Total No. of Questions : 4]

SEAT No. :

P695

[Total No. of Pages : 2

# [4128] - 301

## M.Sc. (Sem. - III)

## POLYMER SCIENCE

### PS - 310 : Chain Polymerization

### (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 is the evidence for the mechanism ? What is cage effect ?

b) What are chain transfer agents ? Describe their role and effect on molecular weight obtained in their presence.

c) What is living polymerization ? Why does it occur ? Write its uses.

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

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

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

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

a) Write a short note on ring opening polymerization.

b) Write a short note on living free radical polymerization.

***P.T.O.***

c) Derive the expression for $\overline{X}n$ in free radical polymerization.

d) Write a short note on nitroxide mediated polymerization (NMP).

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

f) Write a short note on coordination 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) For the following values of $r_1$ and $r_2$ what type of polymers will be expected ? i) $r_1 = 0, r_2 = 0$, ii) $r_2 >> 0, r_2 >> 1$, iii) $r_1$ infinity, $r_2$ infinity. Justify your answer

c) Why do monomers show different reacting tendencies in binary copolymerization ? Which factors influence their relative reactivities ?

d) How is isobutylene polymerized ? State the important properties of the resulting polymer.

e) How is polypropylene prepared ? Explain the formation of stereoregular polypropylenes. Explain the variation of properties due to stereoregularity in polypropylenes.

f) Describe preparation of three halogen containing polymers. Compare their properties and state their applications.

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

a) Describe the polymerization of acrylamide. State the important applications of acrylamide and its copolymers.

b) Describe briefly Ziegler-Natta catalyzed manufacture of polyolefins. How is it different from benzoyl peroxide type initiators used in polymerizations?

c) Describe the manufacture of any one styrene copolymer that can be used as elastomer. Describe their special properties and applications.

d) Enlist the distinguishing features between LDPE and HDPE.

e) Write a note on the preparation of butadiene acrylonitrile copolymer. Give its application.

f) Discuss chemistry, technology and importance of fluoropolymers.

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Total No. of Questions : 4]

SEAT No. :

P696

[Total No. of Pages : 3

# [4128] - 302

## M.Sc. (Sem. - III)

## POLYMER SCIENCE

### PS - 311 : Condensation Polymerization

### (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) Write the steps and mechanism involved in step growth polymerization carbonyl addition and nucleophilic substitution.

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

c) Describe non-linearity in third order plots for self-catalyzed step polymerization reactions. Enlist the factors responsible for non-linearity.

d) Calculate the weight fraction of trimer in step polymerization carried out to 99% conversion.

e) Write a note on multi chain polymerization.

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 any four of the following : **[20]**

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

b) Write a note on kinetic expressions for polymerization in absence and in presence of a catalyst in step polymerization.

***P.T.O.***

c) Write a short note on polydispersity in 3-D step reaction.

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

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

f) Comment on the molecular weight of a polymer when the concentration of one of the reactants is away from the stoichiometric balance.

## SECTION - II

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

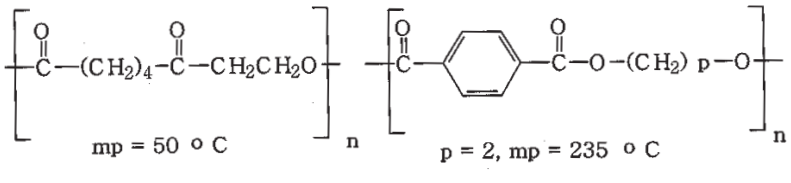
a) With reference to aromatic polyamides, please explain the following :

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

ii) How are aromatic polyamides prepared by interfacial polymerization?

b) Methylethyl ketone peroxide and cyclohexanone peroxide are commercially available. Please draw their structures and explain the role of cobalt octoate and the role of the octoate radical as an accelerator.

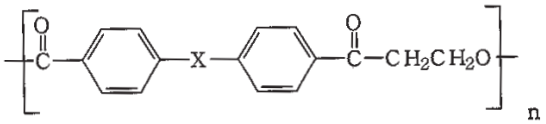
c) Is there a relation between the structure and m.p. for the polymers shown below ? Please write the structures of monomers required for each of these polymers.



mp = 50 ° C

p = 2, mp = 235 ° C

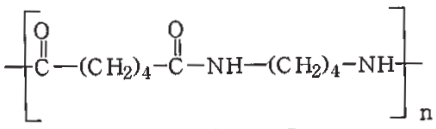
p = 4, mp = 265 ° C



X = $(CH_2)_4$, mp = 170 ° C

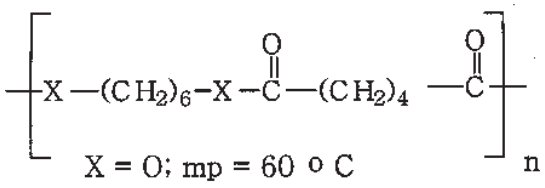
X = $OCH_2CH_2O$; mp = 240 ° C

X = $NH-(CH_2)_2-NH$, mp = 270 ° C



mp = 295 ° C

d) 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.



X = O; mp = 60 °C

X = NH; mp = 265 °C

X = $NCH_3$; mp = 166 °C

e) Typically how is polyurethane flexible foam prepared ? Explain you answer with suitable equations.

f) Write a short note on unsaturated polyestes and alkyds.

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

a) How are polyether ketones prepared ? With suitable examples enlist their applications.

b) 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).

c) Write a note on the preparation and properties of epoxy resins.

d) Discuss the role of aliphatic and aromatic polyamines in the curing of epoxy resins ? Compare and contrast the adhesive properties of both the adhesives.

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

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

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**Total No. of Questions : 4]**

**SEAT No. :** ____

**P697**

**[Total No. of Pages : 2**

# [4128] - 303
# M.Sc. (Sem. - III)
# POLYMER SCIENCE
## PS - 312 : Physical Chemistry of Polymers
## (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) What are first and second order transitions in polymers ? How are these measured ?

b) When a polymer is heated does it shows any transition ? Draw and label the different transitions.

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 150°C it looses transparency. Explain.

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

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

a) Write a note on HDPE, LDPE and LLDPE.

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.

***P.T.O.***

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

f) Write a note on Flory-Fox Equation.

## SECTION - II

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

a) Bring out the differences in the dissolution of crystalline and amorphous 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) Explain Flory-Huggins theory and the parameters on which it is based.

e) What are colligative properties ? Describe ideal, real and non-real solutions.

f) What is LCST and UCST and where does it find application ? Draw diagrams and explain with suitable examples.

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

a) Write a note on the chain models to describe a polymer in solution.

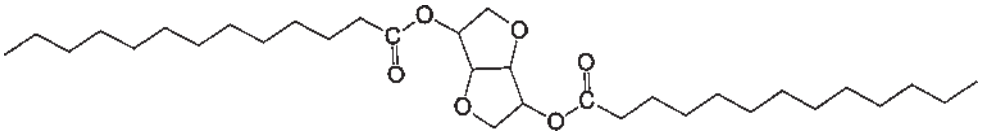
b) Relate Flory-Huggins interaction parameter with cohesive energy density.

c) Write a note on high energy radiation and polymer modification. How does it effect the properties of polymers ?

d) Compare and contrast advantages of radiation induced and free radical polymerization.

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) = 355.80 $cm^3$

$\rho$ (density) = 1.51 $g/cm^3$

Assume the following molar attraction constants (F)

| | |
|---|---|
| - $CH_3$ | 420 |
| -$CH_2$- | 280 |
| -COO- | 511 |
| -CH- | 140 |

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Total No. of Questions : 6]

SEAT No. :

P698

[Total No. of Pages : 4

# [4128] - 304

## M.Sc. (Sem. -III)

## POLYMER SCIENCE

## PS - 313 : Analytical Chemistry of Polymers

## (2008 Pattern)

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

***Instructions :***

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** $C_6H_{10}O_2$ (Mol. Wt. 114) and the polymer **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, 1630, 890 $cm^{-1}$.

**B:** Mol. Wt. 3420; IR: 1735 $cm^{-1}$.

**C:** Mol. Wt. 2160; IR: 3350 $cm^{-1}$. **[4]**

b) Draw structures of six isomeric esters containing benzene ring with the formula $C_8H_8O_2$. Indicate, giving approximate values,how each of these can be differentiated from their IR spectra. **[8]**

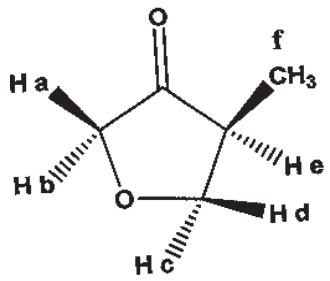
***Q2)*** Answer **any one** of the following: **[10]**

a) A compound $C_{10}H_{15}N$ shows $^1$H-NMR signals given below. Deduce its structure. Assign the signals giving reasons.

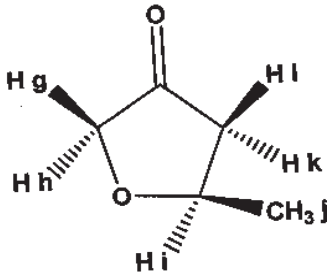
1.85 (quintet, J = 6 Hz, 12 mm); 2.45 (s,18 mm); 2.7 (t, J = 6 Hz, 24 mm); 4.35 (s, 6mm exchanges with $D_2O$); 7.15 (s, 30 mm).

***P.T.O.***

b) The $^1$H-NMR spectra of **1** and **2** are given below. Decide, giving reasons, which spectrum A or B corresponds to which compound. Assign the signals, giving reasons.




1




2

A: 1.15 (d, J = 7 Hz, 24 mm); 2.5 (sextet, J = 7 Hz, 8 mm); 3.73 (t, J = 7 Hz, 8 mm); 3.84 (d, J = 16.5 Hz, 8 mm); 4.07 (d, J = 16.5 Hz, 8 mm) ; 4.41 (t, J = 7 Hz, 8 mm).

B: 1.4 (d, J = 6 Hz, 24 mm); 2.15 (dd, J = 9 Hz and 18 Hz, 8 mm); 2.57 (dd, J = 6 and 18 Hz, 8 mm); 3.8 (d, J = 16.5 Hz, 8 mm); 4.04 (d, J = 16.5 Hz, 8 mm); 4.35 (d, quintet, J = 6 and 9 Hz, 8 mm).

***Q3)*** Answer **any two** of the following. **[12]**

a) Deduce the structures of two possible monomers both with the formula $C_8H_{16}$. Assign the signals.

(i) 13.7 (q), 23.1 (t), 39 (t), 130.6 (d);

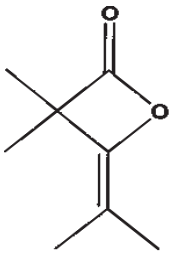
(ii) 18.8 (q), 28.0 (q), 30.3 (q, very strong), 32.2 (s) 130.3 (s), 135.3 (d). In $^1$H-NMR all methyls are singlets.

b) Deduce the structures of the two compounds both $C_9H_{12}$ from their CMR spectra. Assign the signals.

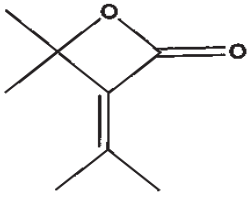
(i) 21.2 (q), 127.1(d), 137.6 (s).

(ii) 19.1 (q), 19.6 (q), 20.9 (q), 126.6 (d), 129.6 (d), 130.5 (d), 133.0 (s) 135.1 (s), 136.1 (s).

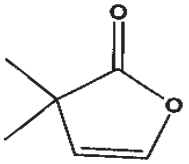
c) Decide, giving reasons, which of the four isomeric structures given below is consistent with the given CMR data.
15.2 (q, *mod), 15.4 (q, *mod), 20 (q, st), 54 (s, w), 104 (s,w), 142 (s,w), 173 (s,w). *mod = moderate, st = strong, w = weak).



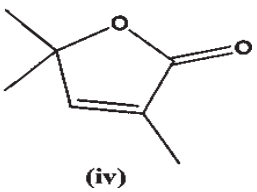

(i)




(ii)




(iii)




(iv)

***Q4)*** A possible monomer $C_4H_6O$ shows the spectral data given below. Assign the signals. Explain your answer. **[6]**

IR: 1640, 720, 650, $cm^{-1}$;

CMR: 76, 124; DEPT-I: 76 (down); 124 (up); DEPT-II: 124 (up).

1H-NMR: 4.7 (d, J = 2 Hz, 10 mm), 5.9 (t, J = 2 Hz, 5 mm).

Table 1 : Some characteristic IR data in $cm^{-1}$; Values are approximate.

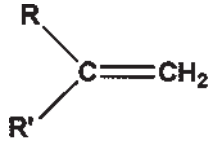
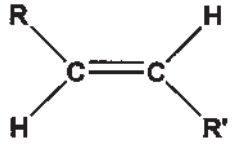
| | | |
|---|---|---|
| OH - 3600 (free) | NH - 3300 | ≡C-H 3300 |
| C≡N 2250 | C≡C 2200 | C = C 1620 |
| Vinyl ester 1760 | Saturated ester 1740 | Saturated ketone 1720 |
| Saturated amide 1650 |  890 |  960 |

Table 2: Approximate chemical shifts ( $\delta$ Values).

| | | |
|---|---|---|
| $CH_3$-C 0.9 | C = C – $CH_3$ 1.6 | O = C – $CH_3$ 2.0 |
| R-$OCH_3$ 3.3 | O = C – $OCH_3$ 3.8 | $H_2C$ = C 4.6 |
| C = C – H 5.1 | HC = C – CO 6.3 | C = CH – CO 5.7 |
| Ph – $OCH_3$ 3.8 | | |

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 ≡ C 75 – 100 | C ≡ N 110 –125 |
| Benzene 128.5 | C = C 100 - 140 | C = N 145 –162 |
| RCOOR, RCONHR, RCOOH 165 –180 | RCOR, RCHO 190 - 210 | |

## SECTION - II

***Q5)*** Attempt **any four** of the following: **[20]**

a) Write a note on dichroism and birefringence and its use in characterization of polymers.

b) With the help of a neatly labeled diagram explain scanning electron microscope. Mention important applications.

c) Define acid number in the analysis of polymers. Describe the method for the analysis of acetyl number of polymers.

d) How is iodine number of unsaturated polymers measured? What is its significance?

e) How are density, refractive index and color tests important in testing and analysis of polymers?

f) Write a short note on semiconductor detector used in x-ray analysis.

***Q6)*** Attempt **any four** of the following: **[20]**

a) Explain with reference to a simple example the analysis of molecular structure of a polymer using XRD technique.

b) Describe the different detectors used for detecting X-rays.

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

$\lambda$ rays used = 154 nm

Order of reflection = 1

Length of blackened arc on the camera = 58.88 mm

Camera radius = 57.3 mm

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

e) Write a short note on significance of refractive index and Abbe number.

f) Explain the different transitions obtained when a semicrystalline polymer is heated in DSC.

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Total No. of Questions : 4]

SEAT No. :

**P700**

[Total No. of Pages : 2

# [4128] - 401

## M.Sc.

## POLYMER SCIENCE

## PS - 404 : Special Topics

## (2008 Pattern) (Sem. - IV)

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

***Instructions to the condidates :***

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 use of protecting groups in the preparation of functional polymers.

b) Describe the various polymeric membranes. Discuss mechanism of separation of fruit juices employing these membranes.

c) Discuss why polymers are the most suitable materials for biomedical applications.

d) With the help of neat diagrams, explain the classification of liquid crystals with reference to polymers.

e) What is the mechanism of conduction in polymer filled with conducting fillers?

f) Discuss the industrial applications of water soluble polymers.

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

a) What is the "Green Polymer Synthesis and Processing" ? What can chemists do to reduce the ill-effects of conventional chemistries?

b) Define polymer gels. Give examples of polymer gels in personal products and in industrial applications.

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

***P.T.O.***

d) Write a note on factors that favour biodegradation and methods to study degradation.

e) Enlist the problems associated with large scale recycling of polymers. Is it advisable to establish a polyvinyl chloride recycling plant? Explain your answer.

f) What are miscible and immiscible blends? Give industrial examples of the two types of blends.

## SECTION - II

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

a) Write a note on the methods of preparation of functional polymers. Give applications of functional polymers.

b) Suggest polymeric membranes for the following separation processes: Ultrafiltration, microfiltration and nanofiltration.

c) Suggest polymers to replace the following: (i) heart, (ii) bones, (iii) blood, (iv) teeth and (v) skin. Explain your choice.

d) What are mesogens? Give examples. Draw diagrams and explain nematic and smectic (A and C).

e) What are n and p dopants? Describe the function of dopants in enhancing conductivity of polymeric materials.

f) Describe the technological applications of water soluble polymers.

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

a) Explain the principles of green chemistry.

b) How are polymer gels prepared? Enlist their applications.

c) Describe various applications of nanomaterials using polymer matrix.

d) Write a note on biodegradable polymers for suture application.

e) Write a note on recycling polyurethanes.

f) With neat diagrams explain LCST and UCST.

■■■

Total No. of Questions : 4]

SEAT No. :

P702

[Total No. of Pages : 2

# [4128] - 403

## M.Sc.

## POLYMER SCIENCE

## PS - 411 : Reheology and Mechanical Properties of Polymers (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 shear stress - shear rate curves for various types of polymers:
   i) Newtonian polymer,
   ii) dilatant,
   iii) Pseudoplastic,
   iv) Bingham plastic and
   v) Venant body.

b) Explain relaxation and retardation in polymeric materials.

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

d) With the help of neat diagrams, describe
   i) Hard and brittle,
   ii) Hard and strong,
   iii) Hard and tough,
   iv) Soft and weak,
   v) Soft and tough polymers.

e) Write a short note on power law model.

f) Explain the usefulness of shear thinning in processing of polymers.

*P.T.O.*

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

a) What is the role of branching and stereoregularity of polymers on the rheological properties?

b) What is storage modulus with respect to polymers ?

c) Describe cone and plate viscometer. What are its scope and limitation in the study of rheology of polymers?

d) Explain stress strain behaviour of i) Strong and soft and ii) Strong and brittle polymeric materials .

e) Write a note on the process of creep and stress relaxation.

f) Write a note on relevance of viscoelastic properties for polymers.

## SECTION - II

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

a) Write a short note on mechanism of adhesion of a substrate to metal, wood and paper surface.

b) What are the failure modes of adhesives?

c) How are adhesives applied on to different substrates? What are the different tools employed?

d) What are the desirable features of packaging material for electronic items?

e) Differentiate between acrylic paint and oil paint?

f) Explain the different components of a paint.

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

a) What is hiding power or covering power of pigments used in surface coating?

b) Enumerate the methods employed for testing of paints and varnishes.

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

d) What type of polymers would be suitable for packing electronic items?

e) Enlist the function a food packaging performs. Give illustrative examples of polymers used in food packaging.

f) Enumerate the criteria for selection of a paint.

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Total No. of Questions : 4]

SEAT No.:

**P1492**

[Total No. of Pages : 3

# [4128]-31
# M.Sc.
# POLYMER SCIENCE
## PS - 310 : Kinetics and Mechanism of Polymerization Processes
## (2004 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) Compare and contrast 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 polymerization reaction.

c) 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.

d) What is the importance of stoichiometric ratio of the reactants in condensation polymerization? Illustrate with suitable examples.

e) In a typical polyesterification, self catalyzed reaction is 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.

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

***P.T.O.***

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

a) Write a detailed note on the different termination processes in radical polymerizations.

b) Describe the role of retarders, inhibitors and chain transfer agents in free radical polymerizations.

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

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

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

f) Discuss the role of temperature and pressure on free radical polymerization.

## SECTION - II

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

a) Compare and contrast dependence of rate of reaction on temperature in case on 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 both the reactions.

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

d) What reactivity ratio values would you require for obtaining the following copolymers :

i) Random copolymers.
ii) Block of 1 with a short group of 2, and
iii) Long block of 1 separated by one unit of 2.

e) Describe Ziegler-Natta catalyst used in co-ordination polymerization of olefins.

f) Write a short note on ring opening polymerization.

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

a) Write an account on the merits of "Q and e" scheme in copolymerization. Are there any limitations?

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

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

d) Derive copolymer composition equation. Explain the assumption under which it is derived.

e) Using the following values of $r_1$ and $r_2$, predict the resulting polymers :

i) $r_1$ and $r_2 = 0$.

ii) $r_1 >>> 0$, $r_2 >>> 0$.

iii) $r_1$ = infinity, $r_2 = 0$. Explain your answer.

f) Describe the tendency of the formation of alternate copolymer with certain monomer pairs.

Total No. of Questions : 4]

SEAT No.:

**P1493**

[Total No. of Pages : 4

# [4128]-32
# M.Sc.
# POLYMER SCIENCE

**PS - 311 : Synthesis, Structural Aspects, Properties and Applications of Polymers**

**(2004 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) 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/$H_3COOH$.
iv) No addition of sodium acetate.
v) Boiling with very dilute $H_2SO_4$.

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 - 40ºC 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 arguments to establish the structure of cellulose.

***P.T.O.***

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; and
iv) Alkyd resins can not be prepared by heating a mixture of oil, polyol and dibasic acid.

e) With respect to polyurethanes, please comment and explain the following :

i) Reactions of polyols with diisocyanates are more widely used than reactions of diols with polyisocyanates.
ii) Hydroxyl terminated polyethers are preferred to hydroxyl terminated polyesters.
iii) The structural differences when diols or polyols react with diisocyanates.

f) Give chemical equations for the preparation of terephthalic acid. Explain the steps and the interchange reaction involved in the conversion of dimethyl terephthalate to poly (ethylene terephthalate). What is the role of the intermediate "ester-alcohol"?

***Q2)*** Attempt Any Four of the following : **[20]**

a) The composition of four typical hydroxyl terminate polyesters are given below. 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 (GI) 0.5;

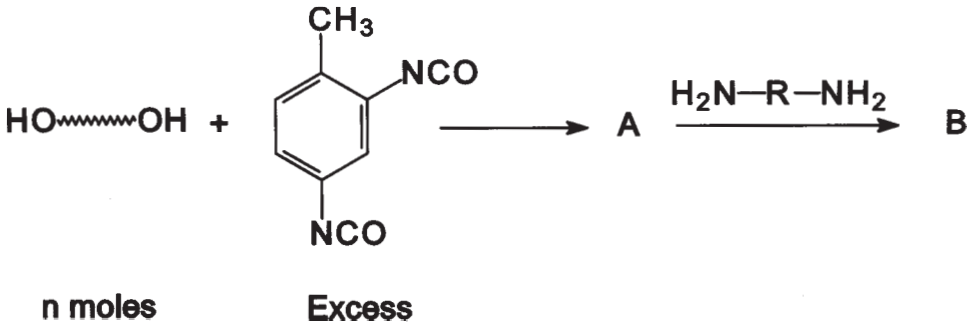
Composition :

iii) AA 3.0, 1,3 butanediol 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 conversion of A to B? In the polymer B, what are the hard and soft segments? Why are these characteristics observed? What happens when this polymer is stretched and when the stretching force is withdrawn? What class of fiber is B?

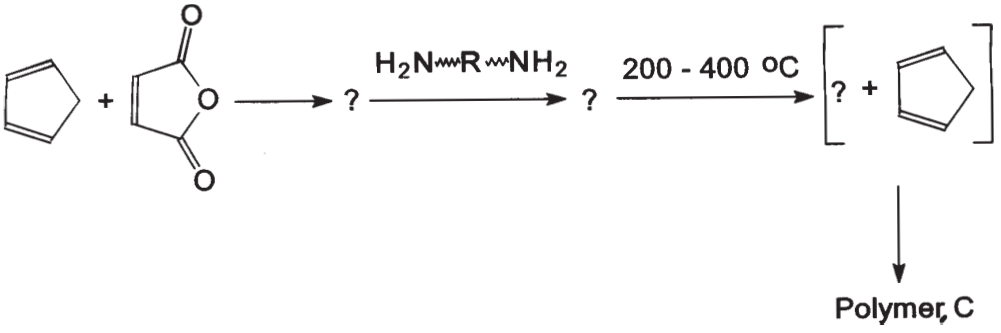



c) A typical formulation for flexible foam is given below. Comment on the role of different components and their quantities. What are the reactions leading to cross linking? Draw a structure indicating crosslinking. Polyether triol 100 (parts by weight), 80:20 TDI 40, water 3.0 DABCO 0.5, stannous octoate 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) How are the aromatic polyamides Nomex and Kevlar prepared? What are their advantages? where are these used? What are their drawbacks?

f) Complete the reactions shown below. The polymer C obtained is called PMR. Explain.



## SECTION - II

***Q3)*** Attempt Any Four of the following : **[20]**

a) Explain how the molecular weight of epoxy prepolymers is controlled? Explain the reasons why the molecular weight of the prepolymers should be controlled.

b) How is melamine formaldehyde resin prepared? Write chemical modifications of melamine formaldehyde resin. Write its important applications.

c) Write a short note on Resol and Novolak polymers.

d) Compare and contrast the crosslinking reactions in phenol-formaldehyde and urea-formaldehyde resins.

e) Write a short note on the preparation and applications of silicone containing polymers.

***Q4)*** Attempt Any Four of the following : **[20]**

a) How are the following monomers prepared

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.

f) Explain briefly the formation of stereoregular polypropylenes in the polymerization of propylene. Explain the role of tacticity on the properties of polypropylenes.

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Total No. of Questions : 4]

SEAT No. :

**P1494**

[Total No. of Pages : 2

# [4128]-33
# M.Sc.
# POLYMER SCIENCE
## PS-312: Polymer Processing
## (2004 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) With the help of a neat diagram explain the working of a reciprocating screw injection molding. Enlist the advantages over ram based injection molding.

b) Explain blow molding process. Enlist industrially important products prepared by this process.

c) What is the importance of flight angle, root diameter and pitch in designing a screw in extrusion?

d) Write a note on compression molding of polymers.

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

f) Describe design peculiarities of pressure forming.

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

a) Explain the typical values of the crystalline melting point and glass-transition temperature for textile fibers.

b) How do the stress-strain properties of the typical fiber change with draw ratio? Explain your answer in detail.

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

***P.T.O.***

d) List and explain the criteria of choosing a polymeric material for desired application.

e) What is the approximate denier of a fiber 0.02 mm in diameter if the specific gravity of the polymer is 1.2?

f) Describe the versatility of extrusion as a process.

## SECTION - II

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

a) Explain with examples of synthetic fibers prepared by wet spinning process.

b) Compare and contrast the properties of natural and synthetic fibers.

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

d) Give examples of thermoformed products. With the help of neat diagrams describe thermoforming process.

e) Write a short note on specialty fibers.

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

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

a) Discuss importance of compounding.

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

c) Differentiate between accelerators and activators? Discuss their role in rubber vulcanization.

d) Writing structures, discuss special properties and applications of any three synthetic elastomers.

e) Compare and contrast reinforcing and non-reinforcing fillers. Describe the theory of reinforcement action of carbon black.

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

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Total No. of Questions : 4]

SEAT No. :

**P1495**

[Total No. of Pages : 2

# [4128]-34
# M.Sc.
# POLYMER SCIENCE
## PS-313: Polymer chains and their characteristics
## (2004 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 do you understand by term 'solubility parameter'? How is solubility parameter of unknown polymer determined? What is the significance of solubility parameter?

b) What is hydrodynamic volume? Give examples of application of hydrodynamic volume of linear and branched polymers.

c) Write a note on solubility of crystalline and amorphous polymers.

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

e) Write a short note on polymer electrolytes.

f) Write a note on LCST and UCST. What is the significance?

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

a) Write a note on virial coefficients. Explain the terms Flory Theta Temperature, a good solvent and a poor solvent.

b) Write a note on the assumptions on which Flory Huggins theory of polymer solubility is based.

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

d) Discuss the applications of radiation induced polymerization in (i) removal of monomer residue and (ii) curing.

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

***P.T.O.***

f) Determine the solubility parameter of poly-n-butyl 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-butyl methacrylate is 1.05.

## SECTION - II

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

a) Explain the terms :

i) Rheology,
ii) Stress tensor,
iii) Deborah Number,
iv) Shear thinning flow, and
v) Elongational flow.

b) Compare solid, fluid and polymeric melt on the basis of rheological properties.

c) Write a note on non-newtonian behavior of polymeric solutions.

d) Explain the rheological properties of a solid and that of polymeric melt.

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

f) Write a note on Burger model for deformation behavior of polymeric materials.

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

a) Given a rheological data at varying temperature and shear for polyethylene of varying molecular weight and MWD, is it possible to predict the rheological properties of another polymer? Explain.

b) Write a note on importance of material functions in rheology.

c) Write a short note on kinetic theory of rubber elasticity.

d) Write a note on time temperature superposition.

e) With respect to polymeric materials explain storage and loss moduli.

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

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**Total No. of Questions : 4]**

**P1496**

**SEAT No. :** ____

**[Total No. of Pages : 5**

# [4128] - 41
## M.Sc.
## POLYMER SCIENCE
## PS - 410 : Analysis and Testing of Polymers
## (2004 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) Determine the structure of a monomer A $C_6H_{10}O_2$ (Mol. Wt. 114) 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 - 1720, 1625, 970 $cm^{-1}$; UV - 215 nm ε ~ 7000

B Mol. Wt.3420; IR - 1735 $cm^{-1}$

C Mol. Wt. 3000; IR - 3300 - 2500 $cm^{-1}$ (broad), 1730 $cm^{-1}$

b) Deduce the structure of any two of the following compounds, all of which are $C_8H_8O_2$. Explain the given data.

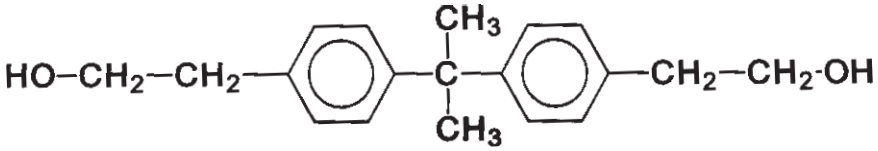
i) IR : 2730, 1680, 1605, 1495, 765 $cm^{-1}$; UV : 257 nm ε ~ 11000.

ii) IR : 1760, 1600, 1505, 760, 680 $cm^{-1}$.

iii) IR : 3300, 1680, 1595, 1495, 850 $cm^{-1}$; UV : 270 nm ε ~ 12000. It gives positive iodoform test.

***P.T.O.***

c) Make a neat sketch of the $^1$H-NMR of the following monomer 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 $CH_2$.




d) 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);

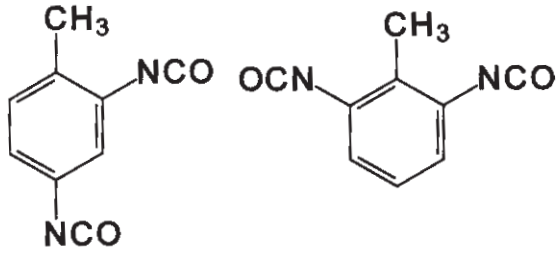
ii) 0.9 (t, 6H); 2.5 (q, 4H);

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);

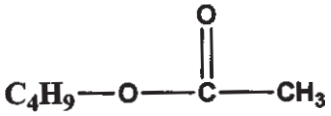
v) 1.0 (s, 9H), 5.7 (s, 1H).

e) The tolylene diisocyanates A and B 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

f) Draw four possible isomers of




indicate the number of signals expected for each of these compounds. For each compound indicate the expected chemical shift, multiplicity, coupling constant, integration (assume 1H = 4 mm) for the protons at highest and lowest field only, with reasons.

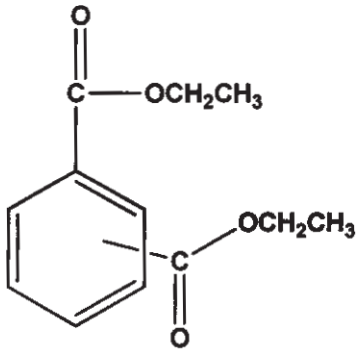
***Q2)*** Attempt <u>any four</u> of the following : **[20]**

a) The CMR spectra of 2 and 3 are given below. Identify which spectrum corresponds to which compound, giving reasons. Assign the signals. Note that both compounds are diethyl esters of important polymer raw material.

i) 14 (q)*, 62(t)*, 129 (d), 130.5 (d), 130.7 (s)*, 134(d)*, 165(s)*.

ii) 12(q)*, 60(t)*, 128(d)*, 130 (d)*, 131(s), 166 (s).

* strong signals




**2 – ortho isomer; 3 – meta isomer**

b) Identify the two possible monomers both $C_4H_6O$ from their CMR data giving reasons. Assign the signals.

i) 76 (down, ab)*, 124 (up, up).

ii) 24 (down, ab)*, 67 (down, ab)*, 98 (up, up), 147 (up, up).

The first word in brackets indicates result of DEPT 1, the second word that of DEPT 2. * ab = absent.

c) 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≡N 2250 | C≡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 |
| R$OCH_3$ 3.8 | -CO-$CH_3$ 3.8 | $H_2$C=C 4.6 |
| C=C-H 5.1 | HC=C-CO 6.3 | C=CH-CO 5.7 |

TABLE 3-Approximate CMR chemical shifts

| | | | |
|---|---|---|---|
| R$CH_3$ 10-30 | $R_2CH_2$ 25-40 | $R_3$-CH 30-50 | $H_3$C-O 53-75 |
| C≡C 75-100 | C≡N 110-125 | Benzene 128.5 | C=C 100-140 |
| C=N 145-162 | RCOOR, R$COCH_2$, RCOOH 165-180 | RCOR, RCHO, 190-210 | |

d) 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).

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 :
H(s, 2H); I(dd, J =2 and 8 Hz, 2H); J(dd J = 2 and 8 Hz, 2H); K(d, J=2 Hz, 2H,) L(dd J=2 and 8 Hz, 2H); 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 any four of the following : **[20]**

a) Write a note on the factors affecting thermal stability of polymers.

b) Write note on DTG for polymer degradation analysis.

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

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

e) Define acid number in the analysis of polymers. Describe the method for the analysis of acetyl number of polymers.

f) With the help of a neatly labeled diagram explain the working of scanning electron microscope. Mention important applications.

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

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

b) Explain principle of TEM analysis for polymer characterization.

c) Explain the significance of glass transition of a polymer obtained from DSC.

d) Write a note on Freeman and Carrol method on TGA analysis.

e) Draw and label the different transitions obtained when a semicrystalline polymer is analyzed by DSC.

f) Discuss heat of fusion and degree of crystallinity in polymers and give one method of their determination.

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**Total No. of Questions : 4]**

**P1497**

**SEAT No. :** ____

**[Total No. of Pages : 2**

# [4128] - 42
# M.Sc.
# POLYMER SCIENCE
## PS - 411 : Structure and Properties of Bulk Polymers
## (2004 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) 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 Tg and Tm of samples before and after quenching.

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

***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.

***P.T.O.***

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.

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? Enlist 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 materials are electronic gadgets normally packed and why.

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

e) Suggest packaging material for
   i) milk and dairy products,
   ii) confectionary items
   iii) agrochemicals.

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

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**Total No. of Questions : 4]**

**P1498**

**SEAT No. :** ____

**[Total No. of Pages : 2**

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# M.Sc.
# POLYMER SCIENCE
## PS - 404 : Special Topics in Polymer Science
## (2004 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) Explain how recycling of post consumer polymer is carried out. Enlist the types of plastic containers that should not be recycled.

b) Explain essential features of biodegradation. Why are polymers generally difficult to biodegrade?

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

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

e) Giving reasons, suggest polymers for bone replacement, dental application and substitute for blood.

f) Discuss the preparations and important applications of nylons as engineering plastics.

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

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

b) What are synergistic and miscible blends? What experimental tools could be used to differentiate them?

c) What are the different methods of increasing thermal stability of polymers.

***P.T.O.***

d) Define thermally stable polymers, flame retardant polymers and polymers with high HDT. Discuss the resulting properties.
e) Describe synthesis of any one thermally stable polymer.
f) What are engineering plastics? Discuss importance of HDT in selecting engineering applications of plastics.

## SECTION - II

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

a) What polymers would one use for the following applications (any three):
   i) hip replacement ii) heart valves
   iii) artificial kidneys and iv) contact lens? Give reasons.
b) Write a note on applications of polymeric membranes in pollution control.
c) Describe the preparation of nylon-6? Enlist important applications.
d) Write a note on the chemistry and technology of PPS or polysulfone.
e) Differentiate between commodity, engineering and specialty plastics. How are HDT and UL rating important in selecting polymers for impact resistance and glass replacement applications.
f) Describe the importance of various molding process option while selecting engineering plastic for various applications.

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

a) What polymeric materials would you recommend for the following application and why?
   i) separation of suspended solid in water
   ii) dissolved salts from water
   iii) separation of $N_2$ and $O_2$ from air.
b) Giving examples of controlled release drugs, describe the various mechanisms to controlled release of drugs.
c) Write a short note on the different applications of piezoelectric PVDF.
d) What are electroactive polymers? Describe the mechanism of electrical conduction using solitons and polarons.
e) Discuss applications of polymeric membranes in food processing.
f) Write a note on the selection criterion for the selection of various engineering plastics for different applications.

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