ਸਬੰਧੀ ਕਿਸੇ ਵੀ ਪ੍ਰਕਾਰ ਦੇ ਸੁਝਾਅ / ਫੀਡਬੈਕ ਯੂਨੀਵਰਸਿਟੀ ਦੇ ਅਕਾਦਮਿਕ ਵਿਭਾਗ ਨੂੰ ਭੇਜੇ ਜਾ ਸਕਦੇ ਹਨ।

ਨੱਥੀ : ਉਕਤ ਅਨੁਸਾਰ।

(ਡਾ. ਬਲਕਾਰ ਸਿੰਘ)
ਡਾਇਰੈਕਟਰ ਅਕਾਦਮਿਕ
ਜਗਦੇਵ ਸਿੰਘ SA

ਇਸ ਦਾ ਇੱਕ ਉਤਾਰਾ :

1. ਇੰਚਾਰਜ ਸਕੱਤਰੇਤ ਉਪ ਕੁਲਪਤੀ ਜੀ ਨੂੰ ਸੂਚਨਾ ਹਿੱਤ।
2. ਕੰਟਰੋਲਰ ਪ੍ਰੀਖਿਆਵਾਂ ਜੀ ਨੂੰ ਬੀ.ਟੈਕ. ਸਮੈਸਟਰ ਪਹਿਲਾ ਅਤੇ ਦੂਜਾ ਬੈਚ 2018 ਦੇ ਮਾਡਲ ਪ੍ਰਸ਼ਨ ਪੱਤਰ ਸਮੇਤ ਉੱਤਰ ਕੁੰਜੀਆਂ ਇਸ ਪੱਤਰ ਨਾਲ ਨੱਥੀ ਕਰਕੇ ਸੂਚਨਾ ਅਤੇ ਲੋੜੀਂਦੀ ਕਾਰਵਾਈ ਹਿੱਤ ਭੇਜੇ ਜਾਂਦੇ ਹਨ ਜੀ।
3. ਡਿਪਟੀ ਕੰਟਰੋਲਰ, ਗੁਪਤ ਵਿਭਾਗ (Confidential Branch) ਜੀ ਨੂੰ ਸੂਚਨਾ ਅਤੇ ਲੋੜੀਂਦੀ ਕਾਰਵਾਈ ਹਿੱਤ।
4. ਡਿਪਟੀ ਕੰਟਰੋਲਰ, ਆਈ.ਟੀ.ਐਸ. ਵਿਭਾਗ ਨੂੰ ਯੂਨੀਵਰਸਿਟੀ ਵੈਬਸਾਈਟ "ਨੋਟਿਸ ਬੋਰਡ" ਉਪਰ ਅਪਲੋਡ ਕਰਨ ਹਿੱਤ ਭੇਜੇ ਜਾਂਦੇ ਹਨ ਜੀ।

(ਡਾ. ਬਲਕਾਰ ਸਿੰਘ)
ਡਾਇਰੈਕਟਰ ਅਕਾਦਮਿਕ
ਜਗਦੇਵ ਸਿੰਘ SA

INSTRUCTIONS TO EXAMINER FOR PAPER- SETTING
B.TECH (ENGINEERING CHEMISTRY)

I. **Section A** will be One Compulsory question (consisting of short answer type questions [1(a)-(j)] covering whole syllabus. There will be no choice in this question. It will be of 20 marks comprising of **10 questions of 2 marks each**.

II. **Section B** will be comprising of four questions [2-5] (two from chapter 1 and one each from chapter 2 and 3) carrying **8 marks** each.

III. **Section C** will be comprising of four questions [6-9] (one each from chapter 4, 5, 6 and 7) carrying **8 marks** each.

IV. Students will have to attempt a total of **five** questions from **Section B & C**, attempting at least two questions from each of section B & C.

ENGINEERING CHEMISTRY
Model Question Paper

Time: 3 Hours **Max Marks:60**

Instructions to Candidates:

1. Section A is compulsory (Each carries 2 marks).
2. Section B & C have FOUR Questions each.
3. Attempt FIVE questions from Sections B & C attempting at least two from each section. (Each carries 8 marks).

Section-A

1.(a) Why is TMS used as internal standard reference in NMR spectroscopy? [2]

(b) Why do transition metals form colored complexes? [2]

(c) Define Huckel Rule and give its significance. [2]

(d) What is the effect of doping on the band structure of semiconductors. [2]

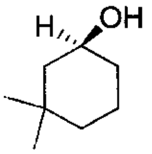
(e) How can a gas be liquified? [2]

(f) Define chromophore. Give two examples. [2]

(g) Why AgI_2^- complex is stable but AgF_2^- complex is not. [2]

(h) Which of the following molecules are chiral? [2]
(a) 3-Bromopentane (b) 1,3-Dibromopentane (c) 3-Methylhex-1-ene (d) *cis*-1,4-Dimethylcyclohexane

(i) Assign *R* or *S* configuration to the chiral center in each molecule [2]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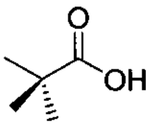
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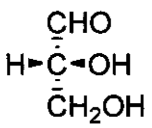
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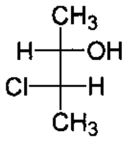
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(j) Why enthalpy is considered more useful than internal energy in chemical reactions? [2]

Section-B

2.(a) Draw molecular orbitals for 1,3-butadiene. [4]

(b) Calculate CFSE and magnetic behavior for the following complexes; [2]
(a) $[Co(CN)_6]^{3-}$ (b) d^8 Tetrahedral.

(c) Compare the stability of N_2, N_2^+ and N_2^{2-}. [2]

3. Derive quantum mechanical expression for the motion of a particle in a 1-D box. Also give important results from the treatment. [8]

4. Derive expression for rotational energies of diatomic molecule. What type of rotational spectrum will be obtained and how does the intensity of these lines vary? [8]

5.(a) What are the reasons for the deviation of real gases from ideal gas behavior? How were they modified in Van der Waal's equation? [4]

(b) Explain the different types of intermolecular forces. [4]

Section-C

6.(a) Calculate the equilibrium constant for the reaction. [4]

$$Sn^{2+}(aq) + Pb(s) \longrightarrow Sn(s) + Pb^{2+}(aq) \text{ at } 298\text{ K}$$

Given $E^{o}(Sn^{2+}/Sn) = -0.14$ V, $E^{o}(Pb^{2+}/Pb) = -0.13$ V

(b) Discuss the cation and anion exchange resins and their usefulness for water softening. [4]

7.(a) What do you understand by electron affinity? Why the electron affinity of fluorine is less than that of chlorine. [4]

(b) What is ionization energy? Why the second ionization energy of Na is higher than magnesium. [4]

8. Explain the following terms [8]

(i) Enantiomerism (ii) Diastereomerism (iii) Mesocompounds (iv) Optical activity

9. Explain the mechanism of [8]

(i) Hydration of alkene (ii) S_N1 reaction

ENGINEERING CHEMISTRY

Answer Key

Section-A

1.(a) Why is TMS used as internal standard reference in NMR spectroscopy? [2]

A: (i) TMS shows sharp peak due to the presence of 12 H atoms which are equivalent.

(ii) TMS is chemically inert

(iii) It is miscible with almost all organic solvents

(iv) TMS has low boiling point (27°C), so it can be removed from a compound easily.

(b) Why do transition metals form colored complexes? [2]

A: The color of coordination complexes in transition metals arises from electronic transitions between levels whose spacing corresponds to the wavelengths available in the visible light. In complexes, these transitions are frequently referred to as d-d transitions because they involve the orbitals that are mainly d in character (for examples: t_{2g} and e_g for the octahedral complexes and e and t_2 for the tetrahedral complexes). Complexes that contain metal ions of d^0 and d^{10} electron configuration are usually colorless while that having d^1-d^9 configuration are colored. The colors exhibited are intimately related to the magnitude of the spacing between these levels, which further depends on factors such as the geometry of the complex, the nature of the ligands, and the oxidation state of the central metal atom.

(c) Define Huckel Rule and give its significance. [2]

A: Huckel's rule states that a planar, cyclic, conjugated molecule is aromatic if it contains $4n + 2$ π electrons, where $n = 0$ or any positive integer.

Huckel's Rule can be used to predict the aromaticity of a compound. For example, the benzene molecule, which has 3 π bonds or 6 π electrons, is aromatic.

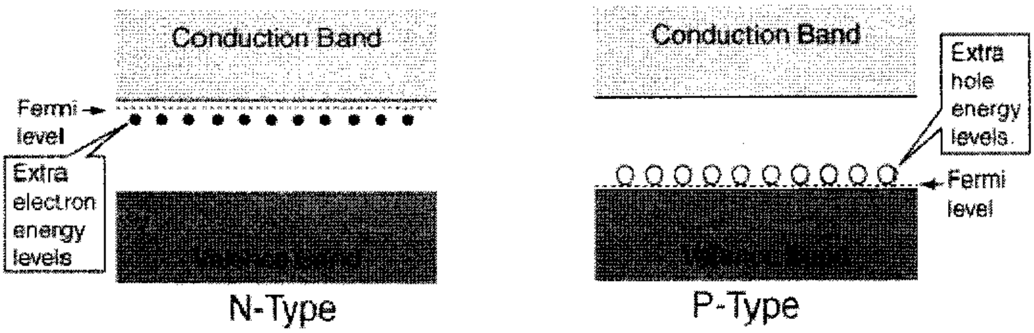
- Number of π electrons $= 4n + 2$
- $6 = 4n + 2$
- $n = 1$

However, 1,3,5,7-cyclooctatetraene, which has 4 π bonds or 8 π electrons, is nonaromatic as

- Number of π electrons $= 4n + 2$
- $8 = 4n + 2$
- $n = 1.5$

(d) What is the effect of doping on the band structure of semiconductors. [2]

A: The doping in semiconductors by addition of n-type and p-type semiconductors impurities show the presence of extra levels, been added by the impurities. In n-type materials there are electron energy levels near the top of the band gap so that they can be easily excited into the conduction band. In p-type material, extra holes in the band gap allow excitation of valence band electrons, leaving mobile holes in the valence band.



N-Type P-Type

(e) How can a gas be liquified? [2]

A: The gases can be converted into liquids by bringing its particles closer, which can be done by either of the two ways as:

1) by decreasing temperature, e.g. Methane gas is processed into LNG by cooling it to −161°C.

2) by increasing pressure.

(f) Define chromophore. Give two examples. [2]

A: Chromophore is defined as a functional group which shows characteristic absorption in ultra-violet region and which may or may not impart a color to compound. For example: nitro group and carbonyl group.

(g) Why AgI_2^- complex is stable but AgF_2^- complex is not. [2]

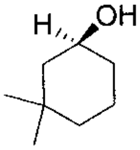
A: Ag^+ ion is a soft acid. Its interaction with I^- ion, soft base, yields a stable complex AgI_2^- whereas its interaction with F^- ion, a hard base, yields an unstable complex, AgF_2^-

Ag^+	+	$2I^-$	$\longrightarrow$	AgI_2^-
Soft acid		Soft base		Stable complex
Ag^+	+	$2F^-$	$\longrightarrow$	AgF_2^-
Soft acid		Hard base		Unstable complex

(h) Which of the following molecules are chiral? [2]
(a) 3-Bromopentane (b) 1,3-Dibromopentane (c) 3-Methylhex-1-ene (d) *cis*-1,4-Dimethylcyclohexane

A: (b) and (c) because both of these molecules contain a chiral centre.

(i) Assign *R* or *S* configuration to the chiral center in each molecule [2]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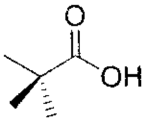
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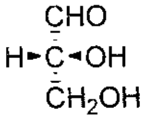
$$\begin{array}{c} CHO \\ H\text{–}C\text{–}OH \\ CH_2OH \end{array}$$
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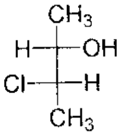
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A: (i) S (ii) Achiral (iii) R (iv) 2S. 3S

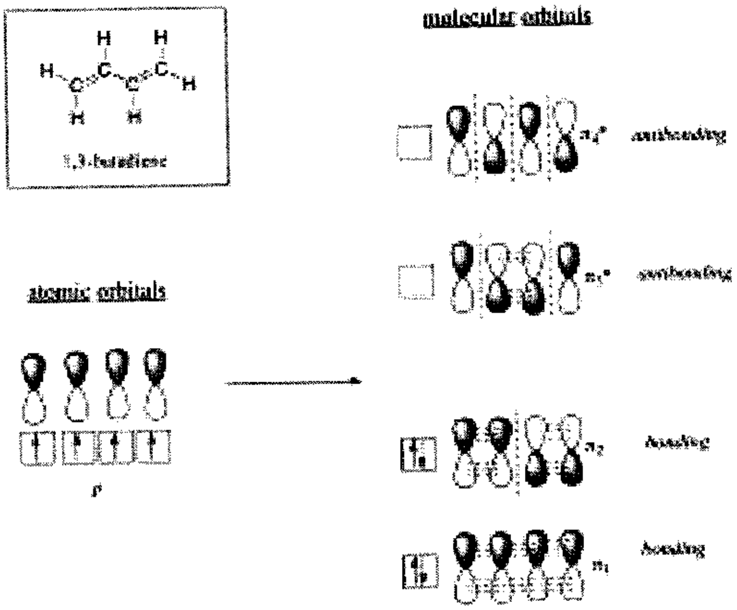
(j) Why enthalpy is considered more useful than internal energy in chemical reactions? [2]

A: Internal energy (U) and enthalpy (H) are measured by keeping constant volume and pressure respectively. Since most of reactions occur under atmospheric pressure, so enthalpy is more useful than internal energy in chemical reactions.

Section-B

2.(a) Draw molecular orbitals for 1,3-butadiene. [4]

A:
1. 1,3-Butadiene contains two double bonds that are conjugated.
2. It is built from 4 sp^2 hybridsed C atoms, each contributing a p atomic orbital containing 1 electron.
3. A set of 4 π molecular orbitals are obtained on overlapping of 4 atomic orbitals, two of which are BMOs and two are ABMOs
4. The lowest energy molecular orbital, π_1, has only constructive interaction and zero nodes. Higher in energy, but still lower than the isolated *p* orbitals, the π_2 orbital has one node but two constructive interactions - thus it is still a bonding orbital overall. The two antibonding orbitals, π_3* has two nodes and one constructive interaction, while π_4* has three nodes and zero constructive interactions.



(b) Calculate CFSE and magnetic behavior for the following complexes; [2]

i. $[Co(CN)_6]^{3-}$

ii. d^8 Tetrahedral.

A: i. $[Co(CN)_6]^{3-}$ CFSE = -24Dq + 2P; Complex is diamagnetic

ii. d^8 Tetrahedral CFSE = -8Dq ; Complex is paramagnetic.

*Students are advised to draw CFS diagrams and then calculate CFSE.

(c) Compare the stability of N_2, N_2^+ and N_2^{2-}. [2]

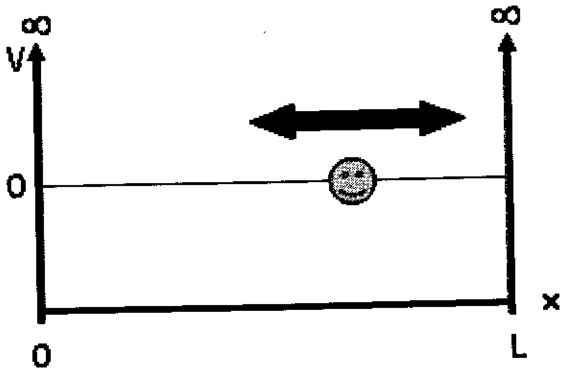
A: Bond Order of N_2, N_2^+ and N_2^{2-} are 3.0, 2.5 and 2.0 respectively. As Bond order is a direct measure of its stability, hence the stability decreases in the order $N_2 > N_2^+ > N_2^{2-}$.

* Students are advised to write electronic configurations of all molecules and then perform bond order calculations using the formula BO = (Nb-Na)/2.

3. Derive quantum mechanical expression for the motion of a particle in a 1-D box. Also give important results from the treatment. [8]

A: A particle in a 1-dimensional box is a common application of a quantum mechanical model to a simplified system consisting of a particle moving horizontally within an infinitely deep well from which it cannot escape. The solutions to the problem give possible values of E and ψthat the particle can possess. E represents allowed energy values and $\psi$is a wavefunction, which when squared gives us the probability of locating the particle at a certain position within the box at a given energy level.

The potential energy *is* 0 inside the box (V=0 for 0<x<L) and goes to infinity at the walls of the box (V=∞ for x<0 or x>L). We assume the walls have infinite potential energy to ensure that the particle has zero probability of being at the walls or outside the box.



The time-independent Schrödinger equation for a particle of mass m moving in one direction with energy E is

$$-\frac{\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2}+V(x)\psi(x)=E\psi(x)$$

- $\hbar$ is the reduced Planck Constant where $\hbar$=h/2π
- m is the mass of the particle
- ψ(x) is the stationary time-independent wavefunction
- V(x) is the potential energy as a function of position
- E is the energy, a real number

This equation can be modified for a particle of mass *m* free to move parallel to the x-axis with zero potential energy (V = 0 everywhere) resulting in the quantum mechanical description of free motion in one dimension:

$$-\frac{\hbar^2}{2m}\frac{d^2\psi(x)}{dx^2}=E\psi(x)$$

This equation has been well studied and gives a general solution of:

$$\psi(x)=A\sin(kx)+B\cos(kx)$$

where A, B, and k are constants.
According to boundary conditions, the probability of finding the particle at x=0 or x=L is zero. When , *x* = 0 sin(0) = 0, and cos(0) = 1; therefore, *B must equal 0* to fulfill this boundary condition

$$\psi(x)=A\sin(kx)$$

Differentiating the wave function wrt x

$$\frac{d\psi}{dx} = kA\cos(kx)$$

$$\frac{d^2\psi}{dx^2} = -k^2 A\sin(kx)$$

Since ψ(x) = Asin (kx), then

$$\frac{d^2\psi}{dx^2} = -k^2\psi$$

Solving for k by comparing with the Schrodinger equation, we get

$$k = \left(\frac{8\pi^2 mE}{h^2}\right)^{1/2}$$

Putting value of k in wave function

$$\psi = A\sin\left(\frac{8\pi^2 mE}{h^2}\right)^{1/2} x$$

To determine A, we have to apply the boundary conditions again, i.e ψ = 0 at x=0 or x=L. Thus when x=L

$$0 = A\sin\left(\frac{8\pi^2 mE}{h^2}\right)^{1/2} L$$

This is only true when

$$\left(\frac{8\pi^2 mE}{h^2}\right)^{1/2} L = n\pi$$

where n = 1,2,3….Thus we get,

$$\psi = A\sin\frac{n\pi}{L}x$$

To determine A, we need to normalize the wavefunction, i.e. the total probability of finding the particle inside the box is 1, meaning there is no probability of it being outside the box.

$$\int_0^L \psi^2 dx = 1$$

Substituting value of ψ we get

$$A^2 \int_0^L sin^2 \left(\frac{n\pi}{L}\right) x dx = 1$$

Using the solution for this integral from an integral table, we find our normalization constant, A as

$$A = \sqrt{\frac{2}{L}}$$

Which results in the normalized wavefunction for a particle in a 1-dimensional box:

$$\psi = \sqrt{\frac{2}{L}} \sin \frac{n\pi}{L} x$$

Solving for E results in the allowed energies for a particle in a box:

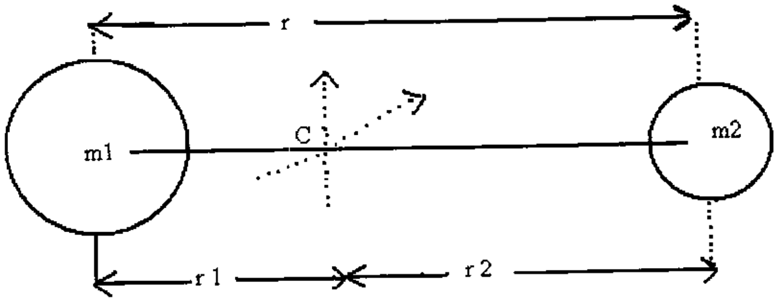
$$E_n = \frac{n^2 h^2}{8mL^2}$$

IMPORTANT RESULTS FROM THIS TREATMENT

1. The energy of a particle is quantized. This means it can only take on discreet energy values.
2. The lowest possible energy for a particle is not zero (even at 0 K). This means the particle always has some kinetic energy.
3. The square of the wavefunction is related to the probability of finding the particle in a specific position for a given energy level. The probability changes with increasing energy of the particle and depends on the position in the box. However, in classical mechanics, the probability of finding the particle is independent of the energy and the same at all points in the box.

4. **Derive expression for rotational energies of diatomic molecule. What type of rotational spectrum will be obtained and how does the intensity of these lines vary?** [8]

A: Consider a linear rigid diatomic molecule



The two independent rotations of this molecule are with respect to the two axes which pass though C and are perpendicular to the "bond length" r. The rotation with respect to the bond axis is possible only for "classical" objects with large masses. For quantum objects, a "rotation" with respect to the molecular axis does not correspond to any change in the molecule as the new configuration is indistinguishable from the old one.

The center of mass is defined by equating the moments on both segments of the molecular axis.

$$m_1 r_1 = m_2 r_2 \tag{1.1}$$

The moment of inertia is defined by

$$I = m_1 r_1^2 + m_2 r_2^2 \tag{1.2}$$

$$= m_2 r_2 r_1 + m_1 r_1 r_2$$

$$= r_1 r_2 \quad (m_1 + m_2) \tag{1.3}$$

Since $m_1 r_1 = m_2 r_2 = m_2 \ (r - r_1), \ (m_1 + m_2) \ r_1 = m_2 r$

Therefore,

$$r_1 = \frac{m_2 r}{m_1 + m_2} \quad \text{and} \quad r_2 = \frac{m_1 r}{m_1 + m_2} \qquad (1.4)$$

Substituting the above equation in (1.3), we get

$$I = \frac{m_1 m_2 \ r^2}{(m_1 + m_2)} = \mu r^2, \ \mu = \frac{m_1 m_2}{m_1 + m_2} \qquad (1.5)$$

Where μ, the reduced mass is given by

$$\frac{1}{\mu} = \frac{1}{m_1} + \frac{1}{m_2} \qquad (1.6)$$

The rotation of a diatomic is equivalent to a "rotation" of a mass μ at a distance of r from the origin C. The kinetic energy of this rotational motion is K.E. = $L^2/2I$ where L is the angular momentum, Iω where ω is the angular (rotational) velocity in radians/sec.

The quantized rotational energy levels for this diatomic are

$$E_J = \frac{h^2}{8\pi^2 I} \ J(J+1) \qquad (1.7)$$

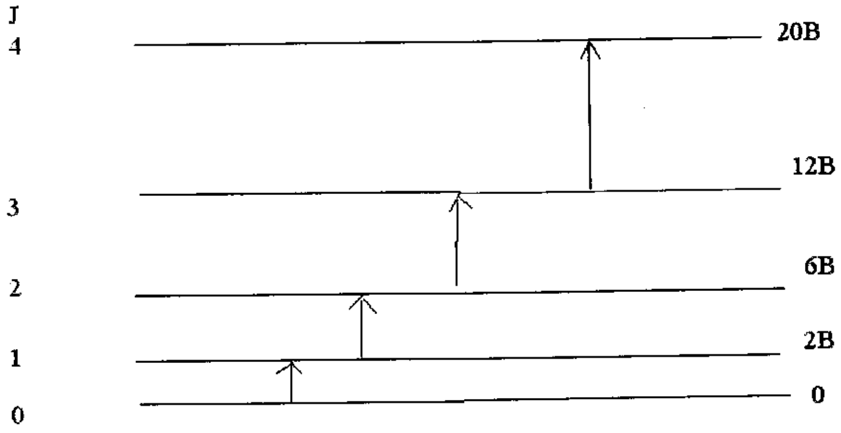
The energy difference between two rotational levels is usually expressed in cm^{-1}. The wave number corresponding to a given ΔE is given by

$$\upsilon = \Delta E / hc, \ cm^{-1} \qquad (1.8)$$

The energy levels in cm^{-1} are therefore,

$$E_J = B \ J(J+1) \ \ where \ \ B = \frac{h}{8\pi^2 Ic} \qquad (1.9)$$

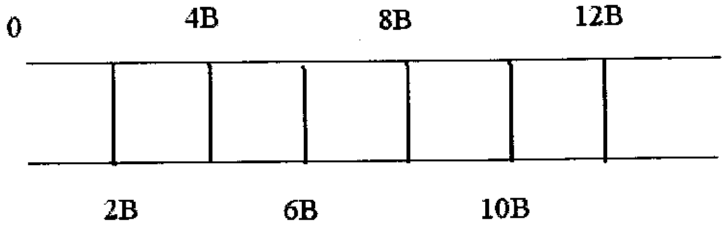
The rotational energy levels of a diatomic molecule are shown as below



The selection rule for a rotational transition is,

$$\Delta J = \pm 1 \qquad (1.10)$$

In addition to this requirement, the molecule has to possess a dipole moment. As a dipolar molecule rotates, the rotating dipole constitutes the transition dipole operator μ. Molecules such as HCl and CO will show rotational spectra while H_2, Cl_2 and CO_2 will not. The rotational spectrum will appear as follows



From the value of B obtained from the rotational spectra, moments of inertia of molecules I, can be calculated. From the value of I, bond length can be deduced.

5.(a) **What are the reasons for the deviation of real gases from ideal gas behavior. How were they modified in Van der Waal's equation.** [4]

A: A gas which obeys the gas laws and the gas equation PV = nRT strictly at all temperatures and pressures is said to be an ideal gas. The molecules of ideal gases are assumed to be volume less points with no attractive forces between one another. But no real gas strictly obeys the gas equation at all temperatures and pressures. Deviations from ideal behaviour are observed particularly at high pressures or low temperatures. The causes of deviations from ideal behaviour may be due to the following two assumptions of kinetic theory of gases.

1. The volume occupied by gas molecules is negligibly small as compared to the volume occupied by the gas.
2. The forces of attraction between gas molecules are negligible.

The first assumption is valid only at low pressures and high temperature, when the volume occupied by the gas molecules is negligible as compared to the total volume of the gas. But at low temperature or at high pressure, the molecules being in compressible the volumes of molecules are no more negligible as compared to the total volume of the gas.

The second assumption is not valid when the pressure is high and temperature is low. But at high pressure or low temperature when the total volume of gas is small, the forces of attraction become appreciable and cannot be ignored.

Van der Waals' Equation of State for a Real Gas

1) **Volume Correction**

We know that for an ideal gas $P'V = nRT$. Now in a real gas the molecular volume cannot be ignored and therefore let us assume that 'b' is the volume excluded (out of the volume of container) for the moving gas molecules per mole of a gas. Therefore due to n moles of a gas the volume excluded would be nb. A real gas in a container of volume V has only available volume of (V - nb) and this can be thought of as an ideal gas in container of volume (V - nb).

Hence, Ideal volume

$$V_i = V - nb \quad \text{............(i)}$$

n = Number of moles of real gas

V = Volume of the gas

b = A constant whose value depends upon the nature of the gas

2) **Pressure Correction**

Let us assume that the real gas exerts a pressure P. The molecules that exert the force on the container will get attracted by molecules of the immediate layer which are assumed not to be exerting pressure.

It can be seen that the pressure the real gas exerts would be less than the pressure an ideal gas would have exerted. The real gas experiences attractions by its molecules in the reverse direction. Therefore if a real gas exerts a pressure P, then an ideal gas would exert a pressure equal to P + p (p is the pressure lost by the gas molecules due to attractions).

This small pressure p would be directly proportional to the extent of attraction between the molecules which are hitting the container wall and the molecules which are attracting these.

Therefore $p \propto n/v$ (concentration of molecules which are hitting the container's wall)
$P \propto n/v$ (concentration of molecules which are attracting these molecules) $\Rightarrow p \propto n^2/v^2$
$P = an^2/v^2$ where a is the constant of proportionality which depends on the nature of gas.

A higher value of 'a' reflects the increased attraction between gas molecules.

Hence ideal pressure

$$P_i = (P + an^2 / V^2) \text{ ....(ii)}$$

Here,

n = Number of moles of real gas

V = Volume of the gas

a = A constant whose value depends upon the nature of the gas

Substituting the values of ideal volume and ideal pressure in ideal gas equation i.e. pV=nRT, the modified equation is obtained as

$$(P + \frac{an^2}{V^2})(V - nb) = nRT$$

(b) Explain the different types of intermolecular forces. [4]

A: There are five types of Intermolecular forces

1. **Ion-dipole forces**: An ion-dipole interaction occurs between a fully charged ion and a partially charged dipole. The strength of the ion-dipole force is proportionate to ion charge. For example; Forces between polar water molecules and a sodium ion.

2. **Ion-induced dipole forces**: An ion-induced dipole interaction occurs between a fully charged ion and a temporarily charged dipole. The temporary dipole is induced by the presence of the ion.

3. **Dipole-dipole forces**: Dipole-dipole interactions are electrostatic interactions between the permanent dipoles of different molecules. These interactions align the molecules to increase the attraction. An example of a dipole–dipole interaction can be seen in hydrogen chloride (HCl): the relatively positive end of a polar molecule will attract the relatively negative end of another HCl molecule. The interaction between the two dipoles is an attraction rather than full bond because no electrons are shared between the two molecules. Hydrogen bonding is also a special case of dipole-dipole forces.

4. **Dipole-induced dipole forces**: A dipole-induced dipole attraction is a weak attraction that results when a polar molecule induces a dipole in an atom or in a nonpolar molecule by disturbing the arrangement of electrons in the nonpolar species.

5. **London dispersion forces**: The London dispersion forces are the weakest intermolecular forces. These are temporary attractive forces that results when the electrons in two adjacent atoms occupy positions that make the atoms form temporary dipoles. Because of the constant motion of the electrons, an atom or molecule can

develop a temporary (instantaneous) dipole when its electrons are distributed unsymmetrically about the nucleus. A second atom or molecule, in turn, can be distorted by the appearance of the dipole in the first atom or molecule (because electrons repel one another) which leads to an electrostatic attraction between the two atoms or molecules. This force is sometimes called an induced dipole-induced dipole attraction.

Section-C

6.(a) **Calculate the equilibrium constant for the reaction.** [4]

Sn^{2+} (aq) + Pb (s) $\longrightarrow$ Sn (s) + Pb^{2+} (aq) at 298 K

Given $E^o(Sn^{2+}/Sn) = -0.14$ V, $E^o(Pb^{2+}/Pb) = -0.13$ V

A: According to Nernst equation:

$$E_{cell} = E_{cell}^{o} - (2.303/nF)\log K$$

For the given equation:

Sn^{2+} (aq) + Pb (s) $\longrightarrow$ Sn (s) + Pb^{2+} (aq)

$E^o_{cell} = E^o_{Sn2+/Sn} - E^o_{Pb2+/Pb}$

$= -0.14 - (-0.13) = -0.01$ V

As, at equilibrium, E_{cell} becomes zero

$E^o_{cell} = (0.059/n)\log K$

$-0.01 = (0.059/2)\log K$

$K = 0.4581.$

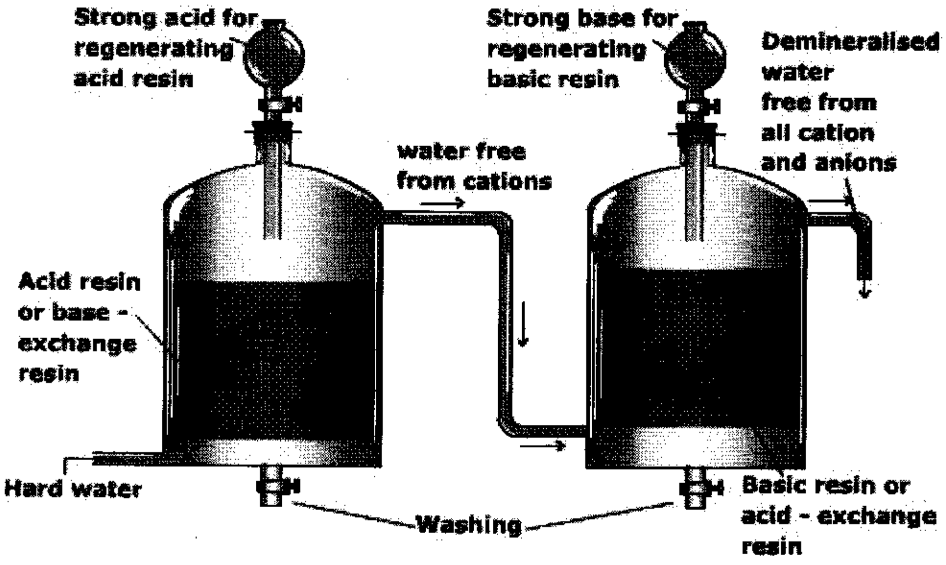
(b) **Discuss the cation and anion exchange resins and their usefulness for water softening.** [4]

A: Ion exchange (IE) is a water treatment method where one or more undesirable contaminants are removed from water by exchange with another non-objectionable or less objectionable substance. Both the contaminant and the exchanged substance must be dissolved and have the same type (+,-) of electrical charge. One example of IE is the process called "water softening."

When contaminants dissolve in water they typically form ions. Ions are electrically charged portions of a compound. There is a balance of positively and negatively charged ions in natural waters. When contaminants are dissolved in water, the water is typically crystal clear. If the water is cloudy or otherwise discolored it is likely that some, or all, of the contaminants are in a solid form. Solid particles are not intended to be removed by IE and solids will clog the treatment media.

A water softener at a private home typically has two or three tanks. The smaller tank contains the sodium or potassium salt used to regenerate the resin media while the taller tank(s) contains the purifying media called a “cation” exchange resin. During normal operations, raw water passes through the ion exchange resin media in the tall tank. The calcium (Ca++), magnesium (Mg++), iron (Fe++), or manganese (Mn++) ions in the water are typically “exchanged” for sodium (Na+) or potassium (K+) ions, which have been temporarily stored in the pores of the resin during the previous regeneration cycle. In fact, any contaminant ion of valence positive 2 or greater will be removed in a water softener. As the softener removes hardness minerals from the water, sodium or potassium will be given back proportionally.

REGENERATION Eventually the removal capacity of the IE resin becomes exhausted and the resin will need to be regenerated. The regeneration process typically begins by a rapid backwashing of the resin to remove fine particles that have been strained out of the water during the production (i.e. service) portion of the treatment cycle. This rapid backwash provides a physical cleaning of the outside of the media, but does not regenerate the resin's IE contaminant removal capability. As the process continues the backwash flow rate is significantly reduced and brine (salt dissolved in water) is added to the backwash flow. The sodium or potassium from the brine permeates the resin pores and displaces the previously removed contaminants. After approximately 20 minutes, the remaining brine along with the concentrated, displaced contaminant ions are flushed out of the resin tank and disposed of into an approved dry well, septic tank, or sewer. The control valve(s) then returns to the taller tank(s) to the service production run. In a single tall tank system the system backwashes late in the evening since raw water would enter the plumbing if there was customer demand. In a more modern “green” softener there are two treatment tanks so that one can be treating while the other is backwashed.



7.(a) What do you understand by electron affinity? Why the electron affinity of fluorine is less than that of chlorine. [4]

A: Electron affinity (E_{ea}) of an atom or molecule is defined as the amount of energy released when an electron is added to a neutral atom or molecule in the gaseous state to form a negative ion.

$$X + e^- \rightarrow X^- + \text{energy}$$

Electron affinity of fluorine is less than that of chlorine as fluorine sits atop chlorine in the periodic table, most people expect it to have the highest electron affinity, but this is not the case. Fluorine is a small atom with a small amount of space available in its 2p orbital. Because of this, any new electron trying to attach to fluorine experiences lower electron affinity from the electrons already living in the element's 2p orbital. Since chlorine's outermost orbital is a 3p orbital, there is more space, and the electrons in this orbital are inclined to share this space with an extra electron. Therefore, chlorine has a higher electron affinity than fluorine, and this orbital structure causes it to have the highest electron affinity of all of the elements.

(b) What is ionization energy? Why the second ionization energy of Na is higher than magnesium. [4]

A: The ionization energy (E_i) is defined as the minimum amount of energy required to remove the most loosely bound electron, the valence electron, of an isolated neutral gaseous atom to form a cation. It is quantitatively expressed in symbols as

$$X + \text{energy} \rightarrow X^+ + e^-$$

where X is any atom or molecule capable of being ionized, X^+ is that atom or molecule with an electron removed, and e is the removed electron. This is an endothermic process.

Sodium has a valency of +1 which means it has to lose one electron to get a noble configuration i.e Neon's configuration. So after it loses one electron it becomes stable and hence more enthalpy is required to remove an electron from the stable atom hence the second ionization enthalpy of sodium is greater than that of Magnesium.

8. Explain the following terms [8]

(i) Enantiomerism (ii) Diastereomerism (iii) Mesocompounds (iv) Optical activity

A: (i) Enantiomerism:

The relationship between two stereoisomers having molecules that are mirror images of each other are termed as enentiomers. The enantiomers have identical chemical and physical properties in an achiral environment but form different products when reacted with other chiral molecules and exhibit optical activity. The enantiomer that rotates the plane a beam of plane polarized light in the clockwise direction is indicated by the prefix (+)-, or d- or dextro-; the other enantiomer rotates light in a counterclockwise direction and is indicated by the prefix (−)-, or l- or levo-.

(ii) Diastereomerism:

Diastereomers are a type of a stereoisomer which occurs when two or more stereoisomers of a compound have different configurations at one or more (but not all) of the equivalent (related) stereocenters and are not mirror images of each other. When two diastereoisomers differ from each other at only one stereocenter they are epimers. Each stereocenter gives rise to two different configurations and thus increases the number of stereoisomers by a factor of two. Diastereomers differ from enantiomers in that the latter are pairs of stereoisomers that differ in all stereocenters and are therefore mirror images of one another. Enantiomers of a compound with more than one stereocenter are also diastereomers of the other stereoisomers of that compound that are not their mirror image. Diastereomers have different physical properties (unlike enantiomers) and different chemical reactivity.

(iii) Mesocompounds:

A meso compound or meso isomer is a stereoisomer with an identical or superimposable mirror image i.e., a non-optically active member of a set of stereoisomers, at least two of which are optically active. Despite of containing two or more stereogenic centers, the molecule is not chiral. A meso compound is superimposable on its mirror image. Two objects can be superposed if all aspects of the objects coincide and it does not produce a "(+)" or "(-)" reading when analyzed with a polarimeter.

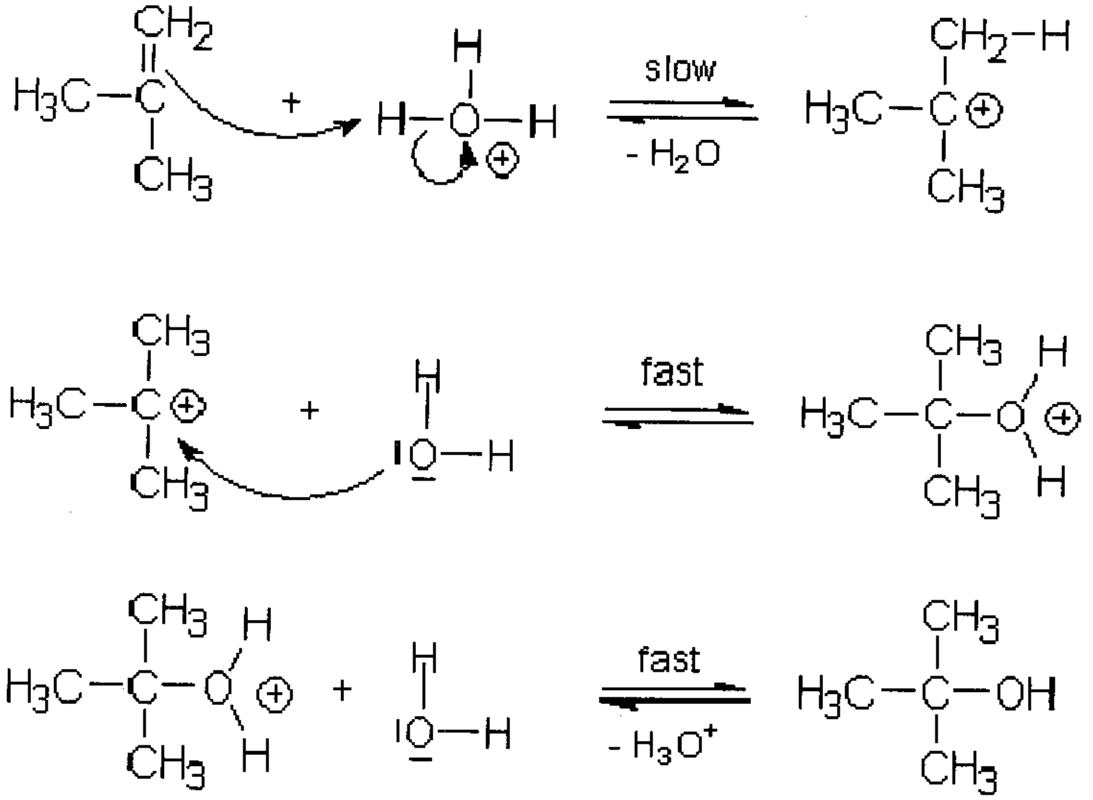
(iv) Optical activity: Optical activity is the rotation of the plane of polarization of linearly polarized light as it travels through certain materials. Optical activity occurs only in chiral materials, those lacking microscopic mirror symmetry. Optical activity can be observed in fluids. This can include gases or solutions of chiral molecules such as sugars, molecules with helical secondary structure such as some proteins, and also chiral liquid crystals. It can also be observed in chiral solids such as certain crystals with a rotation between adjacent crystal planes or metamaterials. The rotation of the plane of polarization may be either clockwise, to the right (dextrorotary), or to the left (levorotary) depending on which stereoisomer is present (or dominant). For example, sucrose and camphor are d-rotary whereas cholesterol is l-rotary. For a given substance, the angle by which the polarization of light of a specified wavelength is rotated is proportional to the path length through the material and (for a solution) proportional to its concentration. Optical activity is measured using a polarized source and polarimeter. This is a tool particularly used in the sugar industry to measure the sugar concentration of syrup, and generally in chemistry to measure the concentration or enantiomeric ratio of chiral molecules in solution.

Relevant examples are to be given in each case.

9. Explain the mechanism of [8]
(i) Hydration of alkene (ii) S_N1 reaction

A: (i) Hydration of alkene

Electrophilic hydration is the opposite of dehydration of alcohols and has useful application in making alcohols for fuels and reagents for further reactions. The addition of water to an alkene in the presence of a catalytic amount of strong acid leads to the development of alcohols. This reaction continues via a standard carbocation mechanism and trails the Markovnikov rule.

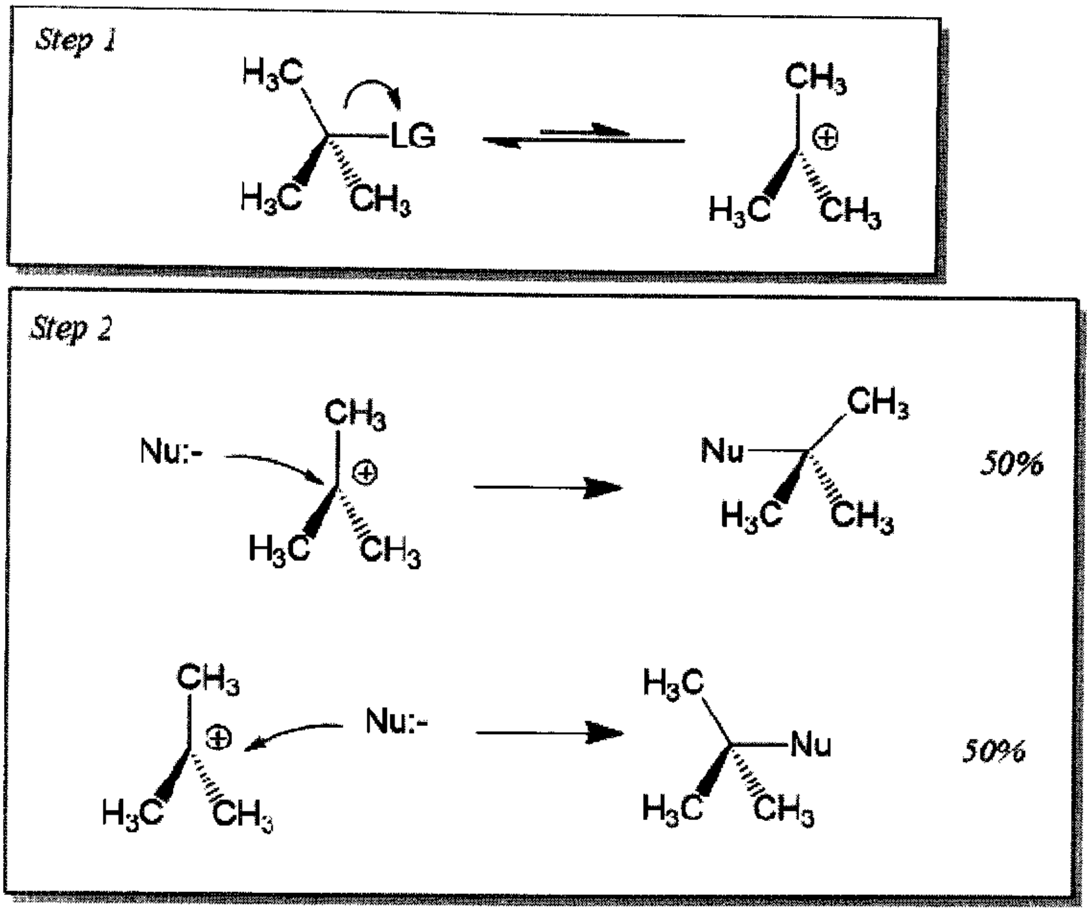


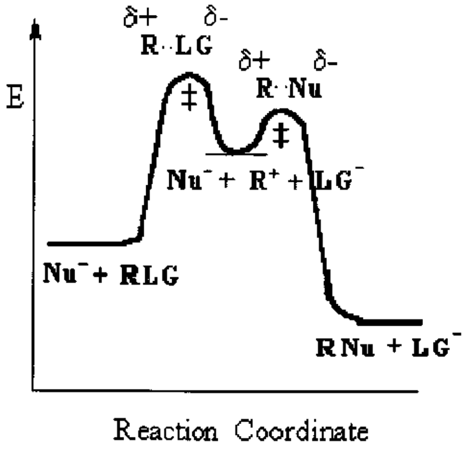
An alkene located in an aqueous non-nucleophilic strong acid immediately ranges out with its double bond and attacks one of the acid's hydrogen atoms (meanwhile, the bond between oxygen and hydrogen executes heterolytic cleavage near the oxygen—in other words, both electrons from the oxygen/hydrogen single bond move onto the oxygen atom.

A carbocation is made on the original alkene in the more-substituted position, where the oxygen end of water assaults with its four non-bonded valence electrons. After the oxygen atom forms its third bond with the more-substituted carbon, it develops a positive charge. The bond between the hydrogen and the oxygen undergoes heterolytic cleavage, and both the electrons from the bond move onto the oxygen. The now negatively-charged strong acid picks up the electrophilic hydrogen. Now that the reaction is complete, the non-nucleophilic strong acid is restored as a catalyst and an alcohol forms on the most substituted carbon of the present alkane. At lower temperatures, more alcohol product can be made.

(ii) S_N1 reaction:

The S_N1 reaction is a unimolecular nucleophilic substitution reaction in organic chemistry. Thus, the rate equation is often revealed as having first-order dependence on electrophile and zero-order dependence on nucleophile. This affiliation holds for situations where the amount of nucleophile is much larger than that of the carbocation intermediate. Instead, the rate equation may be more accurately pronounced using steady-state kinetics. The reaction involves a carbocation intermediate and is commonly seen in reactions of secondary or tertiary alkyl halides under strongly basic conditions or, under strongly acidic conditions, with secondary or tertiary alcohols. With primary and secondary alkyl halides, the alternative S_N2 reaction occurs. This reaction does not rest much on the strength of the nucleophile unlike the S_N2 mechanism. This type of mechanism includes two steps. The first step is the reversible ionization of Alkyl halide in the existence of aqueous acetone or an aqueous ethyl alcohol. This step provides a carbocation as an intermediate. In the second step this carbocation is attacked by the nucleophile to form the product.





This S_N1 reaction takes place in three steps:

In first step, there is Formation of a *tert*-butyl carbocation by separation of a leaving group from the carbon atom which one is a slow and reversible step. In the second step, there is nucleophilic attack and the carbocation reacts with the nucleophile. If the nucleophile is a neutral molecule (solvent) then a third step is required to complete the reaction. When the solvent is water, the intermediate is an oxonium ion. This reaction step is fast. In the deprotonation, the removal of a proton on the protonated nucleophile by water acting as a base giving alcohol and a hydronium ion.

P

Annexure-A

Instructions for Paper-Setter in Physics Course in B. Tech. First Year (For course codes BTPH101-18 To BTPH107-18)

A. Scope

1. The question papers should be prepared strictly in accordance with the prescribed syllabus and pattern of question paper of the University.

2. The question paper should cover the entire syllabus uniformly with proper distribution and Weightage of marks for each question or a part thereof.

3. The language of questions should be simple, direct, and documented clearly and unequivocally so that the candidates may have no difficulty in appreciating the scope and purpose of the questions. The length of the expected answer should be specified as far as possible in the question itself.

4. The distribution of marks to each question/answer should be indicated in the question paper properly.

B. Type and difficulty level of question papers

1. Questions should be framed in such a way as to test the students intelligent grasp of broad principles and understanding of the applied aspects of the subject. The Weightage of the marks as per the difficulty level of the question paper shall be as follows:

i)	Easy question	30%
ii)	Average questions	50%
iii)	Difficult questions	20%

2. The numerical content of the question paper should be upto 25%.

C. Format of question paper

1. Subject title, Subject-code, Mcode, and Paper-ID should be mentioned properly.
2. The question paper will consist of three sections: Sections-A, B and C.
3. Section-A is COMPULSORY consisting of TEN SHORT questions carrying two marks each (total 20 marks) covering the entire syllabus.
4. The Section-B consists of FOUR questions of eight marks each covering the entire Part-A of syllabus.
5. The Section-C consists of FOUR questions of eight marks each covering the entire Part-B of syllabus.
6. Attempt any five questions from Section-B and Section-C, selecting at least two questions from each of the two sections.

Annexure-B ✓

Roll No. in Figures ☐☐☐☐☐☐☐☐☐
[Total No. of Questions: 09]

[Total No. of Pages: 03]

B. Tech. (2018 Onwards) (Sem.-1,2)
MECHANICS OF SOLIDS
MCODE:[......]
Subject Code: BTPH101-18
PaperID: [........]

[Time allowed: 03 hours]

[Max. marks: 60]

INSTRUCTION TO THE CANDIDATES:

1. **Section-A is COMPULSORY consisting of TEN questions carrying two marks each.**
2. **SECTION B & C have FOUR questions each.**
3. **Attempt any five questions from Section-B and Section-C, selecting at least two questions from each of the two sections.**

Section-A

1. Write briefly:
   - (a) Why area is taken as a vector quantity?
   - (b) What are conservative and non -conservative forces?
   - (c) Prove that $\vec{\nabla} \cdot (\vec{\nabla} \times \vec{A}) = 0$
   - (d) What are transverse waves? Give example.
   - (e) A mass of 1.2 Kg is attached to a spring of stiffness constant 30 N/m. Find the natural frequency.
   - (f) Which physical quantity is represented by the product of moment of inertia and angular velocity?
   - (g) Explain the concept of torque.
   - (h) State the expression for the kinetic energy of rotation of a body.
   - (i) What is limiting friction.
   - (j) State the Generalized Hooke's law.

[$2 \times 10 = 20$ Marks]

Section-B

2. a) Prove that a central force is negative gradient of scalar potential.
   b) The force acting on a particle along x-axis is given by: $F(x) = Ax^2 - Bx^3$. Find the expression for the potential energy of particle.

[5+3=8 Marks]

3. a) Prove that $\hat{r}$ $\hat{\theta}$, and $\hat{\phi}$ are orthogonal vectors.
   b) Calculate the volume of a parallelopiped formed by the vectors: $\vec{A} = 2\hat{i} - 3\hat{j} + 4\hat{k}\,, \vec{B} = 3\hat{i} + 1\hat{j} - 4\hat{k}\,, \vec{C} = 4\hat{i} - 2\hat{j} + 3\hat{k}$.

[4+4= 8 Marks]

4. Discuss the theory of forced harmonic oscillations. Explain it from the physical consideration when the frequency of forced vibrations is same as the external force.

[8 Marks]

5. a) Explain the following attenuation coefficients: Logarithmic decrement, Relaxation time, and Quality factor for a damped oscillating system.
   b) The amplitude of an oscillator of frequency 200 per seconds fall to 1/10 of initial value after 2000 cycles. Calculate its relaxation time.

[5+3=8 Marks]

Section-C

6. What is moment of inertia? Derive the expression for a moment of inertia of a rectangular lamina about its diagonal as the principle axis.

[8 Marks]

7. a) State the theorem of parallel axes of moment of inertia.
   b) Four solid spheres each of diameter $\sqrt{5}$ cm and mass 0.5 kg are placed with their centre at the corners of the square of side 4cm. The moment of inertia of the system about the diagonal of the square is $N \times 10^{-4}$ kgm^2. Evaluate N.

[4+4=8 Marks]

8. a) Explain the concept of stress and strain in one dimension using the graph.
   b) A nylon string has a diameter of 2 mm, pulled by a force of 100 N. Determine the stress.
   c) A cord has original length of 100 cm is pulled by a force. The change in length of the cord is 2 mm. Determine the strain.

[4+2+2=8 Marks]

9. a) Define the terms: angle of friction and angle of repose. Show that angle of friction is equal to angle of repose.

b) A pick-up truck carrying a load of mass 150 kg accelerates from some traffic lights at 1.4ms^{-2}. Find the smallest possible value of the coefficient of friction if the load does not slip.

[4+4 =8 Marks]

Roll No. in Figures ☐☐☐☐☐☐☐☐☐
[Total No. of Questions: 09]

[Total No. of Pages: 02]

B. Tech (2018 Onwards) (Sem.-1,2)
OPTICS AND MODERN PHYSICS
MCODE: [........]
Subject Code: BTPH102-18
PaperID: [........]

[Time allowed: 03 hours]

[Max. marks: 60]

INSTRUCTION TO THE CANDIDATES:

1. **Section-A is COMPULSORY consisting of TEN questions carrying two marks each.**
2. **SECTION B & C have FOUR questions each.**
3. **Attempt any five questions from Section-B and Section-C, selecting at least two questions from each of the two sections.**

Section-A

1. Write briefly:

   (a) Explain briefly the phenomena of resonance.

   (b) A mass of 1.0 Kg is attached to a spring of stiffness constant 25 N/m. Find the natural frequency.

   (c) Explain the phenomena of total internal reflection.

   (d) What happens when the number of lines on a grating is increased?

   (e) Write a short note on population inversion.

   (f) What do you understand by the wave-particle duality?

   (g) Calculate the de Broglie wavelength associated with a electron subjected to a potential difference of 1.5kV.

   (h) State Bloch's theorem for periodic system.

   (i) Define density of states.

   (j) What are Fermi energy and Fermi level?

[$2 \times 10 = 20$ Marks]

Section-B

2. What is a damped harmonic oscillations? Solve its differential equation and discuss conditions for the over damping, critical damping, and underdamping action.

[8 Marks]

3. a) Discuss briefly the theory of forced harmonic oscillations. How does sharpness of resonance depends on the damping.

   b) A body of mass 0.01 kg execute simple harmonic motion with amplitude 3×10^{-2} m and time period 2 seconds. Calculate the total energy of particles.

[4+4=8 Marks]

4. a) State the principle of interference. Explain the various types of interference.
   b) Explain how the fringes are formed in Young's double slit experiment.

[4+4=8 Marks]

5. Explain the construction, working, and energy level diagram of a Ruby laser.

[8 Marks]

Section-C

6. a) What is group velocity and phase velocity? Derive the relationship between the two.
   b) Normalise the wavefunctions $\psi(x) = N \sin\left(\frac{n\pi x}{L}\right)$ of a particle in a box of length L. Show that they are orthogonal.

[4+ 4=8 Marks]

7. a)Derive the expressions for time-dependent form of Schrödinger equation.
   b) Calculate the wavelength of a thermal neutron at 27°C, assuming that the energy of a particle at absolute temperature is of the order of kT, where k is Boltzmann constant.

[4+4=8 Marks]

8. a) Explain the terms: drift velocity and relaxation time in Drude model.
   b)Find the relaxation time of conduction electron in a metal of resistivity $1.54 \times 10^{-8}\Omega$m, if the metal has 5.8×10^{28} conduction electron/m^3.

[4+4=8 Marks]

9. Explain the salient features of quantum free-electron theory. Discuss the Kronig-Penny model for the motion of an electron in a periodic potential.

[8 Marks]

Roll No. in Figure

[Total No. of Questions: 09]   [Total No. of Pages: 02]

B. Tech (2018 Onwards) (Sem.)
Electromagnetism
M Code:[.....]
Subject Code: **BTPH-103-18**
Paper ID: [   ]

[Time allowed: 03 hours]   [Max. marks:60]

INSTRUCTIONS TO THE CANDIDATES:

1. **Section-A is COMPULSORY consisting of TEN questions carrying two marks each.**
2. **SECTION B & C have FOUR questions each.**
3. **Attempt any five questions from Sections-B and Section-C, selecting at least two questions from each of the two sections.**

Section-A

1. Write Briefly

(a) Mention the Physical significance of divergence of electrostatic field.

(b) Write Maxwell's equations in integral form for vacuum.

(c) What is lamellar vector field? Give example.

(d) Find the constant 'a' so that the vector $\vec{E} = \hat{\imath}(x) + \hat{\jmath}(y + 4x) + \hat{k}(az)$ is solenoidal.

(e) What is Uniqueness theorem?

(f) Which type of magnetic material is used in the electromagnet and why?

(g) Draw the B-H curve for soft and hard magnetic materials.

(h) State the significance of continuity equation.

(i) Differentiate between circular and elliptical polarization.

(j) If $\vec{H}(z,t) = 100\cos(100t + 50z)\,\hat{k}\,\frac{A}{m}$, identify the amplitude, frequency, phase constant and the wavelength.

[2 x 10 = 20 Marks]

Section-B

2. What is a dipole? Determine the electrostatic field and potential due a dipole. [1+7]

3. Derive and discuss the boundary conditions for magnetic field. [8]

4. a) The vector magnetic potential, $\vec{A}$ due to a direct current in a conductor in free space is given by $\vec{A} = (x^2 + y^2)\hat{k}$ Wb/m^2. Determine the magnetic field produced by the current element at (1,2,3). [4]

   b) Determine the magnetic field due to a bar magnet. [4]

5. a) Derive the Poisson's and Laplace's equations for electrostatic potential. What is the significance of these equations? [3+1]

   b) If a potential $V = x^2yz + Ay^3z$, i) find A so that Laplace's equation is satisfied, ii) with the value of A, determine electric field at (2,1,-1). [2+2]

Section-C

6. a) Derive and discuss the Poynting theorem. [6]

   b) Find the conduction and displacement current densities in a material having conductivity of 10^{-3} S/m and $\varepsilon_r = 2.5$ if the electric field in the material is $E = 5 \times 10^{-6}\sin(9 \times 10^9 t)$V/m. [2]

7. a) Why there was need to modify Ampere's circuital law? What was the modification? [4]

   b) In free space, $\vec{H} = 1000 \sin(\omega t - 10x)$ A/m in z direction. Find **B**, **E** and displacement current density. [4]

8. What is the significance of reflection and transmission coefficients? Derive the reflection and transmission coefficients for reflection and transmission of electromagnetic waves from a non-conducting medium -vacuum interface for normal incidence. [2+6]

9. What is meant by uniform plane wave? Derive wave equation for electromagnetic wave in terms of electric field and magnetic field in conducting medium. [2+6]

Roll No. in Figures

[Total No. of Questions: 09] [Total No. of Pages: 02]

B. Tech (2018 Onwards) (Sem.-1,2)

SEMICONDUCTOR PHYSICS
MCODE: [.....]
Subject Code: BTPH104-18
PaperID: [ ]

[Time allowed: 03 hours] [Max. marks: 60]

INSTRUCTION TO THE CANDIDATES:

1. **Section-A is COMPULSORY consisting of TEN questions carrying two marks each.**
2. **SECTION B & C have FOUR questions each.**
3. **Attempt any five questions from Section-B and Section-C, selecting at least two questions from each of the two sections.**

Section-A

1. Write briefly:

(a) Differentiate between direct and indirect band gap materials?
(b) Define population inversion in Lasers.
(c) State Bloch's theorem for periodic system.
(d) What are salient features of free electron theory?
(e) What is exciton in semiconductors?
(f) State limitations of Drude model.
(g) Which property of the material can be measured using Hot point probe?
(h) How can a resistivity of any semiconductor material be measured?
(i) Calculate the number of donor atoms per m3 of n type material having resistivity of 0.25 Ohm-m, the mobility of electron is 0.3 m^2/Vs.
(j) What is implied by negative effective mass?

[2X10 = 20 Marks]

Section-B

2. a) Describe of limitations of free electron model in describing electronic properties of the materials?

b) Fermi velocity of electron is Cesium metal is 0.73×10^6 m/s. Calculate its Fermi energy and Fermi temperature.

[4+4=8 Marks]

3. Explain origin of the band gap in solids using Kronig-Penny model?

[8 Marks]

4. Why Fermi level is important in semiconductors? How does the fermi level varies in intrinsic n and p type semiconductors with temperature?

[8 Marks]

5. a) Mobilities of electron and holes in a sample of intrinsic Ge at 300*K* are 0.36 and 0.15***m²/Vs***, respectively. If the resistivity of the specimen is 2.12 ***Ohm m***, calculate the forbidden energy gap for Ge.
b) Explain the process of formation of holes in a semiconductor using a suitable schematic diagram?

[5+3=8 Marks]

Section-C

6. a) Explain the concept of absorption, spontaneous emission, and stimulated emission in Lasers.
b) Explain the electric pumping mechanism in a semiconductor laser.

[4+4=8 Marks]

7. Discuss the Fermi golden rule for describing optical transitions in semiconductors when an electromagnetic wave is propagating through the semiconductor.

[8 Marks]

8. a) Describe one method for measuring divergence and wavelength of light.
b) Write a short note on four probe method for measurement of hall mobility.

[4+4=8 Marks]

9. a) How the van der Pauw Method can be used for measuring the resistivity and the Hall coefficient of a sample.
b) Which physical parameters can be measured from voltage-current characteristics?

[6+2=8 Marks]

Roll No. in Figures

[Total No. of Questions: 09]

[Total No. of Pages: 02]

B. Tech (2018 Onwards) (Sem.-1,2)
SEMICONDUCTOR AND OPTOELECTRONICS PHYSICS
MCODE: [.....]
Subject Code: BTPH105-18
PaperID: [ ]

[Time allowed: 03 hours]

[Max. marks: 60]

INSTRUCTION TO THE CANDIDATES:

1. **Section-A is COMPULSORY consisting of TEN questions carrying two marks each.**
2. **SECTION B & C have FOUR questions each.**
3. **Attempt any five questions from Section-B and Section-C, selecting at least two questions from each of the two sections.**

Section-A

1. Write briefly:

(a) Differentiate between direct and indirect band gap materials?
(b) Define population inversion in Lasers.
(c) State Bloch's theorem for periodic system.
(d) What are salient features of free electron theory?
(e) What is exciton in semiconductors?
(f) State limitations of Drude model.
(g) Which property of the material can be measured using Hot point probe?
(h) How can a resistivity of any semiconductor material be measured?
(i) Calculate the number of donor atoms per m3 of n type material having resistivity of 0.25 Ohm-m, the mobility of electron is 0.3 m^2/Vs.
(j) What is implied by negative effective mass?

[2X10 = 20 Marks]

Section-B

2. a) Describe of limitations of free electron model in describing electronic properties of the materials?

b) Fermi velocity of electron is Cesium metal is 0.73×10^6 m/s. Calculate its Fermi energy and Fermi temperature.

[4+4=8 Marks]

3. [illegible]) Explain origin of the band gap in solids using Kronig-Penny model?

[8 Marks]

4. Why Fermi level is important in semiconductors? How does the fermi level varies in intrinsic n and p type semiconductors with temperature?

[8 Marks]

5. a) Mobilities of electron and holes in a sample of intrinsic Ge at 300***K*** are 0.36 and 0.15***m²/Vs***, respectively. If the resistivity of the specimen is 2.12 ***Ohm m***, calculate the forbidden energy gap for Ge.
   b) Explain the process of formation of holes in a semiconductor using a suitable schematic diagram?

[5+3=8 Marks]

Section-C

6. a) Explain the concept of population inversion and simulation emission in Lasers.
   b) Write a short note on the characteristics of a Semiconductor light emitting diodes.

[4+4=8 Marks]

7. a) Explain the working principle and characteristics of a photovoltaic.
   b) What are the various types of semiconductor photo detectors?

[4+4=8 Marks]

8. a) Describe one method for measuring divergence and wavelength of light.
   b) Write a short note on four probe method for measurement of hall mobility.

[4+4=8 Marks]

9. a) How the van der Pauw Method can be used for measuring the resistivity and the Hall coefficient of a material?
   b) Which physical parameters can be measured from voltage-current characteristics?

[6+2=8 Marks]

Roll No. in Figures ☐☐☐☐☐☐☐☐☐

[Total No. of Questions: 09]

[Total No. of Pages: 02]

B. Tech (2018 Onwards) (Sem.-1,2)
OPTICS AND ELECTROMAGNETISM
MCODE: [........]
Subject Code: BTPH106-18
PaperID: [........]

[Time allowed: 03 hours]

[Max. marks: 60]

INSTRUCTION TO THE CANDIDATES:

1. **Section-A is COMPULSORY consisting of TEN questions carrying two marks each.**
2. **SECTION B & C have FOUR questions each.**
3. **Attempt any five questions from Section-B and Section-C, selecting at least two questions from each of the two sections.**

Section-A

1. Write briefly:

   (a) What do you mean by double refraction?

   (b) The refractive index of a polarizer is 1.54. Find the polarization angle.

   (c) What happens when the number of lines on a grating is increased?

   (d) Discuss the necessary condition for optical fibre communication.

   (e) Write a short note on population inversion.

   (f) Explain briefly the Uncertainty principle.

   (g) Calculate the de Broglie wavelength associated with a electron subjected to a potential difference of 1.5kV.

   (h) Write a short note on dielectric polarization.

   (i) Distinguish between the paramagnetic and ferromagnetic material?

   (j) Draw the B-H curve for soft and hard magnetic materials.

[$2 \times 10 = 20$ Marks]

Section-B

2. a) Discuss the phenomena of Fraunhoffer diffraction due to a single slit.
b) A screen is places 5cm away from a narrow slit, find the slit width if the first minima lies 5 mm on either side of the central minimum when light of wavelength $\lambda = 5 \times 10^{-5}$ cm is incident on the slit.

[4+4=8 Marks]

3. Explain the term polarization and Brewster's law. Show that when light is incident at the polarization angle, the reflected and refracted rays are at right angle to each other.

[8 Marks]

4. a) Derive the expression for Acceptance angle and Numerical aperture in an optical fibre.
b) Calculate the numerical aperture for optical fibre given the refractive index of core and cladding are 1.45 and 1.43, respectively.

[4+4=8 Marks]

5. Explain the construction, working, and energy level diagram of a He-Ne laser.

[8 Marks]

Section-C

6. a) Derive the electro-magnetic wave equation in the free space.
b) Show that the electro-magnetic waves travel with velocity of light in free space.

[4+4=8 Marks]

7. a) Why there was need to modify Ampere's circuital law? What was the modification?
b)In free space, $\vec{H} = 1000\sin(\omega t - 10x)$ A/m along z-axis. Find $\vec{B}$, $\vec{E}$ and displacement current density.

[4+4=8 Marks]

8. a) What is group velocity and phase velocity? Derive the relationship between the two.
b) Calculate the de Broglie wavelength associated with a electron subjected to a potential difference of 1.5kV.

[4+4=8 Marks]

9. a) Derive the expression for energy eigen value and eigen functions for a particle confined in one dimensional box. b) Normalise the wavefunctions $\psi(x) = N\sin\left(\frac{n\pi x}{L}\right)$ of a particle in a box of length L.

[4+ 4= 8 Marks]

Roll No. in Figures ☐☐☐☐☐☐☐☐☐

[Total No. of Questions: 09] [Total No. of Pages: 02]

B. Tech (2018 Onwards) (Sem.-1,2)
INTRODUCTION TO PHYSICS IN BIOTECHNOLOGY
MCODE:[........]
Subject Code: BTPH107-18
PaperID: [ ]

[Time allowed: 03 hours] [Max. marks: 60]

INSTRUCTION TO THE CANDIDATES:

1. Section-A is COMPULSORY consisting of TEN questions carrying two marks each.
2. SECTION B & C have FOUR questions each.
3. Attempt any five questions from Section-B and Section-C, selecting at least two questions from each of the two sections.

Section-A

1. Write briefly:

(a) Define population inversion in Lasers.
(b) Difference between Diamagnetic and paramagnetic materials.
(c) Calculate the numerical aperture of step index fiber with core of refractive index of 1.5 and a cladding of refractive index 1.48?
(d) The magnetic susceptibility of medium is 9.48×10^{-9}. Calculate the relative permeability.
(e) What are type I and Type-II superconductors?
(f) Differentiate between hard and soft magnetic materials.
(g) Why are ultrasonic waves no audible to humans?
(h) Why light shows a dual wave particle nature?
(i) Find the shortest wavelength present in the radiation from an x-ray machine whose accelerating potential is 50,000V.
(j) What is effect of electron confinement in nanomaterials?

[2X10 = 20 Marks]

Section-B

2. a) Calculate the refractive index of core and cladding material of fiber from the following data: NA= 0.30 and $\Delta = 0.02$.

b) What is pulse dispersion? Differentiate between the step-index and graded-index multimode fiber.

[4+4=8 Marks]

3. a) What is Meissner effect? Show that superconductors are perfectdiamagnets.

b) Give a qualitative explanation of the BCS theory of superconductors.

[4+4=8 Marks]

4. a) What is the origin of magnetism and explain Magnetic anisotropy?

b) The critical field for Nb is 1×10^5 A/m at 8K and 2×10^5 A/m at 0K. Calculate the transition temperature of the element.

[5+3=8 Marks]

5. Explain the construction, working, and energy level diagram of He-Ne laser.

[8 Marks]

Section-C

6. a) Differentiate between continuous and characteristic X-rays.

b) Describe doppler principle and how it can be used in the medical instruments.

[4+4=8 Marks]

7. a) Discuss the necessary condition for X-rays diffraction and obtain the Bragg's law.

b) Calculate the longest wavelength, that can be analyzed by a rock-salt crystal of spacing d = 2.88 Å in the first order.

[5+3=8 Marks]

8. a) Describe Compton effect and its physical significance.

b) What are the factors on which the energy of the emitted photoelectron depends?

[4+4=8 Marks]

9. a) Differentiate between the top-down and bottom-up approach for synthesis of nanomaterials.

b) Describe qualitatively the concept of quantum well and quantum dot.

[4+4=8 Marks]

INSTRUCTIONS FOR THE EXAMINAR FOR SETTING QUESTION PAPER FOR B.TECH 1st SEMESTER, 2018

1.The written exam will be of subjective type and total of 60 marks

2.The duration of the exam will be of three Hours.

3. There should be three sections in all and contain nine questions as per the following instructions:

a) **Section-A** is compulsory and should contain 10 question of two marks each. This section should cover whole syllabus uniformly.

b) **Section-B** should contain total four questions. Two questions from Unit-I and two from Unit-II. Each question should be of eight marks. Question may carry two subparts of four marks each.

c) **Section-C** should contain total four questions. Two questions from Unit-III and two from Unit-IV. Each question should be of eight marks. Question may carry two subparts of four marks each.

Students shall be asked to attempt any five questions from **Section-B** and **Section-C**, selecting at least **two** questions from each of the two Sections.

[Total No. of Questions: 09] [Total No. of Pages: 02]

Uni. Roll No. ....

Course: B.Tech.
Sem. - 1st
Name of Subject: Engineering Mathematics-I
Subject Code: BTAM101-18

Time Allowed: 03 Hours **Max. Marks: 60**

NOTE:

1) **Section-A** is compulsory
2) Attempt any **five** questions from **Section-B** and **Section-C,** selecting at least **two** questions from each section.
3) Any missing data may be assumed appropriately.

Section-A[Marks: 02 each]

Q.1

(a) Verify Roll's theorem for the function $f(x)=\cos\left(\frac{1}{x}\right)$ on $[-1,1]$

(b) Define improper integral of the first kind

(c) Evaluate $\lim\limits_{x\to 0}\frac{xe^x-\log(1+x)}{x^2}$

(d) If $u=\frac{x+y}{1-xy}$ and $v=\tan^{-1}x+\tan^{-1}y$, find $\frac{\partial(u,v)}{\partial(x,y)}$.

(e) Evaluate $\int_1^2\int_3^4(xy+e^y)dxdy$.

(f) Evaluate $\int_0^{\frac{\pi}{2}}\left[\int_0^{a\cos\theta}r\sqrt{a^2-r^2}dr\right]d\theta$.

(g) Define orthogonal matrix.

(h) State the conditions in terms of rank of coeff. matrix and rank of augmented matrix for a unique solution, no solution and infinite no of solutions for a system of a linear equations.

(i) Discuss the convergence of the sequence $\{a_n\}$ where $a_n=\frac{n+1}{n}$

(j) State De-Alembert's Ratio Test for the convergence of the series.

Section-B [Marks: 08 each (04 for each sub part if any)]

Q.2 (a) State Lagrange's mean value theorem and verify for the function $f(x)=x(x-1)(x-2)$ in $\left[0,\frac{1}{2}\right]$

(b) Expand $e^x\sin y$ in power of x and y as far as terms of third degree.

Q3. (a) Find the volume of the solid generated by the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1,\ a>b$ be the major axis.

(b) Evaluate the improper integral $\int_0^2 \frac{dx}{2x-x^2}$, if it exists.

Q.4 Find the minimum value of $x^2+y^2+z^2$ given that $xyz=a^3$ by using Lagrange's method of undetermined multipliers.

Q.5 (a) Evaluate $\int_0^1 \int_0^{\sqrt{1-x^2}} \int_0^{\sqrt{1-x^2-y^2}} \frac{1}{\sqrt{(1-x^2-y^2)-z^2}}\, dz dy dx$.

(b) By double integration, find the area lying inside the circle $r=a\sin\theta$ and the cardioid $r=a(1-\cos\theta)$

Section-C [Marks: 08 each (04 for each sub part if any)]

Q.6 (a) Verify Cayley-Hamiliton Theorem for the matrix $A=\begin{bmatrix}1&2&3\\2&4&5\\3&5&6\end{bmatrix}$.

(b) Find the rank of the matrix A: $\begin{bmatrix}1&4&5\\2&6&8\\3&7&22\end{bmatrix}$.

Q.7 Find the eigen value and eigen vectors of the following matrix:

$$\begin{bmatrix}-2&2&-3\\2&1&-6\\-1&-2&0\end{bmatrix}.$$

Q.8 (a) Test for the convergence of the series: $\frac{1}{5}+\frac{\sqrt{2}}{7}+\frac{\sqrt{3}}{9}+\frac{\sqrt{4}}{11}+\dots\dots\dots$.

(b)Test for the convergence of the series: $\frac{1}{1.2.3}+\frac{3}{2.3.4}+\frac{5}{3.4.5}+\dots\dots\dots$.

Q9. Test the convergence of the following series:

$$1+\frac{2x}{2!}+\frac{3^2x^2}{3!}+\frac{4^3x^3}{4!}+\frac{5^4x^4}{5!}+\dots\dots\dots+\infty$$

Total Number of Questions: 05

B.Tech. (2018 Onwards)
English
M. Code:.........
Subject Code: BTHU-101-18
Paper ID:........

Time: 03 Hours

M. Marks: 60

INSTRUCTIONS TO CANDIDATES:
1. All questions are COMPULSORY.
2. Question 1, 2 and 3 carrying TEN marks each.
3. Question 4 and 5 carrying FIFTEEN marks each.

Q.1 Discuss in detail the different types of words and word-formation processes in English. (10)

Q.2 Given below is an extract of Bajaj's letter to Nehru. Identify the varied cohesive devices employed in this paragraph followed by a re-writing of the para using a range of alternate cohesive devices. (10)

Whatever the sins of Bakshi Ghulam Mohammed, it must be said in fairness to him that he is making supreme efforts to keep Kashmir with India. It can be done through force but the wiser course would be to do so with free will of the State people. Not much effort has to be made to secure the support of the Hindus for the purpose, but it is not easy to have the goodwill of Muslims. Despite the repressive policy which he has been pursuing all these years and with which I am in total disagreement, I think Bakshi Sahib is sincerely anxious to make the Kashmir Muslims appreciate that integration with India is more beneficial to them than accession to Pakistan. For this endeavour he deserves praise of the patriotic Hindus and not brickbats as are time and again hurled at him.

Q.3 Read the passage and answer the question that follow:

1 In spite of all the honours that were heaped upon him, Pasteur, as has been said, remained simple at heart. Perhaps the imagery of his boyhood days, when he drew the familiar scenes of his birthplace, and nurtured the longing to be a great artist, never wholly left him. In truth he did become a great artist, though after his sixteenth year he abandoned the brush forever. Like every artist of worth, he put his whole soul and energy into his work, and it was this very energy that in the end wore him out. For to him, each sufferer was something more than just a case that was to be cured. He looked upon the fight against hydrophobia as a battle, and he was absorbed in his determination to win. The sight of injured children, particularly, moved him to an indescribable extent. He suffered with his patients, and yet he would not deny himself a share in that suffering. His greatest grief was when sheer physical exhaustion made him give up his active work. He retired to the estate at *Villeneuve Etang*, where he had his kennels for the study of rabies, and there he passed his last summer, as his great biographer, Vallery Radot, has said, "practicing the Gospel virtues."

2 "He revered the faith of his fathers," says the same writer, "and wished without ostentation or mystery to receive its aid during his last period."

3 The attitude of this man to the science he had done so much to perfect can be best summed up in a sentence that he is reputed once to have uttered, concerning the materialism of many of his contemporaries in similar branches of learning to his own: "The more I contemplate the mysteries of Nature, the more my faith becomes like that of a peasant."

4 But even then in retirement he loved to see his former pupils, and it was then he would reiterate his life principles: "Work," he would say, "never cease to work." So well had he kept this precept that he began rapidly to sink from exhaustion.

5 Finally on September 27, 1895, when someone leant over his bed to offer him a cup of milk, he said sadly: "I cannot," and with a look of perfect resignation and peace, seemed to fall asleep. He never again opened his eyes to the cares and sufferings of a world, which he had done so much to relieve and to conquer. He was within three months of his seventy-third birthday.

6 Thus passed, as simply as a child, the man whom the French people were to vote at a plebiscite as the greatest man that France had ever produced. Napoleon, who has always been considered the idol of France, was placed fifth.

7 No greater tribute could have been paid to Louis Pasteur, the tanner's son, the scientist, the man of peace, the patient worker for humanity.

1.1 Answer the following questions :

a. Even accolades and honours did not change the simple man that Pasteur was. Why? **(3 mark)**

b. How did Pasteur view those who suffered from diseases? **(2 mark)**

c. How did France, the country of his birth, honour this great scientist? **(2 marks)**

1.2 Find the words from the passage which mean the same as: 3 marks

a. To give up **(para 1)**

b. People belonging to the same period **(para 3)**

c. Vote by the people of the country to decide a matter of national importance **(para 6)**

Q.4 Write an essay in about 500 words on **Indian society at cross roads. (15)**

Q.5 A company based in Chennai is looking to open a branch in a region around Delhi. The CEO of the company has met you, and wants your company to take up research for the best possible location in the north India. S/he has asked you to evaluate six locations: Faridabad, Gurgaon, Jaipur, Noida, Agra and Dehradun. Your job is to evaluate these cities for business possibilities. Secondly, a number of senior managers of the company are to be transferred to the new branch. Since they would be shifted to new location with their families, you also need to find out whether the new location has all the required facilities for them. Seen thus, work-life balance and/or business possibilities mean a confusing domain for you. Keeping in view the corollaries, design a short report for your client. **(15)**

Total No. of Pages 01

Roll No. _______________

Total No. of Questions: 09

B.Tech. (Sem- 1&2) Dec, 2018
Programming for Problem Solving
Subject code: BTPS101-18

Max. Marks: 60

Time: 3 hrs.

Instructions to Candidates:

1. **Section A is compulsory consisting of ten questions carrying TWO marks each.**
2. **Section B & C have four questions each carrying EIGHT marks each**
3. **Attempt any five questions from Section B& C, selecting at least two from each section.**

SECTION-A

1. **Write briefly:**
   - a. What is an algorithm?
   - b. List various input and output devices.
   - c. What is the significance of operating system?
   - d. Why switch statement is used?
   - e. Write down the syntax of function declaration also give an example.
   - f. Draw block diagram of a computer system.
   - g. Differentiate syntax and logical errors.
   - h. Compute the binary equivalent of 357.
   - i. List jumping statements.
   - j. Write down the syntax of else-if ladder.
   - k. Differentiate RAM and ROM.

SECTION-B

2. List and explain string library functions in detail.
3. Write the following programs
   - **a.** To determine whether a number is palindrome.
   - **b.** To compute transpose of a matrix.
4. Differentiate call by value and call by reference with programming example.
5. Write a program to search an element from a list of numbers.

SECTION-C

6. What do you mean by recursion? Give programming illustration to represent the concept of recursion.
7. Write a program to sort a list of numbers using bubble sort method.
8. Explain the following operators with example
   - a. Relational
   - b. Conditional
   - c. Logical
   - d. Arithmetic
9. Explain the concept of array of structure with programming illustration.

SAMPLE - QUESTION PAPER BTEE-101-18

[Total no of questions:09]

[Total no. of pages: 02]

University Roll No.: ____________________

Programme/Course: **B. Tech All Branches (Semester: 1/2)**
Name of the Subject: **Basic Electrical Engineering**
Subject code: BT**EE-101-18**
Paper ID: **XXXXXX**

Time Allowed: 3 Hours

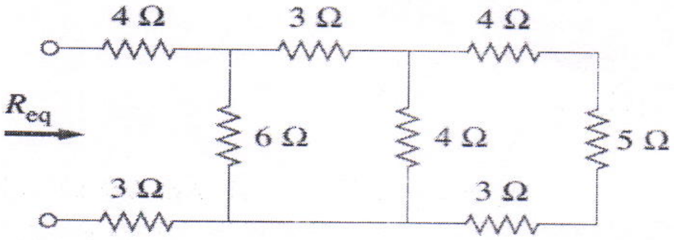
Max Marks: 60

NOTE:

1) **Section-A** is **compulsory**
2) Attempt any **four** questions from **Section-B** and any **two** questions from **Section -C**
3) Any missing data may be assumed appropriately

Section-A **[Marks:02 each]**

Q1. a) Find R_{eq} for the circuit shown: 2



b) In an inductor of L henry, charge is flowing at the rate of q coulombs/sec. What is the energy stored in it? 2

c) Sketch the current and voltage waveform of: 2
$i = I \sin(\omega t - 60°)$
$v = V \cos(\omega t + 30°)$

d) State the Superposition theorem. 2

e) State how the LV and HV windings are placed in a core type transformer. 2

f) A 6-pole induction motor of fed from 50Hz supply and it is running at 960 rpm. Find the synchronous speed and slip. 2

g) What is a single-phase induction motor not self-starting? 2

h) What are the main constructional parts of a alternator/synchronous generator? 2

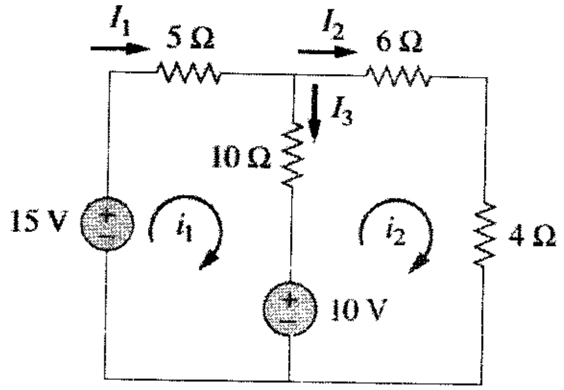
i) What is the purpose of using a fuse in and electric circuit? 2

j) Why is it essential to provide earthing of electrical appliances? 2

Section-B

[Marks:05 each]

Q2. Using mesh analysis find the current I_1, I_2 and I_3 5



Q3. Derive the voltage current relationship in (a) Star Connection (b) Delta Connection 5

Q4. A single phase, 230V/110V, 50 Hz transformer takes an input of 350-volt ampere at no load while working at rated voltage. The core loss in 110 W. Find the working component of no-load current, magnetizing component of no load current and no-load power. 5

Q5. Write a note on DC-DC buck boost converter. 5

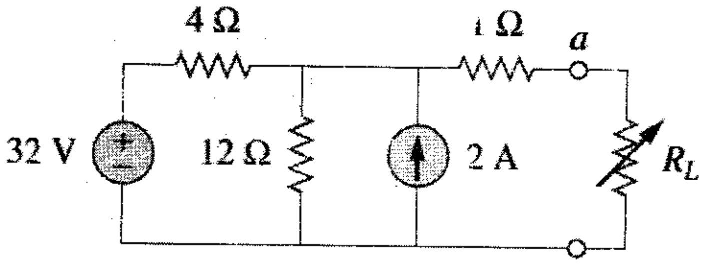
Q6. Write a detailed not on types of wires and cables. 5

Section-C

[Marks:10 each (05 for each sub-part, if any]

Q7. (a) Define Thevenin's theorem. 2

(b) Find the Thevenin Equivalent circuit. Find the current through R_L when its value is 6 ohm. 3,3,2



Q8. Discuss the torque-slip characteristic of a 3-Phase induction motor and its three modes of operation. 10

Q9. A current of 0.9A flows through a series combination of a resistor of 120 Ω and a capacitor of reactance 250 Ω. Find: 10

(i) Impedance
(ii) Power factor
(iii) Supply voltage
(iv) Voltage across resistor
(v) Voltage across capacitor
(vi) Apparent power
(vii) Actual power
(viii) Reactive power

****

Soln 1 (a). → 4Ω, 5Ω & 3Ω in series = 12Ω.

→ 12Ω in ||al with 4Ω = $\frac{4\times\cancel{12}^{3}}{\cancel{16}_{4}}$ = 3Ω

→ 3Ω & 3Ω in series = 6Ω.

→ 6Ω in ||al with 6Ω = $\frac{6\times 6}{12}$ = 3Ω.

→ 4Ω, 3Ω & 3Ω in series = 10Ω.

1 (f) $P = 6$

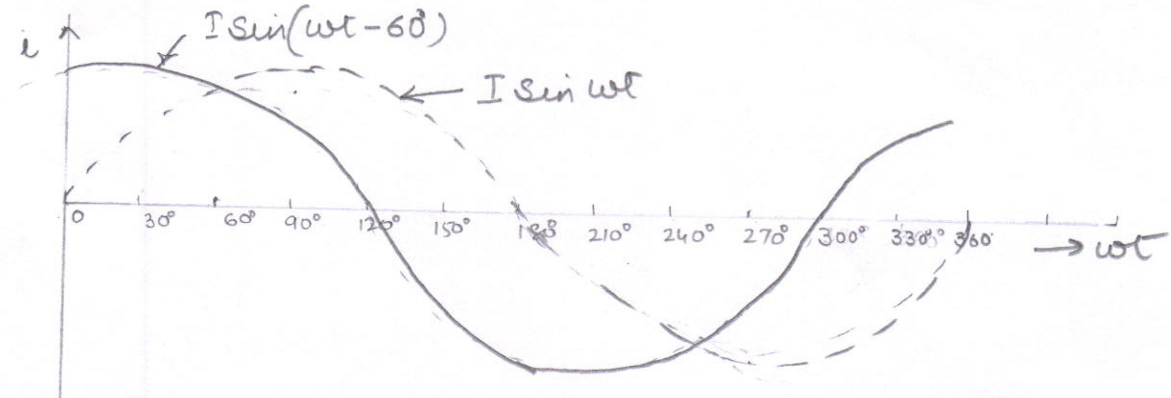
$f = 50$ Hz.

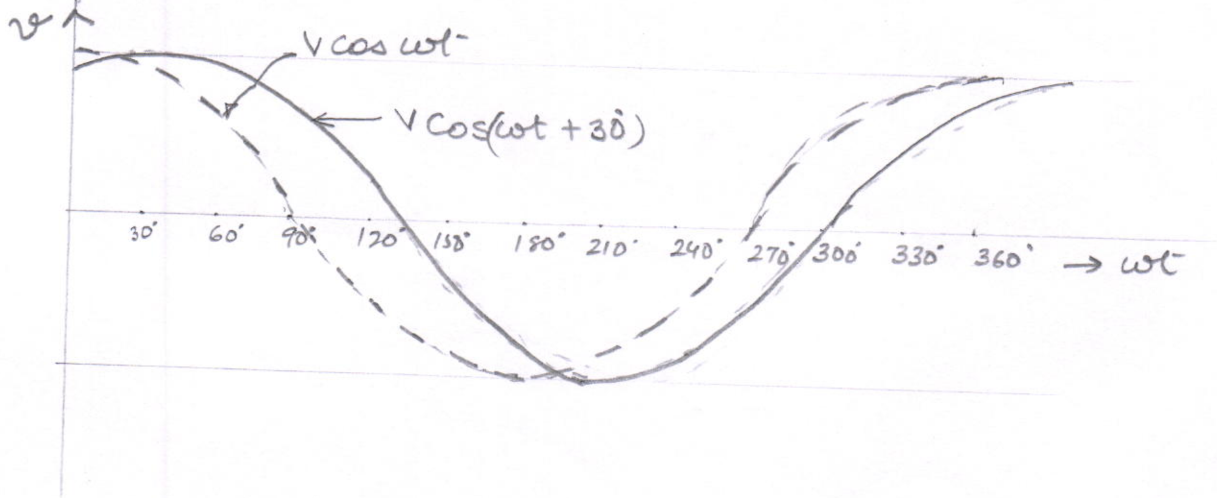
$N = 960$ rpm.

$N_s = \frac{120 f}{P} = \frac{\overset{20}{\cancel{120}}\times 50}{\cancel{6}} = 1000$ rpm

Slip, $S = N_s - N = 1000 - 960 = 40$ rpm

1 (c)





Solution 2: Mesh Current using KVL.

Mesh 1

$-15+5i_1+10(i_1-i_2)+10=0.$

$15i_1-10i_2=5.$

$3i_1-2i_2=1$ —— ①

Mesh 2.

$6i_2+4i_2+10(i_2-i_1)-10=0.$

$20i_2-10i_1=10$

$i_1=2i_2-1$ ②

substitute ② in ①, we get

$3(2i_2-1)-2i_2=1$

$i_2=1$ and $i_1=1$

Now $I_1 = i_1 = 1$ amp

$I_2 = i_2 = 1$ amp.

$I_3 = i_2-i_1=0$

Solution 4 230V/110V, 50Hz., 350 VA

$P_i = 110$ Watt

$P_i = V_1 I_0 \cos\phi_0$

$p.f = \cos\phi_0 = \frac{P_i}{V_1 I_0}$

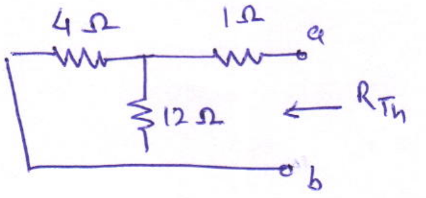
$I_0 = \frac{VA}{V_1} = \frac{350}{230} = 1.52A$

$P.f = \frac{110W}{350VA} = 0.314$

$I_w = I_0 \cos\phi_0 = 1.52 \times 314 = 0.478A.$

$I_m = \sqrt{I_0^2 - I_w^2} = \sqrt{(1.52)^2-(0.478)^2} = 1.44A$

Soln 7 (b) for R_{Th}



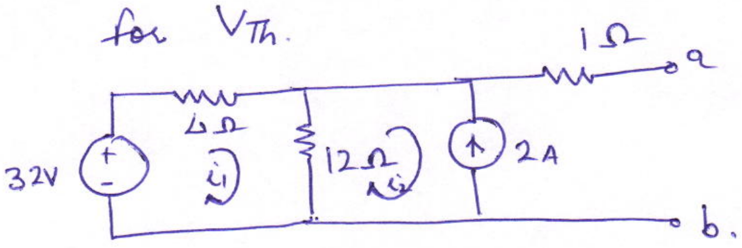
→ 4Ω and 12 Ω in parallel

$$\frac{4 \times 12}{16} = 3\,\Omega.$$

→ 3Ω in series with 1Ω

$$R_{Th} = 4\,\Omega$$

for V_{Th}.



Two loops are there.

$-32 + 4i_1 + 12(i_1 - i_2) = 0$. and $i_2 = 2A$.

$16i_1 - 12i_2 = 32$

$4i_1 - 3i_2 = 8$.

$4i_1 - 3(2) = 8$.

$4i_1 - 6 = 8$.

$i_1 = 0.5A$.

$V_{Th} = 12(i_1 - i_2) = 12(0.5 + 2) = 30V$.

when $R_L = 6\,\Omega$.

$V_{Th} = 30V$.

$I_L = \cancel{\frac{30V}{6\Omega}} \frac{V_{Th}}{R_{Th} + R_L} = \frac{30}{4+6} = 3A.$

Solution 9

$I = 0.9 \angle 0^\circ$ A.

(i) $Z = 120 - j250 = 277.3 \angle -64.4^\circ \Omega$.

(ii) P.f = $\cos\phi = \cos(-64.4) = 0.432$ leading

(iii) $V = IZ = (0.9 \angle 0^\circ)(277.3 \angle -64.4^\circ) = 249.6 \angle -64.4^\circ$ Volts

(iv) $V_R = IR = 0.9 \angle 0^\circ \times 120 = 108 \angle 0^\circ$ volts

(v) $V_C = I X_C = 0.9 \angle 0^\circ \times 250 \angle -90^\circ = 225 \angle -90^\circ$ volts

(vi) Apperent Power = $VI = 249.6 \times 0.9 = 224.6$ VA

(vii) Actual Power = $VI \cos\phi = 224.6 \cos 64.4^\circ = 97.06$ Watts

(viii) Reactive Power = $VI \sin\phi = 224.6 \sin 64.4^\circ = 202.59$ VAR.