P927

[3931] - 31
M.Sc.
POLYMER SCIENCE
PS - 310 : Kinetics Mechanism and Polymerization Process
(2005 Pattern) (Old) (Sem.- III)

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 addition, condensation and ring opening polymerization reactions with respect to the kinetics and molecular weights obtainable.

   b)   Generally a low molecular by-product is continuously removed in a condensation polymerization. Why? Under which condition the reaction is possible in a closed system, where no material exchange is allowed during the course of reaction.

   c)   Describe dependence of X_w, X_n on various factors in polyesterification reaction.

   d)   Calculate X_w, X_n for an equimolar mixture of a diacid and a glycol at the following extent of reaction 0.990, 0.999 when the stoichiometric imbalance is 0.99.

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

   f)   Write short note on gel point.

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

   a)   Discuss different termination processes in radical polymerizations.

   b)   Describe the actions of retardation, inhibition and chain transfer in free radical polymerizations.

   c)   Derive the expression for overall rate of polymerization as a function of conversion in radical polymerization.

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

e) A radical polymerization is carried out in presence of chain transfer agent. Depending on the relative competition between propagation and transfer,what are different effects possible on the rate of reaction and molecular weight achieved.

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

SECTION - II

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

a) Compare dependence of rate of reaction on temperature in case on radical and anionic polymerizations

b) In aqueous solution polymerization of acrylamide, hydrogen peroxide was used as initiator in two different reactions at the same concentration. Out of the two,one reaction was carried out using redox initiation. Comment on the rate expression of both the reactions.

c) Discuss the influence of ion pair on polymerization by ionic mechanism.

d) Write condition under which cyclization is observed in condensation polymerization. What is importance of such reactions?

e) Write different steps involved in the initiation process of free radical polymerization using different types of initiators.

f) Is it possible to control molecular weight and MWD in cationic and anionic polymerization? Explain.

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 of the copolymerizations. Why? Justify the answer with suitable examples.

d) Write any one graphical method of determining reactivity ratio of 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? Comment.

❊❊❊❊❊

P928

[3931]-32
M.Sc.
POLYMER SCIENCE
PS - 311 : Synthesis, Structural Aspects, Properties and Applications of Polymers
(Old) (2005 Pattern) (Sem. - III)

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.*

SECTION - I

Q1) Answer <u>any four</u> of the following :   **[16]**

     a) In the preparation of cellulose triacetate and secondary cellulose, comment on the following

         i) Use of CH_2Cl_2.
         ii) Use of CH_3COOH.
         iii) Addition of 50% aq/CH_3COOH.
         iv) No addition of sodium acetate.
         v) Boiling with very dil H_2SO_4.

     b) In the process of making cellulose nitrate explain the following.

         i) Dried cellulose is stirred with an acid mixture containing HNO_3 (25%), H_2SO_4 (55%) and water (20%) at 30-40°C for 20-60 minutes.
         ii) The product is then centrifuged and dropped in drowning tank.
         iii) Washed with water.
         iv) Product is boiled with water for several hours.
         v) Then treated with NaOCl and washed with water.

     c) Give argument to prove the structure of cellulose.

     d) Explain the following regarding alkyd resins.

         i) Though semi-drying oils are still tacky after air drying for seven days, the resins prepared from these oils undergo effective air drying.
         ii) Such resins are preferred to those from drying oil resins for obtaining high gloss white finishes.
         iii) In the free fatty acid process the solvent process is preferred to the fusion process.
         iv) Alkyd resins can not be prepared by heating a mixture of oil, polyol and dibasic acid.

P.T.O.

e) Comment on the relation of structure and m.p. for the polymers shown below. Indicated the structures of monomers required for each of these polymers.
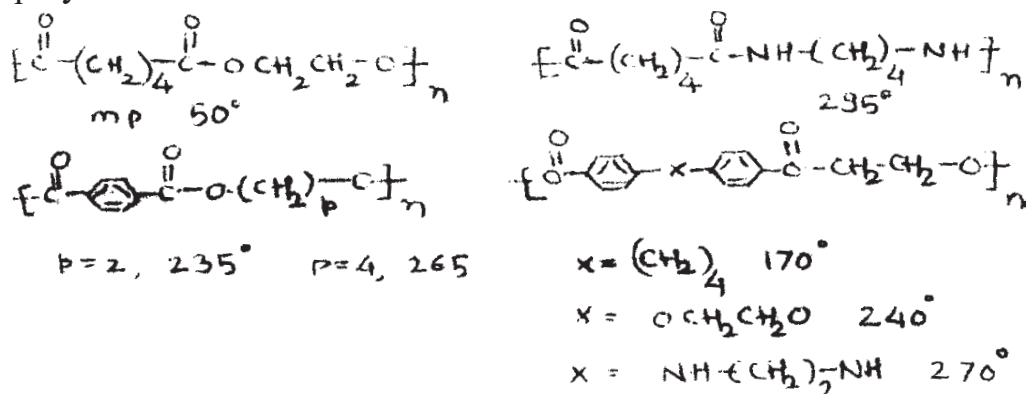
f) Comment on how spectroscopy can be used to determine the average number of styrene units to crosslink two chains of linear unsaturated polyesters. What are the assumptions involved in this method? How is this assumption justified? How can the validity of this assumption be confirmed experimentally?

g) Explain the following in the preparation of polycarbonate by ester interchange.

   i) A mixture of bisphenol A, diphenylcarbonate, and $Li(OH)_2$ is heated at 150° using nitrogen atmosphere.

   ii) The temperature is then raised to 210° over 1 hr. and pressure is reduced to 20mm of Hg.

   iii) Heating is carried out for 5-6 hrs more at 300° and pressure is lowered to 1 mm of Hg.

   iv) Molar excess of bisphenol A is used.

Q2) Answer <u>any four</u> of the following :   [16]

a) The composition of four typical hydroxyl terminate polyesters are shown. Based on these indicate the structural change and use of the resulting polyurethanes for each of the compositions. Comment on the molar proportion of the components in the composition. Explain your answer.

   Composition :

   i) Adipic acid (AA) 1.0; ethylene glycol 0.75, propylene glycol 0.35.

   Composition :

   ii) AA 1.5, sebacic acid 1.5, diethylene glycol DEG 3.25, glycerine (Gl) 0.5,

   Composition

   iii) AA 3.0, 1,3 butanedlol 3.0, Glycerine 1.0,

   Composition

   iv) AA 3.0, DEG 2.0, trimethylol propane 3.0.

b) Give the structures of the polymers A and B what are the terminal groups in A what types of links are formed in and in conversion of A to B? In the polymer B what are the hard and soft segments? Why are these characteristic observed? What happens when this polymer is stretched and when the stretching force is withdrawn? What class of fiber is B?
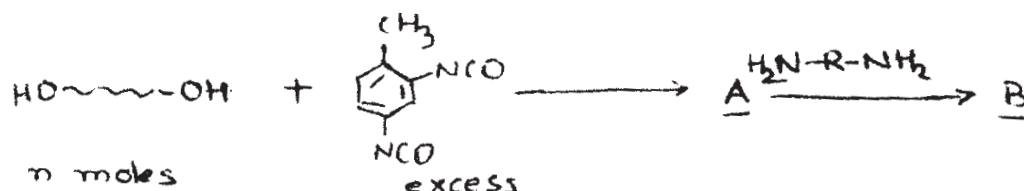
c) A typical formulation for a flexible foam is given below. Comment on the role of different components and their quantities. What are the reactions leading to crosslinking? Draw a structure indicating cross linking. Polyether triol 100 (parts by weight), 80:20 TDI 40, water 3.0 DABCO 0.5, stannous octoate 0.3, silicone block copolymer 1.0.

d) Describe the Japanese process involving photonitrosation for conversion of cyclohexane to caprolactam what are its advantages as compared to the usual process? Give the mechanism of photonitrosation.

e) 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) The m.p given below.
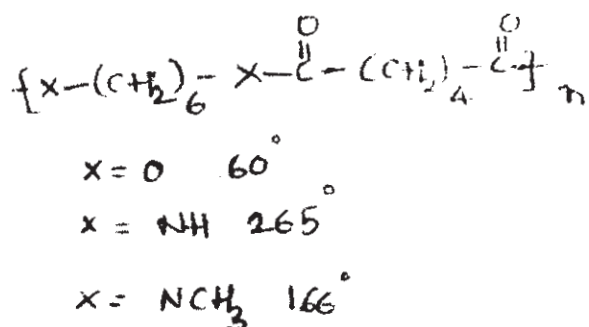
f) How are the aromatic polyamides Nomex and Kevlar prepared? What are their advantages? Where are these used? What are their drawbacks?

g) Complete the reactions shown below. The polymer C obtained is called PMR explain.
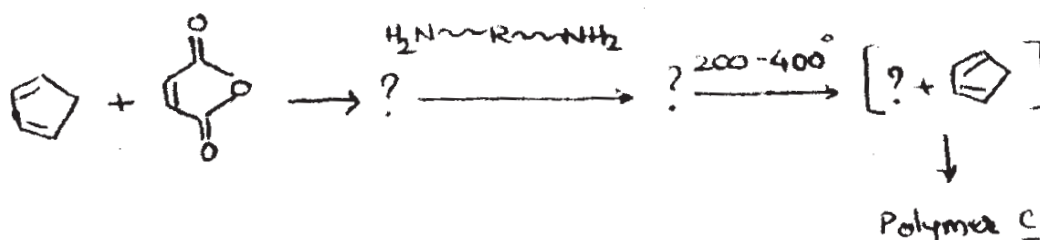
SECTION - II

Q3) Attempt <u>any four</u> of the following : [16]

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 <u>any two</u> of the following : [16]

a) Give a synthetic method to prepare
   i) Acrylic acid.
   ii) Methyl methacrylate.
   iii) Styrene, and
   iv) Vinyl chloride.

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

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

Q5) Attempt <u>any two</u> of the following : [16]

a) Enlist synthetic methods for the preparation of different grades poly (vinyl alcohol). Explain how chemical modifications result in different properties.

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

c) How is 2-chloro - 1, 3-butadiene synthesized? Explain its crosslinking reaction. Illustrate the applications of this rubber in view of its properties.

⊠⊠⊠⊠

P929

[3931]-33

M.Sc. (Sem. - III)
POLYMER SCIENCE
PS-312: Polymer Processing
(Old) (2005Pattern)

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 importance of compounder's Job in rubber industry.

   b) Define vulcanization. Write the mechanism of vulcanization.

   c) Discuss importance of accelerators and activators in rubber vulcanization on a non-sulphur system.

   d) Compare the concept of re-enforcing and nonfeinforcing fillers. Discuss theory of re-enforcement action of carbon black.

   e) With the help of suitable diagram, explain.
       i)   Unvulcanized rubber,
       ii)   Vulcanized rubber, and.
       iii) Vulcanized rubber with filler.

   f) Explain the process of Branburry mixing.

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

   a) What fiber properties are important in textile uses?

   b) What are different Methods of Spinning Synthetic fibers, describe any one in details.

   c) Define Deniere, Tenacity, moisture contents and moisture regain and crimp.

   d) Describe preparation and applications of non woven fiber.

   e) Give examples of any three synthetic fibers. Describe preparation of any one of them.

   f) Write a short note on spinning of inorganic fibers.

P.T.O.

SECTION - II

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

   a)   Explain the role of thermal stabilisers and uvstabilizers in polymers.

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

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

   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.

Q4) 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.

ⵡ ⵡ ⵡ ⵡ

P930

[3931]-34

M.Sc.

POLYMER SCIENCE

PS-313: Polymer Chains and Their Characteristics

(Sem. - III) (Old) (2005 Pattern)

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 solubility? Enlist the factors on which solubility of polymers depend.

    b)   Write a note on determination of solubility parameter of polymers.

    c)   Explain in short.

        i)   Size of linear and branched polymer of identical molecular weight, and

        ii)   Solubility of crystalline and amorphous polymers.

    d)   Write a note on theta temperature and virial coefficients.

    e)   Explain in short polymer electrolytes.

    f)   Discuss the cases of LCST >UCST and UCST>LCST.

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) What are material functions? Explain any three material functions useful in understanding rheological behaviour.
  b) Explain the terms.
    i) Viscosity.
    ii) Shear rate.
    iii) Deformation.
    iv) Shear flow, and
    v) Elongational flow.
  c) Describe different stress strain behaviour exhibited by polymeric materials.
  d) Compare the processes of creep and stress relaxation in polymeric materials.
  e) Compare Maxwell and Voigt model for explaining Viscoelastic behaviour.
  f) Explain the rheological properties of a solid and that of polymeric melt.

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 modulii? Describe with respect to polymeric materials.

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

)( )( )( )(

P931

[3931]-41
M.Sc.
POLYMER SCIENCE
PS-404: Special Topics in Polymer Science
(Old) (Sem - IV) (2005 Pattern)

Time : 3 Hours]

[Max. Marks : 80

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

SECTION - I

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

  a)   Write the different types of recycling of polymeric materials. Compare the products obtained from different types of recycling.

  b)   Describe measures taken to reduce unwanted usage of polymeric materials to reduce formation of polymeric waste.

  c)   Describe different methods for studying biodegradation process of polymers.

  d)   Discuss structure-property relationship in biodegradation of polymeric materials.

  e)   Discuss merits and demerits of using spacer arm technique to obtain functional polymer.

  f)   Describe different applications of functional polymers.

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

  a)   Describe strategies to form LCP from a known low molecular weight mesogen.

  b)   Is it possible to observe different liquid crystalline phases in the same polymer? Justify the answer with suitable examples.

  c)   What is the importance of blends in obtaining materials with desired properties?

  d)   Compare melt blending, emulsion blending and solution blending methods.

e) Explain the influence of limiting oxygen index, bond dissociation energy and crystallinity on inherent thermal stability of polymers.

f) What are heteroaromatic thermally stable polymers? Explain with suitable examples.

SECTION - II

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

a) Why are polymeric materials a preferred choice for biomedical applications as compared to other materials used traditionally in the past.

b) Suggest and explain the polymers for blood veins and arteries, sutures and adhesives to treat deep wounds.

c) What are the selection criteria for engineering applications of plastics?

d) Discuss preparations and important applications of polyacetals as engineering plastics.

e) What are polymeric membranes? Discuss mechanism of separation of suspended and dissolved low molecular weight substances in liquids using polymeric membranes.

f) Discuss the applications of polymeric membranes in gas separations.

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

a) Discuss importance of polymeric materials for various controlled release applications.

b) What are solitons and polarons? How is this concept used for explaining conduction mechanism in inherently conducting polymers?

c) Discuss the applications of inherently conducting polymers.

d) Discuss the use of polymeric materials in the development of engineering composites.

e) Write importance of epoxy resins in composites.

f) Write a note on Fick's law and Ferry's law in separation processes.

✕✕✕✕✕

P932

[3931]-42
M.Sc.
POLYMER SCIENCE
PS - 410 : Analysis and Testing of Polymers
### (Old) (2005 Pattern) (Sem. - IV)

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

Instructions to the candidates:
1) *All questions are compulsory.*
2) *Answers to the two sections must 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) a) A monomer $\underline{A}$ ($C_6H_{11}NO$), with no methyl group) shows the reactions given below. Identify the monomer $\underline{A}$ and the polymers $\underline{B}$ and $\underline{C}$ from the given data. Explain your answer. **[5]**
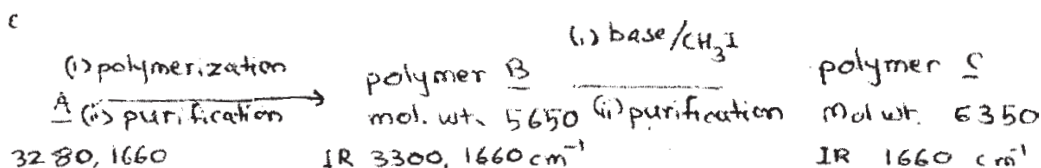
* Assume no degradation during reaction. hydrolysis of $\underline{A}$ and $\underline{B}$ gives a product soluble in aq. HCl and aq. NaOH.

b) Answer <u>any one</u> of the following : **[3]**
   i) Explain the term localized group frequency. Why is the X-H frequency localized? Why are the non-hydrogen bonded stretching frequencies OH > NH > CH > SH.
   ii) Suggest two possible structures for a compound C_5H_8O which gives positive iodoform test and shows IR bands at 3300 (broad) and 2150 cm^{-1}. Explain your answer.

Q2) Answer <u>any two</u> of the following : **[10]**
   a) Make a neat sketch of the ^1H-NMR of a possible monomer 1 shown below. Consider chemical shifts, multiplicity, integration, coupling constants, intensity of lines within a multiplet, and comparative intensity of different lines of different multiplets. Assume no coupling of OH proton with CH_2.

$\underline{1}$
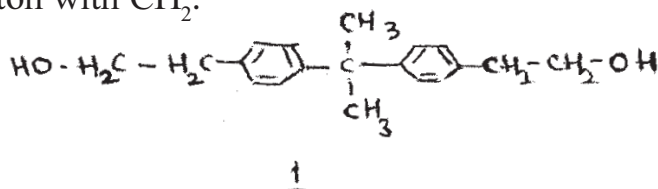
b) The ^{1}H-NMR spectra of 2 and 3 are given below. Identify which spectrum corresponds to which compound. Assign the signals. Clearly explain the differences in chemical shifts in the two compounds. Note that 2 is the ethyl ester of a polyester monomer.


2   X = $COOCH_2CH_3$

3   X = $O\text{-}\overset{O}{\underset{}{C}}\text{-}CH_2CH_3$
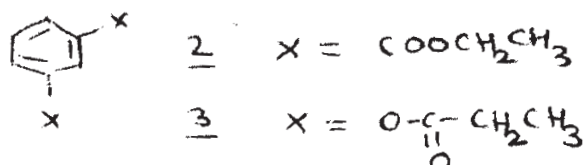
   i)   1.4 (t, J = 6 Hz, 24 mm); 4.4 (q, J = 6 Hz, 16 mm); 7.58 (t, J = 8 Hz, 4 mm); 8.2 (dd, J = 2 and 8 Hz, 8 mm); 8.67 (t, J = 2 Hz, 4 mm).
   ii) 1.1 (t, J = 6 Hz, 24 mm); 2.4 (q, J = 6 Hz, 16 mm); 6.8 (m, 24 mm), 7.28 (t, J = 8 Hz, 8 mm).

c) Identify four aldehydes all with the formula $C_5H_{10}O$ from their ^{1}H-NMR spectra. Explain your answer. D shows only two singlets. E shows four sets of signals both F and G show five sets of signals, F shows 9.7 (t) while G shows 9.7 (d). For isomers E, F and G indicate maximum number of lines expected and integration for each set of signals (Assume for each compound 1H = 4 mm).

Q3) Answer any two of the following :   [14]

a) The CMR spectrum of cycloheptanone shows signals at 24.4 (t*), 30.6 (t*), 43.9 (t*) and 215. * Strong signals.

   Assign these signals. On reaction with base and D_2O it gives a mixture of two products mol. wt 115 and 116. The Proton noise decoupled spectrum around 44 showed signals with intensities 9:18:9:27:9:18:9:9 from high field to low field. Deduce the percentage of the two isomers. Explain your answers.

b) Identify the five isomers of the trinitrotoluenes 4 to 8 from the CMR and ^{1}H NMR data, giving reasons. Isomers H and I both show five signals while J, K and L all show seven signals in the proton noise decoupled spectrum. In the ^{1}H-NMR both H and I show in aromatic region 2H singlet, the singlet of H is more downfield than that of I. while J shows two different singlet each 1H. Isomer K and L both show two doublet J = 8 Hz (each 1H). The most upfield singlet in aromatic region of CMR for K is at higher field than that of L.

4   5   6   7   8
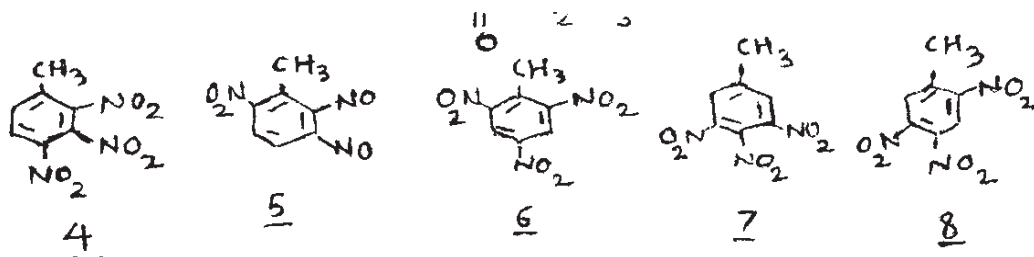
c) The major compound M ($C_{14}H_9Cl_5$) obtained by the reaction of C_6H_5Cl and CCl_3CHO has the CMR given below. Deduce its structure, giving reasons. Two other minor products are isolated in the same reaction both $C_{14}H_9Cl_5$. How can the number of signals seen in the minor products establish their structure. Note that chlorine in C_6H_5Cl is ortho and para directing.

CMR : 68 (d), 103 (s), 128 (d, strong), 132 (d, strong), 134 (s), 137 (s).

Q4) Assign a structure to a possible monomer based on the spectral data. Explain your answer. Assign the signals seen in CMR and ^1H NMR. **[8]**

Mol formula $C_7H_{12}O_4$, UV : Featureless above 220 nm,

IR 3400 to 2500 (broad), $1680 cm^{-1}$.

CMR : 28*, 32, 44*, 180*, *strong signal.

DEPT 1 : 28 up; 44 down; 32, 180 absent

DEPT 2 : no signal.

^1H-NMR : 1.2 (s, 24mn), 2.4 (s, 16mm), 11.5 (s, exchanges, 8 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 = 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	

SECTION - II

Q5) Attempt <u>any four</u> of the following : **[20]**

    a) Sketch and explain the X ray diffraction pattern for oriented and unoriented polyoxymethylene. Define and explain birefringence.

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

    c) Why it is relevant to analyses for elements in polymers?

    d) What are the difficulties encountered in identifying polymers? Explain how burning test and solubility of polymers are useful?

    e) Discuss the analysis of molecular structure of any two polymer samples by X ray diffraction method.

    f) Explain in detail principle of SEM analysis of polymers.

Q6) Attempt <u>any four</u> of the following : **[20]**

    a) Discuss the principle and the application of thermogravimetric analysis for the study of polymers.

    b) How DTA and DSC techniques could be used to supplement the information obtained from TGA of polymer? Explain with examples.

    c) Draw a typical DSC curve for a polymer having Tg 65 degrees, Tm 265 degrees, and decomposition temperature of 320 degree centigrade. Comment on the endo/exo transitions.

    d) Differentiate between dynamic and isothermal TG analysis.

    e) How will you determine the kinetic parameters from the thermogravimetric curve of the polymer.

    f) Describe the determination of crystallinity in polymers using DSC.

☒☒☒☒

P933

[3931]-43
M.Sc.
POLYMER SCIENCE
PS-411: Structure and Properties and Bulk Polymers
(Old) (2005 Pattern) (Sem-IV)

Time : 3 Hours]   *[Max. Marks : 80*
Instructions to the candidates:
　　1) *All questions are compulsory.*
　　2) *Answers to the two sections must be written in separate answer books.*
　　3) *Figures to the right indicate full marks.*
　　4) *Use of logarithmic tables / calculators is allowed.*

SECTION - I

Q1) Attempt any four of the following.   **[20]**
　　a) Discuss in brief, various theories of glass transition.
　　b) Give the best estimate for the weight fraction of plasticizer required to lower the Tg of PVC to 30 degree Celsius. (Tg of PVC is 356 K,and that of the plasticizer 188 K).
　　c) How does hydrogen bonding in polymers effect the Tg and Tm in polymers? Nylon 66 and Kevlar form fibers. Which is more crystalline and why?
　　d) What are plasticizers? What does plasticization depend on? Give suitable examples of plasticized polymers.
　　e) Discuss the various factors which affect the crystallizability of polymers with suitable examples.
　　f) Arrange the polymers in order of increasing Tg / Tm:
　　　　Poly(butylmethacrylate) and poly(laurylmethacrylate). Justify your answer.

Q2) Attempt any four of the following: **[20]**
　　a) Differentiate between crystallinity and crystallizability. What polymers do not exhibit Tg and Tm? Give examples.
　　b) Explain the melting point behaviour of a polymer where n=2 is much higher than when n=3. n is the number of carbon atoms in repeat unit.
　　c) Are the terms configuration and conformation synonymous? Explain. Comment on the Tg of isotactic and atactic polypropylene.

P.T.O.

d) Write notes on.
  i) Spherullites,
  ii) Lamella, and.
  iii) Cold drawing.
e) What is Tg? Explain with a suitable diagram the dilatometric method for the determination of Tg of polymers.
f) Explain the importance of studying the kinetics of crystallization in polymers. Give suitable methods for determination of kinetics of crystallization.

SECTION - II

Q3) Attempt any four of the following: [20]
  a) What are traditional ways of joining materials? What are their disadvantages?
  b) Write an account of naturally occurring polymers used as adhesives.
  c) Describe selection criteria for material to be used as adhesive.
  d) Describe the adhesive used in the field of furniture. Justify the selection.
  e) What are the different adhesives used in leather industry?
  f) Discuss the importance of particle size and shape in selecting pigment for paint formulation.

Q4) Attempt any four of the following: [20]
  a) Discuss importance of barrier properties of surface coatings, with special emphasis on oxidation and protection from atmospheric moisture and corrosive gases.
  b) Enlist different components used in paint formulation. Comment on purpose of each component.
  c) Suggest polymeric materials for 'three layer pack' Give the function of each layer.
  d) Discuss the property requirements for polymer to act as packing material.
  e) Discuss importance of ecofriendly packaging polymeric materials.
  f) Describe the preparation of BOPP. Write its importance as packaging material.

✳✳✳✳✳

P934

[3931]-301
M.Sc.
POLYMER SCIENCE
PS - 310 : Chain Polymerization
(Sem-III) (New Syllabus) (2008 Pattern)

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 the initiation process in free radical polymerization. What are the evidences for its mechanism? What is cage effect?

b) With suitable diagrams and examples discuss role of retarders and inhibitors.

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

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 constants 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 ratios.

c) Describe importance of reactivity of monomers and reactivity of 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 of PE. What is the importance of chemical modification to sulphochlorination?

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

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

e) Write a short note on SAN polymers.

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

�✶✶✶✶✶

P935

[3931]-302
M.Sc.
POLYMER SCIENCE
PS - 311 : Condensation Polymerization
(New Syllabus) (2008 Pattern) (Sem. - III)

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)   How do X_w and X_n depend upon conversion in a typical polycondensation reaction? Explain with the help of suitable diagram.

    b)   Generally a low molecular by-product is continuously removed in a condensation polymerization. Why? Under which condition the reaction is possible in a closed system, where no material exchange is allowed during the course of polymerization reaction.

    c)   Write a note on reactivity and molecular size in step growth polymerization.

    d)   Calculate the weight fraction of trimer in step polymerization carried to 99.6% conversion.

    e)   Write short note on gel point and its determination. What is its significance?

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

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

    a)   Under what conditions does cyclization take place in a polycondensation reaction? What is importance of such reaction?

    b)   Write a note on poly (benzimidazole)s and cyanate ester resins.

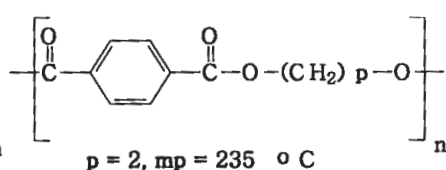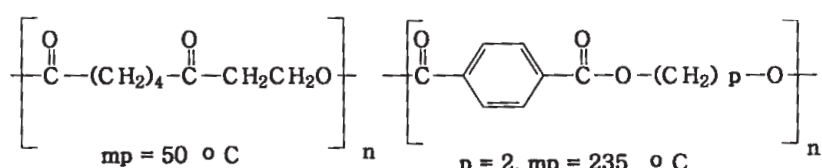   c)   Write a note on mechanism of step reaction polymerization and carbonyl addition elimination.

d) Write a note on convergent and divergent approaches to synthesis of large molecular weight compounds.

e) Write a note on properties and application of hyperbranched polymers.

f) What does one mean by generation in hyperbranched polymers? Enlist monomers that are amenable to such polymerization?
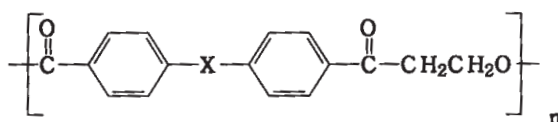
SECTION - II

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

a) With reference to aromatic polyamides, please explain the following :

 i) Aromatic polyamides have not attained the same commercial importance as aliphatic polyamides mainly because of production and processing difficulties.

 ii) How are aromatic polyamides prepared by interfacial polymerization?

b) 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.

c) Write a short note on polyfunctional step growth polymerization.

d) 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.

$$\left[\overset{O}{\overset{\|}{C}} - (CH_2)_4 - \overset{O}{\overset{\|}{C}} - CH_2CH_2O \right]_n \qquad \left[\overset{O}{\overset{\|}{C}} - \text{⬡} - \overset{O}{\overset{\|}{C}} - O - (CH_2)_p - O \right]_n$$

mp = 50 °C   p = 2, mp = 235 °C
                    p = 4, mp = 265 °C

$$\left[\overset{O}{\overset{\|}{C}} - \text{⬡} - X - \text{⬡} - \overset{O}{\overset{\|}{C}} - CH_2CH_2O \right]_n$$

X = (CH$_2$)$_4$, mp = 170 °C

X = OCH$_2$CH$_2$O; mp = 240 °C

X = NH-(CH$_2$)$_2$-NH, mp = 270 °C

$$\left[\overset{O}{\overset{\|}{C}} - (CH_2)_4 - \overset{O}{\overset{\|}{C}} - NH - (CH_2)_4 - NH \right]_n$$
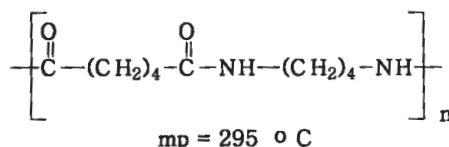
mp = 295 °C

e) 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.

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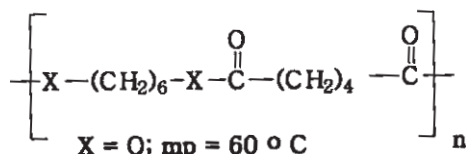
   X = O; mp = 60 °C

   X = NH; mp = 265 °C

   X = NCH3; mp = 166 °C

f) Give the mechanism of addition of ROH to RNCO in the absence of a catalyst. The mechanism should explain how

   i)   R'OH acts as a catalyst,

   ii) electron donors on R'OH and electron withdrawers on RNCO help the reaction. The features mentioned in

   iii) rules out an alternate mechanism. What is the alternate mechanism? Explain your answer.

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

   a) Describe the preparation of D_3 and D_4 siloxane monomers and ring opening polymerization of these monomers to obtain polysiloxanes. Mention important properties of poly (dimethyl siloxanes).

   b) Write a note on the manufacture of UF resins. What are the important applications of UF resins.

   c) Discuss the role of aliphatic and aromatic polyamines in the curing of epoxy resins. What are 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) Write a short note on crosslinking reactions in phenol-formaldehyde and urea-formaldehyde resins.

   f) Hydroxyl terminated polyethers are preferred over hydroxyl terminated polyesters in the alcohol-isocyanate reactions. Explain why?

☒☒☒☒

P936

[3931]-303
M.Sc.
POLYMER SCIENCE
PS - 312 : Physical Chemistry of Polymers
(New Syllabus) (2008 Pattern) (Sem. - III)

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) 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 lable 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 150° C it looses transparency. Explain.

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

Q2) Attempt <u>any four</u> 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 types of polymers do not exhibit Tg and Tm? Give examples.

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

f) Write a short note on factors affecting Tg and Tm of polymeric materials.

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 <u>any four</u> 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 the solubility parameter of isosorbide diester, whose structure is given. What are the units of solubility parameter?
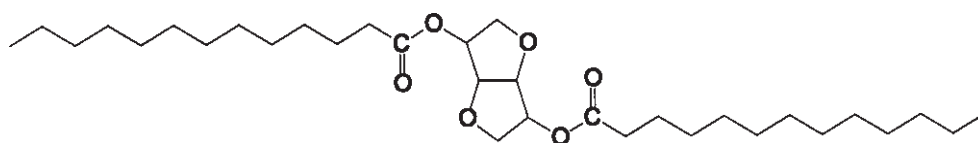
Volume of molecule (V) = 355.80cm^3

Assume the following Molar attraction constants (F)

-CH$_3$	420
-CH$_{2-}$	280
-COO-	511
-CH-	140

☒☒☒☒

P937

[3931]-304

M.Sc.

POLYMER SCIENCE

PS - 313 : Analytical Chemistry of Polymers

(New) (2008 Pattern) (Sem. - III)

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 the following :

   a)   Determine the structure of a monomer **A** $C_7H_{12}O_2$ (Mol. Wt. 128) and the polymers **B** and **C** based on the data given below. Explain your answer.

	i) Polymerization		i) Hydrolysis*	
A	------------------>	Polymer **B**	------------------>	Polymer **C**
	ii) Purification		ii) Purification	

   * Assume there is no backbone degradation during hydrolysis.

   A   IR - 1760, 1625, 965cm^{-1}

   B   Mol. Wt. 6400; IR - 1735cm^{-1}

   C   Mol. Wt. 3600; IR - 3350cm^{-1} **[6]**

   b)   Deduce the structure of any two of the following, explain the given data.**[4]**

   i) C_5H_8O IR : 1695, 1635, 890cm^{-1}; UV : 225 nm $\in$ ~ 10000. Gives positive iodoform test.

   ii) $C_8H_8O_2$ IR : 1710, 1605, 1505, 765, 685cm^{-1}; UV : 230 nm $\in$ ~ 11000.

   iii) $C_8H_8O_2$ IR : 3300 to 2500 broad; 1720, 1610, 1490, 880, 780cm^{-1}; UV : 233 nm $\in$ ~ 9000.

Q2) Answer <u>any one</u> of the following :   **[10]**

    a)   Draw all six isomers of ethers with the formula $C_5H_{12}O$. Identify these, giving reasons, using the proton NMR data given below.

        Isomer **A** shows only two singlets in 3 : 1 ratio.

        For other isomers the signals in the region around 3.3 and 1.0 are shown.
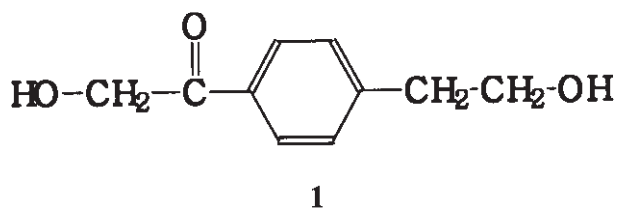
          B ~ 3.3, 4H, m; ~ 1.0, two 3H, t.

          C ~ 3.3, 3H, m; ~ 1.0, 6H, d and 3H, t.

          D ~ 3.3, 3H, s and 1H, m, ~ 1 ; 3H, d, and 3H t.

          E ~ 3.3, 5H of which one is 3H, s; ~ 1.0 3H, d.

          F ~ 3.3 5H of which one is 3H, s; ~ 1.0 6H, d.

    b)   Make a neat sketch of the proton NMR (in D_2O) of the possible monomer **1**. Consider chemical shifts, multiplicity, coupling constants, integration, intensities within a multiplet and comparative intensities of different multiplets.

1

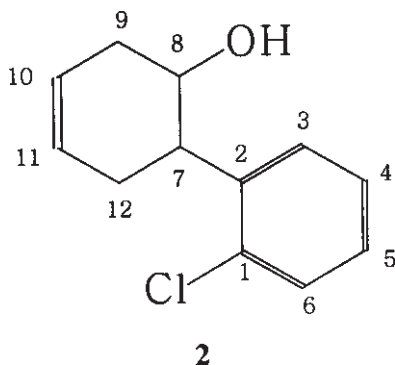*Q3)* Attempt <u>any two</u> of the following :   **[12]**

    a)   Assign the signals seen in the CMR of 2, giving reasons. Figures in brackets indicate intensities. The contribution of substituents to shifts in aromatic carbons is given below :

        25 (101); 34 (102); 39 (86); 87 (91); 123 (95); 126 (162); 127 (89); 128 (92); 129 (89); 133 (16); 140 (24).

2

Shifts	C_1	O	M	P
Cl	6.2	+ 0.4	1.3	− 1.9
Isopropyl	20.1	− 2.0	0.0	− 2.5

b) Identify the two possible monomers both $C_7H_{12}O_4$ from their CMR data. Assign the CMR signals, giving reasons.

    i)   28 (q); 32 (s, weak); 44, 180.

    ii)   26 (q, strong); 32 (t), 38 (t), 42 (s, weak); 182 (s, weak), 185 (s, weak).

c) Deduce the structure of a compound $C_9H_{10}N_2$ from the CMR spectrum. Assign the CMR signals, giving reasons.

39 (strong); 97, 111 (strong); 120, 135 (strong); 152.

DEPT 1 : 39, 111, 135 all up; 97, 120, 152 all absent.

DEPT 2 : 111, 135 both up.

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

O-H 3600 (free)	NH 3300	$\equiv$ C-H 3300
C $\equiv$ N 2250	C $\equiv$ C 2200	C = 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	- C-OCH_3 3.8 $\underset{O}{\overset{\parallel}{}}$	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, RCONHR, 165-180 RCOOH	RCOR, RCHO, 190-210	

Q4) Assign a structure to a possible monomer C_6H_6O from the spectral data. Assign the CMR and ^{1}H-NMR signals. Explain your answer.

UV : 239 $\in$ ~ 10000; IR : 3275 (sharp), 2720 (w), 2089, 1682, 1630, 820cm^{-1}.

CMR : 25, 87, 127, 132, 192.

DEPT 1 : 25, 87, 127, 192 all up; 82, 132 both absent.

DEPT 2 : 87, 127, 192 all up.

^{1}H-NMR : 2.0 (s, 30 mm); 3.5 (s, 10 mm); 6.2 (d, J = 5 Hz, 10 mm); 9.9 (d, J = 5 Hz, 10 mm). **[8]**

SECTION - II

Q5) Attempt <u>any four</u> 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.

Q6) 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.

☒☒☒☒

P938

[3931]-401

M.Sc. (Sem. - IV)

POLYMER SCIENCE

PS - 410 : Polymer Processing

(2008 Pattern) (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 importance of Compounder's Job in rubber industry.

b) Explain with neat diagrams the property changes that occur when an elastomer is vulcanized with sulfur?

c) What are accelerators and activators? Giving examples, discuss their necessity in rubber vulcanization.

d) Draw structures of any three elastomers. Write their properties and applications.

e) Explain reinforcing and non-reinforcing fillers. Discuss theory of reinforcement action of carbon black.

f) Draw and explain stress strain curves for unvulcanized and vulcanized rubber with fillers.

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

a) What are the different methods of spinning synthetic fibers? Describe any one in detail.

b) Define continuous and staple fiber, Deniere, tenacity, moisture contents and moisture regain, and crimp.

c) Explain the fiber properties that are important in textile uses?

d) Write short note on fiber after treatment.

e) Draw and explain stress strain curve for silk like and wool like fibers.

f) Describe preparation and applications of non woven fibers.

SECTION - II

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

    a)   Explain different types of molds used in compression molding.

    b)   Compare process of blow molding and rotational molding.

    c)   Write an account on RIM and RRIM.

    d)   Write a note on co-rotating twin screw extruder.

    e)   Enlist the important features in injection molding.

    f)   Explain the role of UV stabilizers and thermal stabilizers.

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

    a)   Explain the variation in the screw design for processing different type of polymers.

    b)   Draw a neat diagram and comment on importance of flight angle.

    c)   With the help of neat diagram explain injection or blow molding.

    d)   Explain the process of thermoforming in polymers. Give examples and applications of thermoformed articles.

    e)   Explain V shape and drum compounding used for compounding polymers.

    f)   Explain various defects and their causes in injection molding.

⌖⌖⌖⌖⌖

P939

[3931]-402

M.Sc.

POLYMER SCIENCE

PS - 411 : Rheology and Mechanical Properties of Polymers

(New) (2008 Pattern) (Sem - IV)

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 power law model. Why is it important to polymeric materials?

b) Explain the terms:
   i) Bingham plastic.
   ii) Weissenberg effect.
   iii) Zero-shear viscosity.
   iv) Deborah number, and
   v) Shear thickening.

c) Explain relaxation and retardation in polymeric materials.

d) Write a note on dynamic mechanical model for testing polymeric materials.

e) What is shear thickening? Explain with examples shear thickening.

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

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

a) Write a note on time-temperature superposition curve.

b) Write a note on "creep" and "stress relaxation".

c) Write a note on origin of shark skin. Explain your answer in detail.

d) Write a note on material functions and contributions to rheology.

e) How does branching and tacticity in polymers affect rheological properties? Explain your answer with suitable diagrams.

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

SECTION - II

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

a) With the help of diagrams explain the mechanisms of adhesion to different surfaces.

b) Conventionally, how are adhesives classified?

c) Write a short note on hiding power and tinting of quality paint.

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

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

f) What polymers are suitable for the packaging of circuit boards? Give reasons.

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

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

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

c) Discuss the mechanism of permeation through polymers for food applications.

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

e) What are the barrier properties of polymers to protect the failure modes for food products.

f) Write a short note on the instruments for testing paints.

✄✄✄✄✄

P940

[3931]-403

M.Sc. (Sem. - IV)
POLYMER SCIENCE
PS - 404 : Special Topics
(2008 Pattern) (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) Why are polymeric materials a preferred choice for biomedical applications?

  b) Suggest polymers for skin replacement, hip joint replacement, and blood veins replacement.

  c) What are polymeric membranes? Recommend polymeric membranes for each of the following separations. Explain with reasons.

   i) Suspended solid in water;

   ii) Dissolved salt from sea water;

   iii) N_2 and O_2 from air.

  d) Write a note on Fick's law or Ferry's laws and explain the various terms.

  e) Discuss various mechanisms of controlled release of drugs.

  f) Write short note on any TWO:

   i) Entire artificial heart,

   ii) Applications of membranes in dyestuff industries;

   iii) Targeted release of drugs.

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

  a) What are electroactive polymers? Discuss the mechanism of conducting polymers using concept of solitons and polarons.

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

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

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

e) Write a note on different water soluble polymers. Indicate their industrial applications.

f) Write a note on the theoretical development in predicting behaviour of nanomaterials.

SECTION - II

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

a) What are the principles of green chemistry? Discuss each in short.

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

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

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

e) In a certain polymer recycling process, caprolactam is reclaimed. With suitable diagrams and equations, indicate the recycling of that polymer.

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

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 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?

�✠✠✠✠✠rangle