P818

[3831]-31
M.Sc.
POLYMER SCIENCE
PS - 310 : Kinetics and Mechanism of Polymerization Processes
(Old Syllabus)

Time : 3 Hours]   *[Max. Marks : 80*

Instructions to the candidates:
1) *All questions are compulsory.*
2) *Answers to the two sections should be written in separate answer books.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic table/calculator is allowed.*

SECTION - I

Q1) Attempt any four of the following :   **[20]**

a) How do addition and condensation polymerizations differ from each other?

b) Discuss the effect of by-product removal on the molecular weight built up of the polymer formed in step reaction polymerization with a suitable example.

c) What is importance of stoichiometric ratio of the reactants in condensation polymerization? Illustrate it with suitable example.

d) In a typical polyesterification, self catalyzed reaction is of the third order with respect to carboxylic acid concentration. However it is much slower than the similar reaction with strong acid as a catalyst, which is second order with respect to the carboxylic acid concentration. Explain.

e) What will be the effect of monofunctional and trifunctional chemicals in condensation polymerization? How will it affect gel point?

f) Derive relation between number average degree of polymerization and extent of reaction for step reaction polymerization process, when stoichiometry is not maintained.

Q2) Attempt any four of the following :   **[20]**

a) Discuss cationic mechanism of addition polymerization.

b) In a radical polymerization, is it advisable to use retarder for inhibiting the reaction? Comment on it.

c) What are chain transfer agents? Describe their effect on the rate expression and molecular weights obtained in their presence chain transfer agents.

d) Compare and explain the steps involved in cationic and anionic polymerization.

e) Enlist assumptions made for deriving rate expression for typical polyesterification reaction. Describe its suitability based on experimental evidences.

f) Discuss effect of temperature and pressure on chain polymerization.

SECTION - II

Q3) Attempt any four of the following : **[20]**

a) Unlike in free radical polymerization both cationic and anionic polymerizations show a marked dependence on type of solvent used. Discuss the causes behind it.

b) Describe the structure of Ziegler-Natta catalyst used in co-ordination polymerization of olefins. Write any one mechanism.

c) Discuss the influence of ion pair on polymerization by cationic and anionic mechanisms.

d) Write a short note on ring opening polymerization.

e) Write a short note on living polymer.

f) Rate of radical polymerization needs to be doubled. Suggest various alternatives to achieve it.

Q4) Attempt any four of the following : **[20]**

a) Vinyl cinnamate does not readily form copolymer with acrylic acid. However it forms copolymer very easily with vinyl acetate. Explain this phenomenon. Predict copolymerization of vinyl acetate with acrylic acid.

b) What are advantages of "Q and e" scheme in copolymerization? State its limitations.

c) For estimating reactivity ratios, most of the methods require very low conversions in the copolymerization reactions. Why? Justify the answer with suitable examples.

d) Write any one graphical method of determining reactivity ratio in binary copolymerization. State its limitations.

e) Predict the values of reactivity ratios for obtaining the copolymers as described as follows :
    i)   random copolymer,
    ii) block of 1 with short group of 2, and
    iii) long block of 1 separated by one unit of 2.

f) Is it possible to take a feed ratio for preparation of copolymer that is directly observed in the copolymer formed? Explain with appropriate diagram.

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P819

[3831]-32

M.Sc.
POLYMER SCIENCE
PS - 311 : Synthesis, Structural Aspects, Properties and Applications of Polymers
(Old)

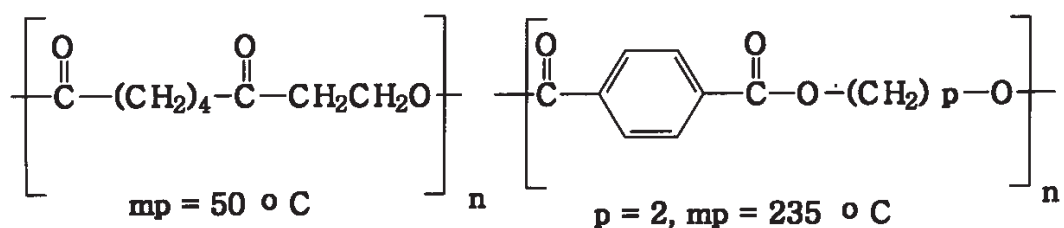*Time : 3 Hours]*   *[Max. Marks : 80*

Instructions to the candidates:

1) *All questions are compulsory.*
2) *Answers to the two sections should be written in separate answer books.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic table/calculator is allowed.*
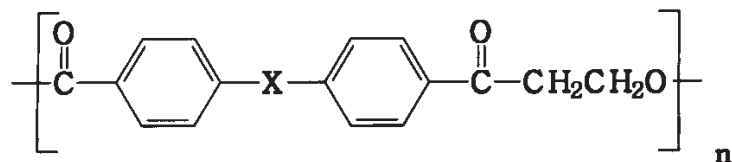
SECTION - I

Q1) Attempt any four of the following :   **[20]**

a) Write the structure of lignin. What are the different types of bonds joining chains? How is pulp sulfated? What happens to lignin and why is the process called sulfate pulping?

b) Concerning aromatic polyamides, please explain the following :
   i) Aromatic polyamides have not attained commercial importance of aliphatic polyamides mainly because of production and processing difficulties.
   ii) How are aromatic polyamides prepared by interfacial polymerization?

c) Explain the mechanism by which oils dry in air using linoleic acid as an example. Explain
   i) the formation of hydroperoxides,
   ii) primary decomposition,
   iii) induced temperature, and
   iv) termination steps.

d) Methylethyl ketone peroxide and cyclohexanone peroxide are commercially available. Please write their structure and explain the role of cobalt octoate and the role of the octoate radical as an accelerator.

e) Is there a relation between the structure and m.p. for the polymers shown below? Please write the structures of monomers required for each of these polymers.
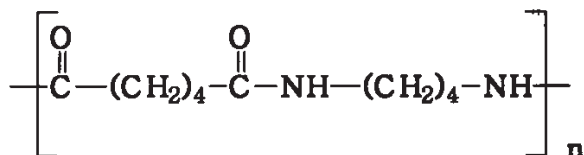
$$\left[\begin{matrix} \overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-CH_2CH_2O \end{matrix}\right]_n$$

mp = 50 °C

$$\left[\begin{matrix} \overset{O}{\overset{\|}{C}}-\bigcirc\!\!\!-\overset{O}{\overset{\|}{C}}-O-(CH_2)\,p-O \end{matrix}\right]_n$$

p = 2, mp = 235 °C

p = 4, mp = 265 °C

$$\left[\begin{matrix} \overset{O}{\overset{\|}{C}}-\bigcirc\!\!-X-\bigcirc\!\!-\overset{O}{\overset{\|}{C}}-CH_2CH_2O \end{matrix}\right]_n$$

X = (CH2)4, mp = 170 °C

X = OCH2CH2O; mp = 240 °C

X = NH-(CH2)2-NH, mp = 270 °C

$$\left[\begin{matrix} \overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-NH-(CH_2)_4-NH \end{matrix}\right]_n$$

mp = 295 °C

f) Explain the following regarding nylon 6.

i) Nylon 6, 6 and nylon 6 are used as fibers, nylon 6, 10 and nylon 11 are used as surgical sutures and brushes;

ii) Melting points are given below.

$$\left[\begin{matrix} X-(CH_2)_6-X-\overset{O}{\overset{\|}{C}}-(CH_2)_4 \quad \overset{O}{\overset{\|}{C}} \end{matrix}\right]_n$$
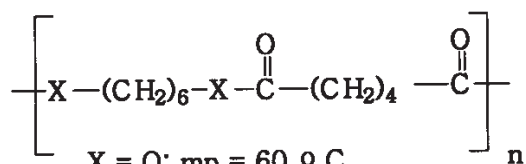
X = O; mp = 60 °C

X = NH; mp = 265 °C

X = NCH3; mp = 166 °C

Q2) Attempt any four of the following : **[20]**

a) In the preparation of linear unsaturated polyesters, explain the following:

i) the preference of phthalic anhydride over phthalic acid;

ii) the conversion of naphthalene to phthalic anhydride, 4.5 mole so oxygen are used to give CO_2 and H_2 (2 mols each) as by-product, and

iii) for the manufacture of anhydride o-xylene is preferred to naphthalene.

b) Using load deflection curves, explain why flexible foam present from hydroxyl terminated polyethers are preferred to those prepared from hydroxyl-terminated polyesters for upholstery application. By contrast the opposite is true for use as shoulder pads for coats. Why?

c) Explain how spectroscopy can be used to determine the average number of styrene units to crosslink two chains of linear unsaturated polyesters. What are the assumptions involved in this method? How is this assumption justified? How can the validity of this assumption be confirmed experimentally?

d) Describe mechanism and the process of photonitrosation for conversion of cyclohexane to caprolactam. What are its advantages as compared to the usual process?

e) Write the structures of maltose and cellobiose and bring out the differences. How does one determine the stereochemistry of the glycoside linkage established in these two isomers? Can the structure of cellobiose and maltose be determined and how?

f) A typical formulation of rigid foam is given below. Comment on the role of different compounds and their quantities. Give the structure of DABCO. Low molecular weight polyether polyols (100 parts by weight); crude MDI (stoichiometric + 5%); $CFCl_3$ 50; Glycerine 10; DABCO 0.5; silicone block copolymer 1.0.

SECTION - II

Q3) Attempt any four of the following : **[20]**

a) Resol prepolymers were synthesized using sodium hydroxide and magnesium hydroxide as catalyst. The prepolymers formed were used towards step II crosslinking reaction. Will the behaviour of the two prepolymers be different towards crosslinking? Explain.

b) Explain the role of aliphatic and aromatic polyamines in the curing of epoxy resins. Describe the differences in the adhesive properties of both the adhesives.

c) Write importance of chemical modification of the M-F resins. Explain the equations involved in such modifications.

d) Describe any one method of manufacturing silicon containing polymers. Explain the applications of the manufactured polymer.

e) Compare crosslinking reactions in phenol-formaldehyde and urea-formaldehyde resins.

f) What are resol polymers? How does the ratio of phenol to formaldehyde affect the properties of the polymer formed?

Q4) Attempt any four of the following :　　　　　　　　　　　　　　**[20]**

a) Give a synthetic method for the preparation of
   i)　acrylonitrile,
   ii)　vinyl acetate,
   iii)　styrene, and
   iv)　acrylic acid.

b) Describe the manufacture of any methacrylate polymer. State its important applications.

c) Describe variation in the manufacturing of LDPE, LLDPE, and HDPE.

d) Describe at least three halogen containing polymers. Compare their different properties. State their applications.

e) Write a short note on Ziegler-Natta catalyzed manufacture of polyethylene. Explain the advantages of gas phase over solution phase process.

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P820

[3831]-33
M.Sc.
POLYMER SCIENCE
PS - 312 : Polymer Processing
(Old)

Time : 3 Hours]   *[Max. Marks : 80*

Instructions to the candidates:
   1)   All questions are compulsory.
   2)   Answers to the two sections should be written in separate answer books.
   3)   Figures to the right indicate full marks.
   4)   Use of logarithmic table/calculator is allowed.

SECTION - I

Q1) Attempt any four of the following :   **[20]**

   a)   Why is there a need for polymers to be processed? How do the polymer processes differ from that of metals?

   b)   Explain the need and role of various additives that are added to a polymer before processing? Explain with respect to any non elastomeric polymer.

   c)   Explain citing suitable examples, the role of plasticizer and thermal stabilizer.

   d)   Describe the selection criteria for selecting a specific polymer for making an object, amongst many polymers available.

   e)   What are the different processes that can be used to make a cup like object of about 900 cubic centimeters? Which criteria should be applied to choose a specific process?

   f)   Size, complexity and number of pieces of objects required influence the choice of polymer processing. Explain.

Q2) Attempt any four of the following :   **[20]**

   a)   What are merits and demerits of compression molding over other processes to get a similar product?

   b)   If temperature control is not efficient in a transfer molding operation, what will be the defects caused in the product.

c) Describe the transfer molding process citing typical processing parameters.

d) Compare compression molding with transfer molding.

e) With the help of suitable diagram explain the role of different zones in extruder barrel.

SECTION - II

Q3) Attempt any four of the following : **[20]**

a) Enlist and define different screw parameters with the help of suitable diagram. Explain their role in processing condition.

b) Explain the importance of screw design in different zones of the extruder barrel.

c) Explain the need of twin screw in extrusion. Describe its advantages over single screw extrusion.

d) Describe counter rotating twin screw extrusion.

e) Describe co rotating twin screw extrusion.

f) Explain in brief, the principal behind the processes of injection molding, reaction injection molding reinforced reaction injection molding.

Q4) Attempt any four of the following : **[20]**

a) What are the advantages of reciprocation screw injection molding over ram based injection molding process?

b) Discuss peculiarities of injection molding process.

c) Describe any one process of obtaining an object with large internal hollow space.

d) Explain the differences between extrusion blow molding and injection blow molding.

e) Describe a process of blow molding for a bottle with thread on its neck.

f) Explain various defects occurring in injection molding and suggest remedies for them.

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P821

[3831]-34

M.Sc.

POLYMER SCIENCE

PS - 313 : Polymer Chains and their Characteristics

(Old Syllabus)

Time : 3 Hours]   *[Max. Marks : 80*

Instructions to the candidates:

    1)   *All questions are compulsory.*

    2)   *Answers to the two sections should be written in separate answer books.*

    3)   *Figures to the right indicate full marks.*

    4)   *Use of logarithmic table/calculator is allowed.*

SECTION - I

Q1) Attempt any four of the following :   **[20]**

    a) Compare and contrast the dissolution process of low molecular weight solute and high molecular weight polymers.

    b) Define cohesive energy density and solubility parameter. Enlisting the variables influencing solubility parameter, explain its industrial significance.

    c) What are virial coefficients? Explain Flory Theta temperature, a good solvent and a poor solvent.

    d) Write short notes on colligative properties with respect to the molecular weights of polymers.

    e) Explain Flory-Huggins theory and the parameters on which it is based.

    f) What is LCST and UCST? Explain with suitable examples.

Q2) Attempt any four of the following :   **[20]**

    a) Explain the concept of Theta temperature.

    b) What is hydrodynamic volume and excluded volume? What is the origin of excluded volume?

c) Determine the solubility parameter of poly-n-butyl acrylate

Assume the following :

Group	Fsmall	Fvolume
$-CH_2-$	133	16.45
$>C<$	-93	4.75
$-CH_3$	214	22.8
$-COO-$	310	21.0

Density of poly-n-butyl acrylate is 1.05.

d) What happens when polymers are irradiated with radiations?

e) Discuss the application of radiation induced polymerisation in
   i)   grafting,
   ii)   polymer modification, and
   iii) removal of monomer.

f) A relatively small dose of radiation causes appreciable change in the physical properties of a polymer though the chemical change produced is negligible. Explain.

SECTION - II

Q3) Attempt any four of the following :   [20]

a) Explain the following :
   i)   Weissenberg effect,
   ii)   Bingham plastic,
   iii) Plasticity,
   iv)   Elasticity, and
   v)   Viscosity.

b) Write and explain Hook's equation and Newton's equation.

c) Explain Voigt model. Which phenomenon is explainable using this model? What are the limitations of the model?

d) Explain the term visco-elasticity with respect to polymeric materials.

e) Explain how the parameters such as :
   i)   molecular entanglement,
   ii)   crystallinity, and
   iii) molecular weight affect visco-elastic properties for polymers.

f) Describe Burger model for deformation behaviour of polymeric material.

Q4) Attempt any four of the following :   **[20]**

 a) Explain power law model.

 b) Draw and explain stress strain curve for the following polymeric materials.
   i) Hard and brittle,
   ii) Hard and strong,
   iii) Hard and tough,
   iv) Soft and weak, and
   v) Soft and tough.

 c) Describe cone and plate viscometer. Explain its scope and limitation in the study of rheological behaviour of polymeric melt.

 d) Describe the effect of molecular weight, molecular weight distribution on viscosity and zero shear viscosity.

 e) What are storage and loss moduli? Describe with respect to polymeric materials.

 f) Explain the relevance of die swell and shark skin effect to the rheological behaviour.

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P822

[3831]-41

M.Sc.
POLYMER SCIENCE
PS - 404 : Special Topics in Polymer Science
(Old Syllabus)

Time : 3 Hours]   *[Max. Marks : 80*

Instructions to the candidates:

1)   All questions are compulsory.

2)   Answers to the two sections should be written in separate answer books.

3)   Figures to the right indicate full marks.

4)   Use of logarithmic table/calculator is allowed.

SECTION - I

Q1) Attempt any four of the following :   **[20]**

   a)   Discuss the hurdles in recycling polymers after their use.

   b)   Describe the classification/codes for polymers with respect to recycling.

   c)   Describe the different criteria for assessing biodegradability of polymers.

   d)   What are the peculiarities for biological degradation of small molecules that are not met with in biodegradation of polymers?

   e)   What are functional polymers? Describe application of functional polymers in organic synthesis.

   f)   Explain the formation of functional polymers by chemical modification route. Are these reaction different from reactions of low molecular weight compounds.

Q2) Attempt any four of the following :   **[20]**

   a)   Explain the different phases in a liquid crystalline polymer. Discuss the structure property relationship in liquid crystalline polymers.

   b)   Describe synergistic blends and miscible blends? Describe the experimental tools to differentiate them.

   c)   Enlist and explain the different methods of increasing thermal stability of polymers.

d) Describe with equations the addition and the condensation route for the preparation of polyimides.

e) Discuss the various methods to obtain polymeric material with predictable properties. What are the advantages and limitations of blending polymers to obtain the desired properties?

f) Define thermally stable polymers, flame retardant polymers and polymers with high HDT. Discuss the resulting properties.

SECTION - II

Q3) Attempt any four of the following : **[20]**

a) Compare suitability of polymers with other materials for biomedical applications.

b) What polymers find applications in :
   i) bone replacement,
   ii) dental applications, and
   iii) blood substitute?

c) Discuss the applications of polymeric membranes in pollution control.

d) How is nylon as an engineering plastic prepared? What are its important applications?

e) Describe the chemistry and technology of PPS or polysulfone.

f) Differentiate commodity, engineering and specialty plastics. Explain with suitable examples, how HDT and UL rating are important in selecting engineering plastics for :
   i) moisture resistance applications,
   ii) fire retardant applications, and
   iii) impact resistance and glass replacement applications.

Q4) Attempt any four of the following : **[20]**

a) What is controlled release of drugs? Give two examples of controlled release drugs. With suitable examples describe the various mechanisms to controlled release.

b) Describe the role of general purpose resins in composites.

c) Write a note on the selection criterion for the selection of various engineering plastics for different applications.

d) Discuss the mechanism of gas separation using polymeric membranes.

e) Write a note on electrical conduction in intrinsically conducting polymers and their applications.

f) Enlist and discuss polymeric composites in aerospace and automotive industries.

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P823

[3831]-42
M.Sc.
POLYMER SCIENCE
PS - 410 : Analysis and Testing of Polymers
(Old Syllabus)

Time : 3 Hours]   *[Max. Marks : 80*

Instructions to the candidates:

    1)   *All questions are compulsory.*

    2)   *Answers to the two sections should be written in separate answer books.*

    3)   *Figures to the right indicate full marks.*

    4)   *Use of logarithmic tables/calculator is allowed.*

SECTION - I

Q1) Attempt <u>any four</u> of the following :   **[20]**

    a)   Determine the structures of two monomers <u>A</u> and <u>B</u> and that of copolymers <u>C</u> and <u>D</u> from the data given below. Infer the ratio of <u>A</u> and <u>B</u> in the copolymer <u>C</u>.
Explain your answer.

        Monomer <u>A</u> ($C_3H_4Cl_2$) IR; 1630, 900 cm^{-1}.

        Monomer <u>B</u> (C_9H_7N) IR; 2260, 1635, 1600, 1495, 960, 765, 695 cm^{-1}.

        Copolymer <u>C</u> Mol wt. 11820 IR; 2240, 1600, 1495, 765, 695 cm^{-1}.

        Copolymer <u>D</u> Mol wt. 12580 IR 3300 to 2500 (broad), 1730.1600, 1495, 765, 695 cm^{-1}.

        Assume no backbone degradation during hydrolysis.

    b)   Make a neat sketch of the ^{1}H-NMR spectrum of following structure.
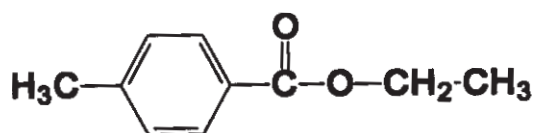

        Consider chemical shifts, multiplicity, integration, coupling constants, intensity of lines within a multiplet and comparative intensity of different lines of different multiplets.

c) Identify the different isomers of $C_5H_{10}Cl_2$ from the ^{1}H-NMR data given below :

   i)   1.1 (s, 6H), 3.7 (s, 4H);
   ii)   0.9 (t, 6H); 2.5 (q, 4H);
   iii) 0.9 (d, 6H), 1.75 (m, 1H), 4.15 (m, 2H); 4.9 (m, 1H);
   iv)   1.3 (quintet, 2H), 1.9 (m, 4H), 3.75 (m, 2H)
   v)   1.0 (s, 9H), 5.7 (s, 1H).

d) The tolylene diisocyanates 2 and 3 are important raw materials for the preparation of polyurethanes. Indicate the differences in the ^{1}H-NMR of each of the aromatic protons for both these compounds. Consider integration, chemical shift, multiplicity and coupling constants.


                A   B
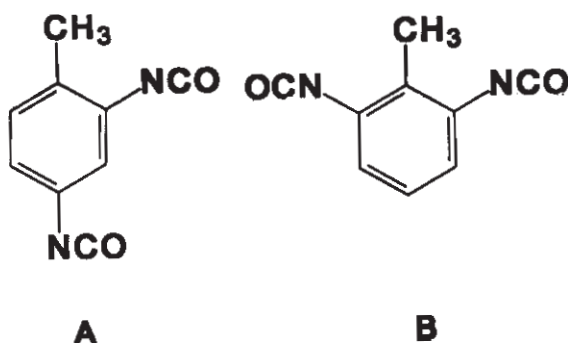
e) Draw structures of all eight benzene derivatives with the formula C_9H_{12}, Assign each structure to a letter based on the CMR data given below. Explain your answer.

   i)   Isomer E shows 3 signals in the Proton Noise Decoupled (PND) spectrum.

   ii)   Isomer F and G both show 6 signals in PND spectrum. For the sp^3 carbons F shows q (st), (d) while F show q (st), q in off resonance spectrum (SFORD).

   iii) Isomer H and I both show 7 signals in PND spectrum. For the sp^3 carbons H shows q, q, t while I shows q, t, t (in SFORD).

   iv)   Isomer J, K and L each shows nine signals in PND spectrum for the sp^3 carbon J shows q, q, q while K and L each shows q,q, t (in SFORD spectrum). In ^{1}H-NMR K shows one aromatic hydrogen as a triplet with J = 2 Hz.
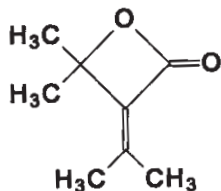
f) Answer <u>any one</u> of the following :

    i) Decide, giving reasons which of the four structures given below is consistent with the given CMR data; Assign the CMR signals :
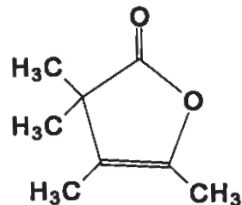
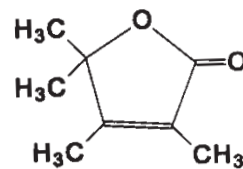   15.2 (q), 15.4 (q), 20 (q, strong), 54 (s), 104 (s), 142 (s) 173 (s).
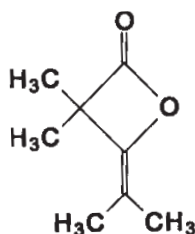
       4   **5**   **6**   **7**

    ii) Assign structures to the two possible polymer raw materials both with the formula $C_5H_8O_2$.

      A) 18, 53, 125, 137, 168

         DEPT 1 : 18, 53 up; 125 down, 137, 168 absent,

         DEPT 2 : No signal,

      B) 14.4, 60.4, 129.3, 130.0, 166

         DEPT 1 : 14.4, 130.0 up, 60.4, 129.3 down, 166 absent

         DEPT 2 : 130.0 up

Q2) Attempt <u>any four</u> of the following :   **[20]**

   a) Assign a structure to a possible polymer monomer based on the spectral data. Explain your answer. Assign the signals seen in CMR and ^{1}H-NMR

     Mol. formula $C_7H_{12}O_4$; UV featureless above 220 nm,

     IR : 3400 to 2500 (broad), 1729 cm^{-1}.

     CMR (in D_2O) : 26 (q, strong), 32 (t), 38 (t), 42 (s), 182 (s), 185 (s)

     ^{1}H-NMR (in D_2O) : 1.1 (s, 60 mm). 1.7 (t, J = 6 Hz, 20 mm); 2.2 (t, J = 6 Hz, 20 mm).

     TABLE 1 - Some characteristics IR data in cm^{-1}. Values are approximate.

O-H 3600 (free)	NH 3300	C-H 3000
$C \equiv N$ 2250	$C \equiv C$ 2200	$C \equiv C$ 1620
vinyl ester 1760	Saturated ester 1740	Saturated ketone 1720
Saturated amide 1650		

TABLE 2 - Approximate chemical shifts of protons (δ values).

CH_3-C 0.9	C = C-CH_3 1.6	O = C-CH_3 2.0
ROCH_3 3.8	-CO-CH_3 3.8	H_2C = C 4.6
C = C-H 5.1	HC = C-CO 6.3	C = CH-CO 5.7

TABLE 3 - Approximate CMR chemical shifts.

RCH_3 10-30	R_2CH_2 25-40	R_3-CH 30-50	H_3C-O 53-75
C $\equiv$ C 75-100	C $\equiv$ N 110-125	Benzene 128.5	C = C 100-140
C = N 145-162	RCOOR, RCOCH_2, RCOOH 165-180	RCOR, RCHO, 190-210	

b) The CMR spectra of indole (A), quinoline (B) and isoquinoline (C) are shown below. Identify the spectrum consistent with the structure. Assign the signals indicated by numerals to the different carbon atoms.

  i) 120.8 (d), 126.3 (d), 128# (s), 128.3 (d), 129.2 (d), 130.2 (d), 135.7# (d) 148.1# (s), 150.1# (d)

  ii) 102.1# (d), 111.1# (d), 119.6 (d), 120.5 (d), 121.7 (d), 124.1 (d), 127.6# (s), 135.5# (s)

  iii) 120.2 (d), 126.2 (d), 127 (d), 127.3 (d), 128.5# (s), 130.1 (d), 135.5# (s), 142.7# (d), 151.7# (d).

c) Identify four isomeric dicarboxylic acid $C_5H_8O_4$ which could be possible monomers from their ^{1}H-NMR data D only two singlets, E three sets of signals, F four sets of signals, G five sets of signals (both COOH group in D give only one signal. For isomer E, F, G indicate maximum number of lines expected and integration assume for each compound 1H = 4 mm) for each set of signals.

d) The ^{1}H-NMR of CHF_2-CF_2-CH_2OH is given below. Assign the signals. Comment on the chemical shifts and coupling constants. Why is there such a large difference in the magnitudes of the coupling constants?

  2.72 (s, 12 mm exchanges with D_2O); 3.97 (triplet of triplet J = 1 and 12Hz, 24 mm) 5.9 (tt, J = 6 and 52 Hz, 12mm).

e) Identify the six isomers of the dinitronapthalenes from the CMR and NMR data given below. Explain your answer. Clearly show which carbons are identical in each isomer and indicate which are the protons referred in ^{1}H NMR. In proton noise decoupled spectrum isomers H and I show five signals, J and K show six signals while L and M show ten signals. In ^{1}H-MNR the most down field region is as follows :

$\underline{H}$ (s, 2H); $\underline{I}$ (dd, J = 2 and 8 Hz, 2H); $\underline{J}$ (dd J = 2 and 8 Hz, 2H); $\underline{K}$ (d, J = 2 Hz, 2H,)

$\underline{L}$ (dd J = 2 and 8 Hz, 2H); $\underline{M}$ (two doublets each 1H, J = 2 Hz); N (two doublet each 1H, J = 8 Hz).

f) Write short note on overtone and combination bands seen in infra red.

SECTION - II

Q3) Attempt <u>any four</u> of the following : **[20]**

a) Discuss citing suitable polymer example the factors affecting TGA curves.

b) Write note on DTG for polymer degradation analysis.

c) What are the dielectric properties of polymers? Give one method for determination of dielectric constant.

d) Write a note on the factors affecting the accuracy of thermogravimetric measurement for polymer structure analysis.

e) Explain the term dichroic ratio and infra red dichromism. What information about the polymer sample can be obtained from the dichromism absorption band?

f) Sketch and explain the X ray diffraction pattern for oriented and unoriented poly oxymethylene. Define and explain birefringence.

Q4) Attempt <u>any four</u> of the following : **[20]**

a) Explain the power camera method used to study X ray diffraction pattern of polymers.

b) Discuss the importance of preliminary tests of a polymeric sample.

c) What is the need of testing and analyzing for elements in polymers? Explain the ashing and combustion flask methods for the determination of elements in polymers.

d) Explain principle of TEM analysis for polymer characterization.

e) Discuss citing suitable polymer example the factors affecting TGA curves.

f) Write note on DTG for polymer degradation analysis.

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P824

[3831]-43

M.Sc.

POLYMER SCIENCE

PS - 411 : Structure and Properties of Bulk Polymers

(Old Syllabus)

Time : 3 Hours]

[Max. Marks : 80

Instructions to the candidates:

1) All questions are compulsory.

2) Answers to the two sections should be written in separate answer books.

3) Figures to the right indicate full marks.

4) Use of logarithmic table/calculator is allowed.

SECTION - I

Q1) Attempt any four of the following : **[20]**

a) Enlist the differences between crystallinity and crystallizability. Is it possible to obtain 100% crystalline and 100% amorphous polymers? Explain.

b) With the help of structures explain the cis-, trans- and 1,2-vinyl configuration of butadiene units in polybutadiene molecule. Which one is most crystalline and why?

c) What is the effect of molecular weight on glass transition temperature?

d) Explain Schatzki crankshaft model? With the help of examples explain your answer.

e) Explain what happens to polymers upon quenching. Comment on the T_g and T_m of samples before and after quenching.

f) Define first order and second order transition in polymers. What is secondary glass transition? How does secondary glass transition exhibit itself?

Q2) Attempt any four of the following : **[20]**

a) Do poly(methylmethacrylate) and syndiotactic poly(methylmethacrylate) exhibit glass transition temperature? Justify your answer.

b) Show with suitable examples the effect of restricting groups on glass transition of polymers.

c) Write a note on the growth and structure of spherulites in crystalline polymers and the arrangement of molecules in the spherulites.

d) Define heat capacity. Explain the construction and method of suitable instrument to determine glass transition temperature.

e) Write a suitable expression for the estimation of glass transition temperature of copolymers.

f) Write a short note on theories of glass transition temperature.

SECTION - II

Q3) Attempt any four of the following : **[20]**

a) What is the difference between adhesion and cohesion. Write a note on the mechanism of adhesion of a substrate to metal, wood and paper surface.

b) Write and explain the differences between varnishes and paints. Give commercial examples of paints and varnishes.

c) What is tinting and tint resistance? Explain tinting resistance of white pigment and tinting power of dye pigment.

d) Write a note on the classification of adhesives.

e) How does one test the adhesives during their manufacture? What are the quality control tests?

f) What are the salient features to be considered before adhesive application on a surface?

Q4) Attempt any four of the following : **[20]**

a) How is pigment to binder ratio important in the preparation of a paint formulation?

b) Why is polylactic acid preferred as a packaging material in several commercial applications?

c) In what polymeric material are electronic gadgets normally packed and why?

d) Write a note on the equipment used in the paint industry. Explain the working of any one equipment.

e) Suggest packaging material for :
   i)   milk and dairy products,
   ii) confectionery items,
   iii) agrochemicals,
   iv) printed circuit boards, and
   v)   glass wares.

f) Write a note on oil bound paints, enamel paints and powder coating.

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P825

[3831]-301

M.Sc.
POLYMER SCIENCE
PS - 310 : Chain Polymerization
(New Syllabus)

Time : 3 Hours]   *[Max. Marks : 80*

Instructions to the candidates:

1) *All questions are compulsory.*
2) *Answers to the two sections should be written in separate answer books.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic table/calculator is allowed.*

SECTION - I

Q1) Attempt any four of the following :   **[20]**

    a) Discuss mechanism of vinyl polymerization.

    b) What are inhibitors and retarders? Explain with neat diagrams.

    c) Derive the expression for over all rate of polymerization as a function of conversion.

    d) Write a note on kinetic chain length in free radical polymerization.

    e) With suitable examples, explain the need of chain transfer agents. What is its primary role?

    f) Comment on the thermodynamic parameters of chain polymerization.

Q2) Attempt any four of the following :   **[20]**

    a) Both cationic and anionic polymerizations show a marked dependence on the type of solvent used. Discuss the causes and nature of solvent used.

    b) Comment on cross propagation rate constant in controlled radical copolymerization. Discuss its significance.

    c) Write a short note on atom transfer radical polymerization.

    d) Write a short note on ring opening polymerization.

    e) Write short note on living polymer.

    f) Derive the expression for $\overline{X}n$ in cationic polymerization.

SECTION - II

Q3) Attempt any four of the following : **[20]**

   a) Write copolymer composition equation and explain the assumption under which it is derived.

   b) Describe any one method for the estimation of reactivity ratio.

   c) Describe importance of reactivity of monomers and radicals in explaining mechanism of copolymer formation.

   d) Describe any one method for the synthesis of following monomers :
      i)   acrylonitrile,
      ii) vinyl acetate,
      iii) styrene,
      iv) methacrylic acid and
      v)   chloroprene.

   e) Describe the bulk polymerization process for the preparation of polystyrene. State the advantages and limitations of bulk polymerization.

   f) Describe one method each of preparation of HDPE and LDPE. Describe the differences in the properties of both the polymers.

Q4) Attempt any four of the following : **[20]**

   a) Describe the polymerization of vinyl chloride. Explain the variation in the structure of the polymer. State important applications of PVC.

   b) Write a note on Ziegler-Natta catalyzed manufacture of polyethylene. Explain the advantages of gas phase over solution phase manufacture. What is the importance of chemical modification to sulphochlorination?

   c) What is SBR? Give its preparation and important applications.

   d) How is isoprene prepared? Comment on its polymerization to give polyisoprene.

   e) Write a short note on SAN polymers.

   f) Write a short note on fluoropolymers. Explain the reasons for their thermal stability.

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P826

[3831]-302

M.Sc.

POLYMER SCIENCE

PS - 311 : Condensation Polymerization

(New Syllabus)

Time : 3 Hours]   *[Max. Marks : 80*

Instructions to the candidates:

   1) All questions are compulsory.

   2) Answers to the two sections should be written in separate answer books.

   3) Figures to the right indicate full marks.

   4) Use of logarithmic table/calculator is allowed.

SECTION - I

Q1) Attempt any four of the following :   **[20]**

   a) What is gel point? How is it experimentally determined?

   b) Describe dependence of $\overline{X}w, \overline{X}n$ on various factors in polyesterification reaction.

   c) Write in detail how stoichiometric balance effects the DP in condensation polymers.

   d) Write a note on multi-chain polymerization.

   e) Derive the rate equation for step polymerization in the absence of catalyst and show that the molecular weight is proportional to the square root of time.

   f) What are the assumptions made during derivation of rate expression for condensation polymerization? Justify those assumptions.

*Q2)* Attempt any four of the following :   **[20]**

   a) Describe the methods for the preparation of hyperbranched polymers and dendrimers. What are the limitations?

   b) Write a note on synthesis of branched polymers by group transfer polymerization.

   c) Write a short note on the characterization techniques employed for hyperbranched polymers and dendrimers.

d) A polyester made with equivalent quantities of a dibasic acid and a glycol is stabilized in molecular weight at $\overline{X}n = 100$ by adding methanol. Calculate $\overline{X}w$ and the weight number fraction of monomers in the resulting polymer.

e) A linear step polymerization is 98% complete. Calculate $\overline{X}n, \overline{X}w$ and PDI.

f) Write a note on kinetic chain length in free radical polymerization.

SECTION - II

Q3) Attempt any four of the following : **[20]**

a) Explain the following regarding the preparation of linear unsaturated polyesters :
   i) phthalic anhydride is preferred to phthalic acid.
   ii) in the conversion of naphthalene to phthalic anhydride 4.5 moles of oxygen are used to give CO_2 and H_2O (2 moles each) as by-products.
   iii) for the manufacture of the anhydride o-xylene is preferred to naphthalene.

b) What is the difference between short, medium and long oil resins? What are the differences in solubility, mode of curing and nature of finishes using these three categories of resins?

c) Comment on the Tg of the polycarbonates shown below.
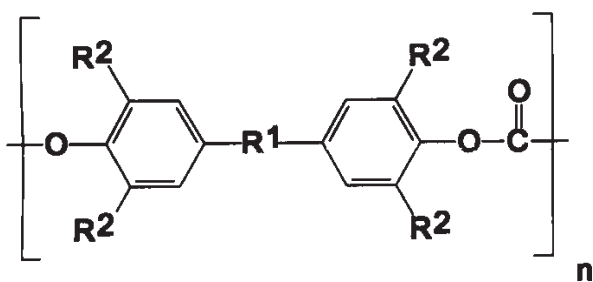
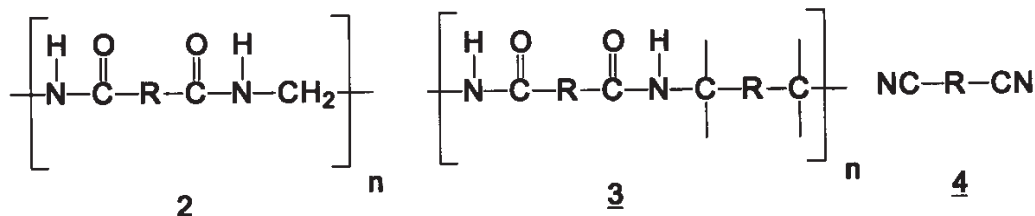| R^1	R^2	Tg^0c
CH_2	H	147
$C(CH_3)_2$	H	149
$C(PH)_2$	H	121
$C(CH_3)_2$	CH_3	210
SO_2	CH_3	260

d) How is the polymer (1) prepared? Explain why it has greater hardness, smaller elongation at break and lower water absorption than nylon 6. Why is this polymer preferred to nylon 6 where physical and electrical properties have to be maintained under humid conditions?


1
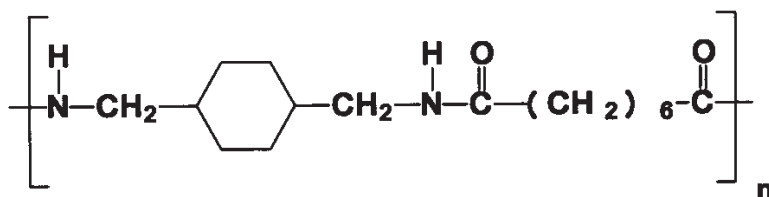
e) Explain the following regarding synthesis of polyamides.

   i) the use of picrylchloride in the synthesis starting from p-aminobenzoic acids;

   ii) the formation of nylon 2 from α - amino acids using $COCl_2$;

   iii) the formation of 2 and 3 from 4.

$$\left[-N(H)-C(O)-R-C(O)-N(H)-CH_2- \right]_n \quad \quad \left[-N(H)-C(O)-R-C(O)-N(H)-C-R-C- \right]_n \quad NC-R-CN$$

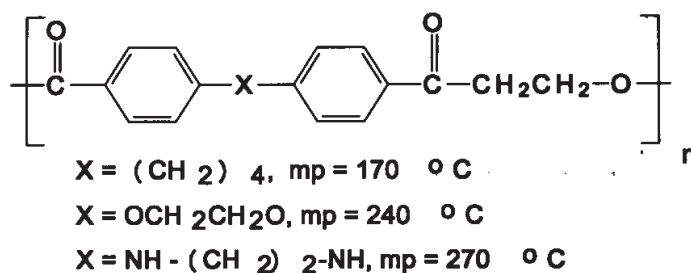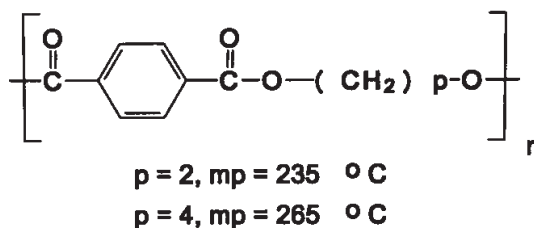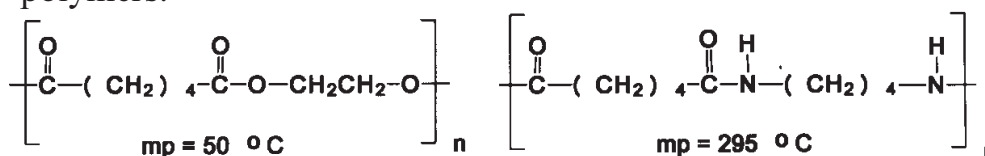$$\underline{2} \quad\quad\quad \underline{3} \quad\quad\quad \underline{4}$$

f) Give the structures of A, B and in the reaction shown. How is step (i) and step (ii) carried out? The formation of voids in step (ii) is a problem. What causes this and how can it be avoided?

$$n A \; + \; n B \xrightarrow{\text{Step (I)}} C \xrightarrow{\text{Step (II)}} \left[\text{polyimide structure} \right]_n$$
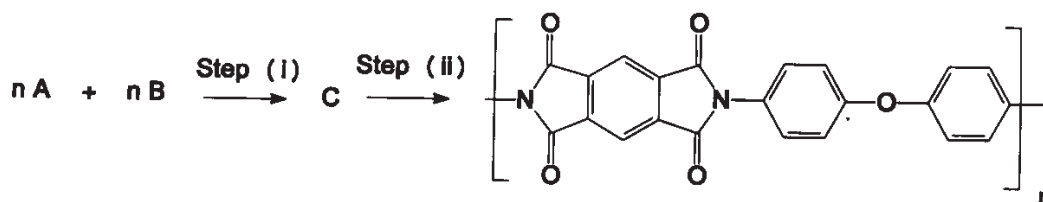
Q4) Attempt any four of the following : **[20]**

a) Comment on the relation of structure and m.p. for the polymers shown below. Indicate the structures of monomers required for each of these polymers.

$$\left[-C(O)-(CH_2)_4-C(O)-O-CH_2CH_2-O- \right]_n \quad\quad \left[-C(O)-(CH_2)_4-C(O)-N(H)-(CH_2)_4-N(H)- \right]_n$$

$$mp = 50\ ^oC \quad\quad\quad mp = 295\ ^oC$$

$$\left[-C(O)-\text{(benzene)}-C(O)-O-(CH_2)_p-O- \right]_n$$

$$p = 2, mp = 235\ ^oC$$
$$p = 4, mp = 265\ ^oC$$

$$\left[-C(O)-\text{(benzene)}-X-\text{(benzene)}-C(O)-CH_2CH_2-O- \right]_n$$

$$X = (CH_2)_4, mp = 170\ ^oC$$
$$X = OCH_2CH_2O, mp = 240\ ^oC$$
$$X = NH-(CH_2)_2-NH, mp = 270\ ^oC$$

b) Resol prepolymers were synthesized using sodium hydroxide and magnesium hydroxide as catalyst. The prepolymers formed were used towards Step II crosslinking reaction. Will the behaviour of the two prepolymers be different towards crosslinking? Explain.

c) Explain the role of aliphatic and aromatic polyamines in the curing of epoxy resins. Describe the differences in the adhesive properties of both the adhesives.

d) Write importance of chemical modification of the M-F resins. Explain the equations involved in such modifications.

e) Describe any one method of manufacturing silicon containing polymers. Explain the applications of the manufactured polymers.

f) Compare crosslinking reactions in phenol-formaldehyde and urea-formaldehyde resins.

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P827

[3831]-303

M.Sc.

POLYMER SCIENCE

PS - 312 : Physical Chemistry of Polymers

(New Syllabus)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) *All questions are compulsory.*
2) *Answers to the two sections should be written in separate answer books.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic table/calculator is allowed.*

SECTION - I

Q1) Attempt any four of the following : **[20]**

a) What is glass transition temperature? Do highly crystalline polymers exhibit glass transition temperature? Explain your answer.

b) When a polymer is heated it shows several transitions. With the help of a suitable diagram explain the different transitions. Explain your answer with reference to amorphous polymers and elastomers.

c) Explain the thermomechanical method of determination of Tg of polymers. Sketch a thermomechanical curve for an amorphous polymer and label Tg on this curve.

d) Discuss various factors which affect the crystallinity of PET.

e) Polycarbonate based on BPA is as transparent as glass. However, on annealing at about 150ºC it looses transparency. Explain.

f) Taking the example of PP, discuss the effect of tacticity on the crystallinity of stereoregular PP.

Q2) Attempt any four of the following : **[20]**

a) Are the terms configuration and conformation synonymous? Explain. Comment on Tg of isotactic and atactic polypropylene.

b) Discuss various factors influencing the glass transition temperature of polymers.

c) How can DTA and DSC techniques be used to supplement the information obtained from TGA of polymers? Explain with examples.

d) Differentiate between crystallinity and crystallizability. What polymers do not exhibit Tg and Tm? Give examples.

e) Compare the Tg of poly(methylacrylate) and syndiotactic poly(methylmethacrylate). Justify your answer.

f) When a polymer is heated it shows several transitions. With the help of a suitable diagram explain the different transitions. Explain your answer with reference to amorphous polymers and elastomers.

SECTION - II

Q3) Attempt any four of the following : **[20]**

a) Compare and contrast the dissolution process of low molecular weight solute and high molecular weight polymers.

b) Define cohesive energy density and solubility parameter. Enlisting the variables influencing solubility parameter, explain its industrial significance.

c) What are virial coefficients? Explain Flory theta temperature, a good solvent and a poor solvent.

d) Write a short note on colligative properties with respect to the molecular weights of polymers.

e) Explain Flory-Huggins theory and the parameters on which it is based.

f) What is LCST and UCST? Draw diagrams and explain with suitable examples.

Q4) Attempt any four of the following : **[20]**

a) Discuss the dissolution of crystalline and amorphous polymers.

b) Relate Flory-Huggins interaction parameter with cohesive energy density.

c) How does high energy radiation bring out chemical changes in polymers? How does it affect the properties of polymers?

d) Describe applications of radiation induced modification of polymers.

e) Predict the effect of high energy radiation on polystyrene, PVC and PMMA.

f) Estimate solubility parameter of poly-n-ethyl methacrylate.

Assume the following :

Group	Fsmall	Fvolume
$-CH_2-$	133	16.45
$>C<$	-93	4.75
$-CH_3$	214	22.8
$-COO-$	310	21.0

Density of poly-n-ethyl methacrylate is 1.05.

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P828

[3831]-304

M.Sc.

POLYMER SCIENCE

PS - 313 : Analytical Chemistry of Polymers

(New)

Time : 3 Hours]   *[Max. Marks : 80*

Instructions to the candidates:

1)   All questions are compulsory.

2)   Answers to the two sections should be written in separate answer books.

3)   Figures to the right indicate full marks.

4)   Use of logarithmic table/calculator is allowed.

SECTION - I

Q1) Attempt <u>any four</u> of the following :   **[20]**

    a)   Assign structures to the two possible polymer raw materials both with the formula $C_5H_8O_2$.

        i)   18, 53, 125, 137, 168

               DEPT 1 : 18, 53 up; 125 down, 137, 168 absent,

               DEPT 2 : No signal,

        ii)   14.4, 60.4, 129.3, 130.0, 166

               DEPT 1 : 14.4, 130.0 up, 60.4, 129.3 down; 166 absent

               DEPT 2 : 130.0 up

    b)   Deduce the structures of one of the compounds given below. Explain your answer.

        i) C_5H_8O : IR 3300 optically active on oxidation gives $C_5H_6O_2$ which gives IR bands 3300 to 2500, 1730 cm^{-1}.

        ii) $C_9H_8O_2$: IR 1680, 1600 1505, 760 cm^{-1}

            UV 256 $\in$ about 12000. Gives positive iodoform test.

c) Make a neat sketch of the ^{1}H-NMR of p-tert-amyl phenol $\underline{1}$ which is one of the raw materials for making oil soluble resins for surface coatings.
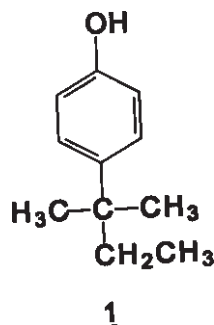
$\underline{1}$

Consider chemical shifts, multiplicity, integration, coupling constants, intensity of lines within a multiplet, and comparative intensity of different lines of different multiplets.

d) The ^{1}H-NMR of CHF_2-CF_2-CH_2OH is given below. Assign the signals. Comment on the chemical shifts and coupling constants. Why is there such a large difference in the mangnitudes of the coupling constants.

2.72 (s, 12 mm exchanges with D_2O); 3.97 (triplet of triplet J = 1 and 12Hz, 24 mm) 5.9 (tt, J = 6 and 52Hz, 12 mm).

e) Which technique can be used to determine iodine value of unsaturated polymer?

f) Explain the importance of testing for acid number in polymers. Describe one method for the analysis of acetyl number of polymer.
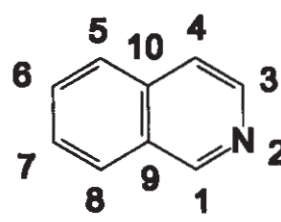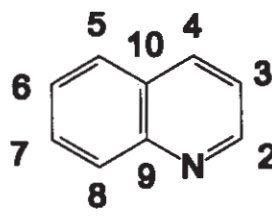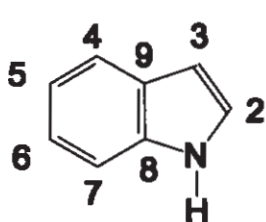
Q2) Attempt <u>any two</u> of the following :   **[20]**

a) Identify the six isomers of the dinitronapthalenes from the CMR and NMR data given below. Explain your answer. Clearly show which carbons are identical in each isomer and indicate which are the protons referred in ^{1}H NMR. In proton noise decoupled spectrum isomers H and I show five signals, J and K show six signals while <u>L</u> and <u>M</u> show ten signals. In ^{1}H-MNR the most down field region is as follows :

<u>H</u> (s, 2H); <u>I</u> (dd, J = 2 and 8 Hz, 2H); <u>J</u> (dd J = 2 and 8 Hz, 2H); <u>K</u> (d, J = 2 Hz, 2H,)

<u>L</u> (dd J = 2 and 8 Hz, 2H); <u>M</u> (two doublets each 1H, J = 2 Hz); N (two doublet each 1H, J = 8 Hz).

b) The CMR spectra of 2 and 3 are given below. Identify which carbon spectrum corresponds to which compound. Clearly explain the differences in chemical shift in the two compounds. Assign the signals. Note that 2 is the ethyl ester of a polyester monomer.

2 X = $-\overset{\displaystyle ||}{\underset{\displaystyle O}{C}}-O-CH_2CH_3$

3 X = $-O-\overset{\displaystyle ||}{\underset{\displaystyle O}{C}}-CH_2CH_3$
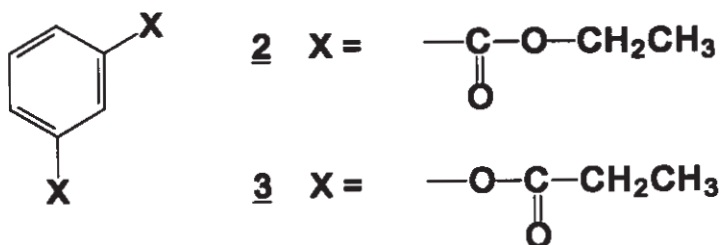
i) 14 (q*), 62 (t*), 129 (d), 130.5 (d), 130.7 (s*) 134 (d*), 165 (s*)* strong signal.

ii) 9 (q*), 28 (t*), 116 (d), 120 (d*), 129 (d) 152 (s*), 167 (s*) * strong signal.

c) The CMR spectra of indole (4), quinoline (5) and isoquinoline (6) are given below. Decide giving reasons which spectrum corresponds to which letter. Assign the signals indicated by # to different carbon atoms.

4

5

6

i) 120.8 (d), 126.3 (d), 128# (s), 128.3 (d), 129.2 (d), 130.2 (d), 135.7# (d) 148.1# (s), 150.1# (d)

ii) 102.1# (d), 111.1# (d), 119.6 (d), 120.5 (d), 121.7 (d), 124.1 (d), 127.6# (s), 135.5# (s)

iii) 120.2 (d), 126.2 (d), 127 (d), 127.3 (d). 128.5# (s), 130.1 (d), 135.5# (s), 142.7# (d), 151.7# (d)

SECTION - II

Q3) Attempt any four of the following : [20]

a) Write a note on small angle scattering of X-rays by polymers.

b) Find the interplanar spacing from the following data for the crystal obtained in a powder camera method :

λ of X rays used = 154 nm
Order of reflection = 1
Length of blackened arc on the camera = 58.88 mm
Camera radius = 57.3 mm

c) Describe the different detectors used for detecting X rays.

d) Write a note on birefringence and dielectric properties of polymeric materials.

e) Write the differences between TGA, DTA and DSC. With suitable diagrams explain the different information you could derive from each of these?

f) Explain the behavior of PTFE during TGA studies.

Q4) Attempt <u>any four</u> of the following :   **[20]**

a) How is thermal stability of a polymer elucidated from TGA studies?

b) Write a short note on DTG for polymer characterization.

c) Explain refractive index and Abbe number. How are these useful in getting information about transparency, mechanical properties and moisture resistance of the polymeric materials?

d) How is DTA useful in the study of first order and second order transitions in polymers?

e) Explain the phenomenon of glass transition temperature in polymers.

f) Discuss the maximization method used in TGA.

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P829

[3831]-401

M.Sc.

POLYMER SCIENCE

PS - 410 : Polymer Processing

(New Syllabus)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) *All questions are compulsory.*
2) *Answers to the two sections should be written in separate answer books.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic table/calculator is allowed.*

SECTION - I

Q1) Attempt any four of the following : **[20]**

a) Describe reciprocating screw injection molding. What are its advantages over ram based injection molding?

b) With the help of neat diagram, explain injection blow molding.

c) Write an account of pultrusion. What are their specific applications?

d) Compare the processes of blow molding and rotamolding.

e) Explain the variation in number of rollers and their arrangement in the process of calendering.

f) Describe design peculiarities of pressure forming.

Q2) Attempt any four of the following : **[20]**

a) Define crimp, tenacity, denier continuous filament.

b) Write design characteristics of object obtained by compression molding. Discuss advantages and disadvantages of compression molding.

c) Discuss the criteria of choosing a polymeric material for desired application.

d) Explain defects occurring in transfer molding. Suggest the measures to avoid the defects.

e) Describe the versatility of extrusion as a process.

f) Explain variation in the screw design for processing different types of polymers.

SECTION - II

Q3) Attempt any four of the following :   **[20]**

    a) Describe wet spinning process for synthetic fibers.

    b) Compare the properties of natural and synthetic fibers.

    c) What do you mean by the term staple fiber and filament?

    d) With the help of a neat diagram describe wet spinning process.

    e) Write a short note on specialty fibers.

    f) What is the significance of molecular weight drawing ratio and temperature in melt spinning?

Q4) Attempt any four of the following :   **[20]**

    a) Discuss importance of compounding.

    b) Define vulcanization. Discuss sulphur or non sulphur mechanism of vulcanization.

    c) What are accelerators and activators? Discuss their importance in rubber vulcanization.

    d) Enlist any five synthetic elastomers. Write their structure, special properties and applications.

    e) Explain re-enforcing and non-reinforcing fillers. Discuss theory of re-enforcement action of carbon black.

    f) Draw and explain curves showing effect of vulcanization time/temperature on various properties of rubber.

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P830

[3831]-402

M.Sc.

POLYMER SCIENCE

PS - 411 : Rheology and Mechanical Properties of Polymers

(New Syllabus)

Time : 3 Hours]   *[Max. Marks : 80*

Instructions to the candidates:

   1) *All questions are compulsory.*
   2) *Answers to the two sections should be written in separate answer books.*
   3) *Figures to the right indicate full marks.*
   4) *Use of logarithmic table/calculator is allowed.*

SECTION - I

Q1) Attempt any four of the following :   **[20]**

   a) Explain the terms stress tensor, shear thickening, Weissenberg effect, elasticity and elongation flow.

   b) Describe Voigt model for visco-elastic material.

   c) Describe the deviation of flow properties from ideality.

   d) What is the effect of molecular weight and molecular weight distribution on the viscosity and Zero shear viscosity.

   e) Explain Burger model for deformation behaviour of polymeric materials.

   f) Can the theory of visco-elasticity for amorphous polymeric material be extended to crystalline polymeric materials? Explain.

Q2) Attempt any four of the following :   **[20]**

   a) Write an account on the rheological properties of polymeric melt. Explain its behavior like a solid and a fluid.

   b) Explain the importance of time-temperature superposition.

   c) Describe any one instrument to study rheological properties of polymer. Explain its scope and limitation in the study of rheological behaviour of polymeric melt.

   d) What are material functions? Explain any three material functions useful in understanding rheological behaviour.

e) Compare the processes of creep and stress relaxation.

f) Explain the relevance of die swell and shark skin effect to the rheological behaviour.

SECTION - II

Q3) Attempt any four of the following :   **[20]**

a) Discuss the hiding power or covering power of pigments used in surface coating.

b) What techniques are used for testing of paints and varnishes.

c) Discuss the significance of polylactic acid as a packaging materials in various commercial applications.

d) Suggest polymeric materials for packaging of special electronic gadgets. Give reasons.

e) Discuss the property requirements of polymers for packaging of food, fruit and vegetables.

f) Enlist the equipments used for the production of paints. Explain the working of ball mill.

Q4) Attempt any four of the following :   **[20]**

a) Describe advantages of adhesives over traditional techniques of joining substrates.

b) Describe the classification of adhesives on the basis of origin, citing suitable examples.

c) Describe influence of mechanical properties on the choice of adhesives.

d) Explain the procedures to quantify the performance of adhesive in paper industry.

e) Describe adhesives used in the field of stationary. Justify the selection.

f) Give various purposes of the different types of surface coatings?

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M.Sc.

POLYMER SCIENCE

PS - 404 : Special Topics

(New Syllabus)

Time : 3 Hours]   *[Max. Marks : 80*

Instructions to the candidates:

    1)   All questions are compulsory.

    2)   Answers to the two sections should be written in separate answer books.

    3)   Figures to the right indicate full marks.

    4)   Use of logarithmic table/calculator is allowed.

SECTION - I

Q1) Attempt any four of the following :   **[20]**

   a) How are functional polymers different as compared to unfunctionalized polymers? Bring out the differences in terms of their applications.

   b) What type of polymeric membranes would you recommend for each of the following separations? Explain with reasons.

      i)   Suspended solid in water;

      ii)   Salt from sea water;

      iii) N_2 and O_2 from air.

   c) Compare suitability of polymers with other materials for biomedical applications.

   d) Explain the different phases in a liquid crystalline polymer. Discuss the structure property relationship in liquid crystalline polymers.

   e) What are piezo electric and pyroelectric polymers? Explain the application of piezo electric and pyro electric PVDF.

   f) Write a note on different water soluble polymers used in oil recovery.

Q2) Attempt any four of the following :   **[20]**

   a) What is green chemistry? What are the principles of green chemistry?

   b) Write a note on the use of polymer gels in personal care products.

   c) Write a short note on the specific role of polymers in nanocomposites.

d) Describe the different criteria for assessing biodegradability of polymers.

e) Describe the classification/codes for polymers with respect to recycling.

f) Write a note on polymer blends and alloys. Give examples.

SECTION - II

Q3) Attempt any four of the following : **[20]**

a) What are functional polymers? Describe application of functional polymers in organic synthesis.

b) Write a note on Fick's Law or Ferry's Laws and explain the various terms.

c) Suggest polymers to replace the following :
   i)   bones,
   ii) teeth,
   iii) blood.
   Give reasons.

d) Draw neat diagrams and bring out the differences among the different liquid crystalline phases in polymers.

e) Describe solitons and polarons and the conduction mechanism in electroactive polymers.

f) Explain why polyacrylamide and xanthan gum are used oil recovery.

Q4) Attempt any four of the following : **[20]**

a) Give a list of green sources of chemicals? What are green solvents? Give five examples.

b) Write a note on super absorbent polymer gels.

c) Comment on the theoretical development of behaviour of nanomaterials.

d) Enlist the factors that influence biodegradation. How do you estimate extent of degradation?

e) Comment on the "Green" Recycling Routes of poly(ethylene terephthalate) (PET).

f) Discuss the various methods to obtain a polymer with predictable properties. What are the advantages and limitations of blending polymers to obtain the desired properties?

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