

# SYLLABUS

## Saurashtra University



### DDU Kaushal Kendra

#### Curriculum for

#### MASTER of VOCATION

in

#### CHEMICAL TECHNOLOGY (POLYMER SCIENCE & TECHNOLOGY)

(Under UGC – DDU Kaushal Kendra sanctioned to Shree Manibhai Virani & Smt. Navalben  
Virani Science College-Rajkot)

(Sanction Letter No. 3-43/2015(KAUSHAL) dated 14.08.2015)

#### M.Voc. Semester I & II

Credit Based Semester System (CBSS)

Effective from June 2015-16

## **Master of Vocation – Chemical Technology (Polymer Science & Technology)**

(2 years – Four Semester Full Time Course)

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### **DEEN DAYAL UPADHYAY KAUSHAL KENDRAS**

(XII plan guidelines for Deen Dayal Upadhyay Centres for knowledge acquisition and up gradation of skilled human abilities and livelihood (KAUSHAL) in universities and colleges - 2014 - 2017)

#### **Introduction:**

Education plays an important role in the overall development of a human being as well as the nation. It is a unique investment in the present and for the future. Every country develops its own system of education to express and promote its unique socio-cultural identity besides meeting the challenges of time to leverage the existing potential opportunities. India, at present, is recognized as one of the youngest nations of the world with over 50% of population under the age of 30 years. It is estimated that by 2025, India will have 25% of the world's total workforce. In order to harness the full demographic dividend, India needs high quality educational system which is affordable, flexible and relevant to the individuals, as well as to needs of the society as a whole. Today, the country faces a demand – supply mismatch as the economy needs more 'skilled' workforce as also the managers and entrepreneurs than produced annually. In fact, majority of the contemporary institutions of higher learning remain almost disconnected with the requirements of the workplace. The higher education system has to incorporate the requirements of various industries in its curriculum, in an innovative and flexible manner while producing well groomed graduates. UGC introduced two schemes known as – Community Colleges and B.Voc. Degree Program in universities and colleges during the XII Plan. However, there is a need for taking integrated initiatives towards knowledge acquisition and up-gradation of skilled human competencies in universities and colleges to address the emerging needs of the economy so as to ensure that the graduates have adequate knowledge and skills to get appropriately employed or become entrepreneurs and, thereby, meet the economic and industrial needs at the regional and national level. Government of India, taking note of the requirement for skill development among students developed National Vocational Education Qualification Framework (NVEQF) which was later on assimilated into National Skills Qualifications Framework (NSQF). Various Sector Skill Councils (SSCs) are developing Qualification Packs (QPs), National Occupational Standards

(NOSs) and assessment mechanisms in their respective domains, in alignment with the needs of the industry.

In view of this, the UGC implemented the scheme of Community Colleges from 2013-14 in pilot mode on the initiative of the MHRD. However, realizing the importance and the necessity for developing skills among students, and creating work ready manpower on large scale, the Commission decided to implement the scheme of Community Colleges as one of its independent schemes from the year 2014-15. The Commission also launched another scheme of B.Voc. Degree program to expand the scope of vocational education and also to provide vertical mobility to the students admitted into Community Colleges for Diploma programs to a degree program in the Universities and Colleges. While these two schemes are being implemented, it is also realized that there is a need to give further push to vocational education on a even larger scale. It is therefore proposed to establish as many as 100 'Deen Dayal Upadhyay Centres for Knowledge Acquisition and Up gradation of Skilled Human Abilities and Livelihood (KAUSHAL)' during the XII Plan period. These Centers would take-up the vocational education to new levels and offer courses beyond B.Voc. degree also. These Centres would also embed and follow the guiding principles of NSQF, QPs, and NOSs for their programs and would not focus on skilling alone but also develop entrepreneurship traits. The Centres may endeavor to maintain a pyramidal structure of student enrolment with respect to Diploma, Advanced Diploma, B.Voc. and further studies.

### **Objectives of the Scheme:**

The main objectives of these centres are to:

- a) create skilled manpower for industry requirements at various levels. The scheme provides for vertical mobility from short term certificate courses to full-fledged post graduate degree program, and further research in specialized areas. The courses would be planned/ designed to have provision of multiple entry and exit at various levels culminating up-to a research degree level. These shall also include courses which are offered under the Community College Scheme and B.Voc. degree program of UGC.
- b) Formulate courses at postgraduate level keeping in mind the need of i) Industry in specialized areas; ii) Instructional design, curriculum design and contents in the areas of Skills Development; iii) Pedagogy, assessment for skills development education and training; iv) trained faculty in the areas of skill development; and v) Entrepreneurship; etc.

- c) work for coordination between the higher education system and industry to become a Centre of Excellence for skill development in specialized areas.
- d) network with other such centers and universities and colleges imparting vocational education under the scheme of Community Colleges and B.Voc degree program in their region and coordinate with them for targeted development of skill oriented education.
- e) undertake R&D in the areas related to skill education & development, entrepreneurship, employability, labour market trends etc. at the post-graduate and research level.
- f) act as finishing school by providing supplementary modular training programs so that a learner, irrespective of his/her training background, is made job ready with necessary work skills (soft, communication, ICT skills etc) and fill the gaps in the domain skills measured against QPs/NOSs.
- g) provide for Recognition of Prior Learning (RPL) framework for job roles at NSQF Level 4 onwards by conducting assessment and certification with respective Sector Skill Councils (SSCs) / Directorate General of Employment and Training (DGET).
- h) Maintain 'Labour Market Information' for respective regions in coordination with other government agencies and industry associations.
- i) develop and aggregate curriculum, content and learning materials for skills development in different sectors.

#### **Basic Principles for Curriculum Design:**

While formulating the curriculum under the scheme, the Centres may:

- a) follow credit based semester system;
- b) provide for provision for credit transfer across courses;
- c) ensure alignment of skill component with the QPs/NOSs of the relevant job roles based on the exit profiles of the students. The focus of skill development components should be to equip students with appropriate knowledge, practice and attitude, so as to make them work ready. The skill development components should be relevant to the industries as per their requirements;
- d) provide credits for practical work, apprenticeship, on the job training, and project work;

- e) provide multiple exit and entry points with provision for vertical and horizontal mobility;
- f) assess and certify the skill competence for the selected job roles through the respective SSCs / DGET;
- g) provide credits for general education component and skill component broadly in the ratio of 40 : 60. The general education will also include credits in communication skills, ICT skills, soft skills, critical thinking, problem solving, environmental studies and value education.
- h) review the courses periodically in accordance with the changing requirements of the industry and regional / national economic priorities.
- i) follow UGC guidelines for skill development courses at different levels specified under Community Colleges, B.Voc. degree program and as may be prescribed from time to time.

**Programs and Curricula:** (UGC guidelines for curricular aspects, assessment criteria and credit system in skill based vocational courses under national skills qualification framework (NSQF))

In order to make education relevant and to create 'industry fit' skilled workforce, the institutions recognized under Community Colleges / B.Voc Degree program, and Deen Dayal Upadhyay KAUSHAL Kendras offering skill based courses will have to be in constant dialogue with the industry and respective Sector Skill Council(s) so that they remain updated on the requirements of the workforce for the local economy. There will be credit-based modular programs, wherein banking of credits for skill and general education components shall be permitted so as to enable multiple exit and entry. This would enable the learner to seek employment after any level of Award and join back as and when feasible to upgrade her / his qualification / skill competency either to move higher in her / his job or in the higher educational system. This will also provide the learner an opportunity for vertical mobility to second year of B.Voc degree program after one year diploma and to third year of B.Voc degree program after a two year advanced diploma. The students may further move to masters and research degree programs (NSQF Level 8 – 10)

**Degree of Master of Vocation in  
Chemical Technology (Polymer Science & Technology)  
(M.Voc. – Chem. Tech.-PST) Degree Course**

**O.S. M.Voc.- Chemical Technology (Polymer Science & Technology) – 1 :**

**Admission Eligibility:** There may be three types of learners getting admission to first semester of skill based courses under NSQF:

**Category – 1 :** students already acquired NSQF certification Level 7 in a particular industry sector and opted admission in the skill based courses under NSQF in the institutions recognized under Community Colleges / B.Voc Degree program / DDU KAUSHAL Kendras in same trade with job role for which he / she was previously certified.

**Category – 2 :** students who have acquired NSQF certification Level 7 but may like to change their trade and may enter into skill based courses in a different trade(candidate has to take up Skill Bridge course during semester I/II).

**Category – 3 :** students passed B.Sc. - Chemistry / Ind. Chemistry/ Applied chemistry / B. E. - Chemical Engineering / B. Pharm. examination with at least second class from recognized University.

Candidate who have passed an equivalent examination from any other University or examining body and is seeking admission to the Master of Vocation – Chemical Technology (Polymer Science & Technology) course will be required to provide necessary eligibility certificate.

**O.S. M.Voc.- Chemical Technology (Polymer Science & Technology) – 2 :**

The duration of the course will be of two full time academic years. No candidate will be allowed to join any other course or service simultaneously. The examination for the Master of Vocation – Chemical Technology (Polymer Science & Technology) (M.Voc.- Chemical Technology (Polymer Science & Technology)) course will be divided into four semesters.

**Multi-level Exit :**

Candidate will be eligible to receive PG Diploma(NSQF Level 8) after first 2 semesters according to guidelines of UGC.

**O.S. M.Voc.- Chemical Technology (Polymer Science & Technology) – 3 :**

Subject to the provisions laid down in Ordinance **O.S. M.Voc.- Chemical Technology (Polymer Science & Technology) – 2**, a candidate who has passed the M. Voc. semester I & II of this University and if there is a break in the studies for any reason and if there is a change in the courses from semester system to annual part Examination system, the candidate will be admitted to M. Voc. Part II and the marks/ credits obtained by the candidate in his previous examination of this University in M. Voc. semester I and II will be carried forward and the result of the M. Voc. Final Examination will be declared accordingly.

**O.S. M.Voc.- Chemical Technology (Polymer Science & Technology) – 4 :**

To pass the whole M. Voc. Examination, student should clear M. Voc. Semesters I to IV and examinations within a period of five years from the date of his/her registration. Failing to this He /She will be required to register himself as a fresh candidate and keep the attendance and appear and pass all semester examinations afresh from first onwards in order to obtain the Degree of Master of Vocation.

**O.S. M.Voc.- Chemical Technology (Polymer Science & Technology) – 5 :**

No candidate will be admitted to any semester examination for Master of Vocation – Chemical Technology (Polymer Science & Technology) (M.Voc.- Chemical Technology (Polymer Science & Technology)) unless a student has put on at least 80% of the total lecture periods and practical periods in each subject in each semester.

**O.S. M.Voc.- Chemical Technology (Polymer Science & Technology) – 6 :**

No candidate will be permitted to reappear at any semester examination, which he has already passed. The marks of successfully completed paper will be carrying forwarded for the award of class.

**O.S. M.Voc.- Chemical Technology (Polymer Science & Technology) – 7 :**

There shall be an examination at the end of each semester to be known as Pre PG Diploma (first semester) examination, PG Diploma (second semester-NSQF Level-8) examination, Pre M.Voc. Degree (third semester) examination and M.Voc. Degree (fourth semester-NSQF Level-9) examination. At which a student shall appear in that portion of theory papers, practical and viva – voice if any, for which he has kept the semester in accordance with the regulations in this behalf.

A candidate whose term is not granted for what so ever reason shall be required to keep attendance for that semester or term when the relevant papers are actually taken at the college.

**R.S.M.Voc.- Chemical Technology (Polymer Science & Technology) -1:**

The M. Voc. Degree may be taken by written examination and practical (if any) or partly by papers including practical (if any) and Training / dissertation.

### **R.S.M.Voc.- Chemical Technology (Polymer Science & Technology) -2:**

There will be theory and practical examinations at the end of each semester. The viva voce examination will be conducted at the end of each semester.

A candidate failing in more than two theory papers at the end of Semester-I and II will not be allowed to keep term. The candidate must have at least 80% presence in theory as well as practical. In any circumstances if candidate fails in fulfilling the required presence, the term will not be granted for appearing in the examination.

### **R.S.M.Voc.- Chemical Technology (Polymer Science & Technology) -3:**

#### **Standard of Passing**

The standard of passing for Master of Vocation – Chemical Technology (Polymer Science & Technology) (M.Voc.- Chemical Technology (Polymer Science & Technology)) degree examination will be as under :

- 1) To pass any semester examination of the Master of Vocation – Chemical Technology (Polymer Science & Technology) degree, a candidate must obtain at least 40% marks in the University examination separately in each course of theory and practical.
- 2) Total marks of each theory paper are 100 (External examination 70 marks + Internal examination 30 marks)
- 3) No internal examination marks in practical and project/training-viva papers.
- 4) Total marks of Entrepreneurship Development & Soft skill Training is 100. This subject will be evaluated either orally &/or practically on the basis of Project report submitted by the student.

### **R.S.M.Voc.- Chemical Technology (Polymer Science & Technology) -4:**

The passing standard in theory, practical and viva voce examination will be 40% in each head of passing. The final class will be awarded as under:

- 1) The candidate securing greater than equal to 70% aggregate marks obtained in all semesters together (Sem. I –IV) will be awarded a distinction class.
- 2) The candidate securing below 70% but less than equal to 60% aggregate marks obtained in all semesters together (Sem. I –IV) will be awarded first class.
- 3) The candidate securing the aggregate percentage from 50 to less than 60% aggregate marks obtained in all semesters together (Sem. I –IV) will be awarded a second class.



## Saurashtra University

### M.Voc. Chemical Technology (Polymer Science & Technology)

Name of the Program(s) (Diploma, Adv. Diploma, Degree)	Semesters	No. of Credits <b>30 Cr./Sem</b>	Job Roles and <b>NSQF-Levels</b>
B. Voc. (Hons.) <b>OR</b> PG Diploma in <b>Chemical Technology</b> <b>(Polymer Science)</b>	1	60 Credits	<b>NSQF Level 8</b> Hons / PG Dip
	2		
M.Voc. in <b>Chemical Technology</b> <b>(Polymer Science &amp; Technology)</b>	3	60 Credits	<b>NSQF Level 9</b> M.Voc. Master
	4		

*Note: A student has to earn additional 1 credit per year for Universal Human Value Education Course.*

## Saurashtra University

### M. Voc. Chemical Technology (Polymer Science & Technology)

#### Semester-I

S.N.	Paper No.	Subject	Credit	Marks
1	MCTPST-101	Basic Concept in Polymer Science	3	100
2	MCTPST -102	Industrial Polymers	3	100
3	MCTPST -103	Basic concept in material Science	3	100
4	MCTPST -104	Industrial chemistry	3	100
5	MCTPST -105	Practical -101,102,103 & 104 + viva voce	18	250+50
<b>Total Credit Semester-I</b>			<b>30</b>	<b>700</b>

## Saurashtra University

### M. Voc. Chemical Technology (Polymer Science & Technology)

#### Semester-II

S.N.	Paper No.	Subject	Credit	Marks
1	MCTPST-201	Polymer Characterization	3	100
2	MCTPST -202	Polymer additives	3	100
3	MCTPST -203	Polymer processing Technology	3	100
4	MCTPST -204	Polymer Rheology & Speciality Polymers	3	100
5	MCTPST -205	Training / Project Report	2	100
6	MCTPST -206	Practical -201,202,203 & 204 + viva voce	16	250+50
<b>Total Credit Semester -II</b>			<b>30</b>	<b>800</b>

## Saurashtra University

### M. Voc. Chemical Technology (Polymer Science & Technology)

#### Semester-III

S.N.	Paper No.	Subject	Credit	Marks
1	MCTPST-301	Rubber Technology	3	100
2	MCTPST -302	Polymer composite and fiber Technology	3	100
3	MCTPST -303	Selected topics in polymer science (blends, adhesive, pigments,	3	100
4	MCTPST -304	Environmental Chemistry	3	100
5	MCTPST -305	Practical -301,302,303 & 304 + viva voce	18	250+50
<b>Total Credit Semester -III</b>			<b>30</b>	<b>700</b>

## Saurashtra University

### M. Voc. Chemical Technology (Polymer Science & Technology)

#### Semester-IV

S.N.	Paper No.	Subject	Credit	Marks
1	MCTPST-401	Modern analytical techniques	3	100
2	MCTPST -402	Entrepreneurship development and soft skill training	3	100
3	MCTPST -403	Dissertation work	24	200+50+50
<b>Total Credit Semester -IV</b>			<b>30</b>	<b>500</b>

# Saurashtra University

## M. Voc. Chemical Technology (Polymer Science & Technology)

### Semester – I

#### Chemical Technology (Polymer Science & Technology)

Paper No.	Subject	Marks
MCTPST-101	Basic Concept in Polymer Science	100
MCTPST -102	Industrial Polymers	100
MCTPST -103	Basic concept in material Science	100
MCTPST -104	Industrial chemistry	100
MCTPST -105	Practical -101,102,103 & 104 + viva voce	250+50
	Total	700

# M.Voc. Chemical Technology (Polymer Science & Technology)

## SEMESTER I

### MCTPST-101: Basic Concept in Polymer Science

#### 1. Introduction to Polymer Science:

Importance of polymers, Basic concepts, Classification of polymers, Thermoplastics, thermosetting behavior, Tacticity in polymers, Average molecular weight concept, Polydispersity and molecular weight distribution, Crystallization of polymers, degree of crystallinity, Glass transition temperature (T<sub>g</sub>).

#### 2. Chemistry of polymerization and its techniques:

Addition polymerization - free radical, ionic, co-ordination polymerization, Condensation polymerization, Copolymerization, Polymerization techniques

#### 3. Polymer Degradation:

Introduction, Types of degradation- thermal degradation, mechanical degradation, degradation by ultrasonic waves, photo degradation, degradation by high-energy radiation, oxidative degradation and hydrolytic degradation and biodegradation

#### 4. Polymer Recycling and Waste Management:

Introduction - sources of plastics waste, separation techniques - density based sorting, optical sorting, spectroscopic sorting, electrostatic sorting, sorting by size reduction, melting temperature, selective dissolution. Plastics Waste Management – reduction, reuse, repair, recycling, recycling classification, code of practice – primary, secondary, tertiary, quaternary recycling with examples

#### Reference Books:-

1. A Textbook of Polymers Science, F.W. Billmeyer, John Wiley & Sons, New York, 3rd edn.
2. Polymer Science, V.R. Gowariker, New age International, Mumbai.
3. Plastics Materials, J. A. Brydson, Butterworth's, London.
4. Polymer Technology, Miles & Briston, J. G, Chemical Publishing company, Inc, New York.
5. Polymer Science and Technology of Plastics and Rubber, P. Ghosh, McGraw hill, New York.
6. Principles of Polymer Chemistry, P. J. Flory, Asian Books.
7. Introduction to Polymer Chemistry, R. Saymour.
8. Elements of Polymer Degradation, Leo Rach & Salvatores. S. Stivala, McGraw Hill Co.
9. Comprehensive polymer science, Pergamon, New York.
10. Hand book of biodegradable polymers, Abraham J. Domb, Harwood Academic Publishers.
11. Principles of Polymer Science, Bahadur & Sastry, Norsa Publishers, New Delhi

# M.Voc. Chemical Technology (Polymer Science & Technology)

## SEMESTER I

### MCTPST-102: Industrial Polymers

- 1. Thermoplastics Polymers:** Synthesis of monomers, Polymerization, Structure related properties, general properties and applications of various thermoplastics materials like polyolefin's, viz. Polyethylene, Polypropylene, olefinic copolymers, Vinyl polymers, Fluorine-containing Polymers, Poly(vinyl acetate) and its derivatives, Acrylic plastics, plastics based on Styrene and Cellulose plastics
- 2. Engineering Polymers:** Intermediates for Polyamides, polymerization of aliphatic polyamides, their structure and applications, Structure, properties and applications of Polyacetals and Polycarbonates, Thermoplastics Elastomers: Introduction, Structure related properties, general properties and applications of various TPE like styrenics, polyesters, thermoplastics poly urethanes (TPU), polyamides and thermoplastics olefinic elastomers (TPO).
- 3. Thermosetting Polymers:** Manufacture, curing and application of Epoxide resins, Unsaturated Polyester resins, Polyurethanes, Phenolic resins, Urea-formaldehyde resins, Melamine formaldehyde resins, Furan resins.
- 4. Polymers from green precursor:** Introduction, Synthetic absorbable polymers, Natural, Semi synthetic & Biosynthetic polymers.

#### Reference Books:-

1. Fundamental principles of polymer materials practices for engineers, Plastics Materials, Stephen L. Rosen, Barnes & Noble, New York.
2. Plastics Materials, J. A. Brydson, Butterworths, London.
3. Polymer Technology, Miles & Briston, J. G, Chemical Publishing company, Inc, New York.
4. Plastics Materials and Processes, Seymour S. Schwartz S.H. Goodman, Van Nostrand Reinhold, New York.
5. Plastics Technology, R. V. Milbey, McGraw Hill, Book Company New York,
6. Polymer science and Technology of Plastics and Rubber, P. Ghos.
7. Handbook of Biodegradable Polymers, Arham J Domb, Joseph Kost & David M Wiseman, Taylor & Francis Group

## **M.Voc. Chemical Technology (Polymer Science & Technology)**

### **SEMESTER I**

#### **MCTPST-103: Basic Concept in Material Science**

1. Laws of thermodynamics, Thermodynamics functions, Heat capacity, Enthalpy, Internal Energy, Gibbs potential, Heat content, Entropy, Free energy, Reversible & Irreversible process, Adiabatic process, carnot cycle, Refrigeration Engine, Gibbs Helmholtz equations and its limitation, Nernst heat theorem, Consequences of third law
2. Microstates and macrostates, thermodynamics probability. Derivation of distribution equation(s) following Maxwell – Boltzmann statistics and Bose-Einstein statistics
3. Concept of Engineering stress and strain, Elastic Deformation, Elastic properties, Anelasticity, Viscoelastic Behaviour of Materials , Plastic deformation of single crystal and polycrystalline materials, creep in materials, Fracture, Griffith theory, Fatigue Hardness.. Tensile testing, failure modes, bend testing, impact testing, fracture toughness, fatigue testing, creep testing, hardness testing of different materials (Metallic, Polymeric and Ceramic Materials).
4. Heat capacity, Temperature dependence of heat capacity, Specific heats of solids, Latent heat, Melting point, Thermal expansion and kinetic theory, thermal conductivity and thermal diffusivity, thermal stresses

#### **Reference Books:-**

1. Physical Chemistry – Rakshit
2. Thermodynamics for Chemists -- Glasstone
3. Thermodynamics, Kinetic Theory & Statistical Thermodynamics – F.W.Sears, G.Salinger
4. Molecular Statistics for Students of Chemistry -- L.A.Woodwar.
5. Materials Science and Engineering, An Introduction-William D. Callister

## M.Voc. Chemical Technology (Polymer Science & Technology)

### SEMESTER I

#### MCTPST-104: Industrial Chemistry

**1. Unit operation:**

Basic concepts, characteristics, and equipments for Separation of solid from solid, Liquid-liquid extraction, Transportation & mixing of fluid, Agitation & mixing of fluid

**2. Unit Process:**

Halogenations, Alkylation, Oxidation, Hydrogenation, Sulfonation, Nitration, Hydrolysis, Esterification, Hydration and Synthesis based on Carbon monoxide & hydrogen

**3. Manufacturing process (Glass, Cement):**

Introduction, Classification and types, basic raw materials, principal of manufacturing process including chemical reactions

**4. Principles & Application of Crystallization, Distillation, Drying**

**5. Principles & Application of Absorption, Filtration, Sedimentation**

#### Reference Books:-

1. Mass Transfer operations; Robert Trebal, Mc Graw Hill Co., 3rd edition.
2. Chemical process principal Vol. I & II, Horgan Watson, Asian Pub. House, 2nd edition.
3. Chemical kinetics, S. K. Jain, Vishal pub. , Jallander.
4. Unit process in organic systems, Groggins, Tate, Mc Graw Hill Co., 5th edition.
5. Encyclopedia of industrial chemical analysis, Foster Dee Snell, Leslie S., Etre, Interscience pub., Wiley & Sons N.Y., 1973, Vol-1 to 20
6. Ullmann's Encyclopedia of industrial chemistry, Vol.: 1 to 39, Wiley-VCH, Weinheim, 2003
7. Shreve's chemical process industries by George T Austin, Mc Grow-Hill International Co.
8. Unit Operations : Volume I & II, by K. A. Gavhane ( Nirali Prakashan- Pune)
9. Introduction to Chemical Engineering by Walter L Badger and Juline T Banchemo (McGraw-Hill Book Co.)
10. Unit Operation of Chemical Engineering by Warreh L Mc Cabe & Jullian C Smith (McGraw-Hill Book Co.)
11. Chemical Engineering ( volume I & II) by J. M. Coulson & K. F. Richardson (Asian Books Pvt. Ltd., New delhi)
12. Mass Transfer operations; Robert Trebal, Mc Graw Hill Co., 3rd edition.
13. Unit operations of chemical engineering, W. Mc Cabe Smith, Mc Graw Hill Co., 7th edition
14. Chemical process principal Vol. I & II, Horgan Watson, Asian Pub. House, 2nd edition.



## **M.Voc. Chemical Technology (Polymer Science & Technology)**

### **SEMESTER I**

#### **MCTPST-105: Laboratory course**

**Laboratory course of M.Voc. Chemical Technology (Polymer Science & Technology) includes practical based on following subjects.**

- Basic properties of polymers & material Science
- Industrial Polymers
- Industrial chemistry-Unit Operations,
- Industrial chemistry-Unit Processes

# Saurashtra University

**M.Voc.** Chemical Technology (Polymer Science & Technology)

**Semester – II**

Chemical Technology (Polymer Science & Technology)

<b>Paper No.</b>	<b>Subject</b>	<b>Marks</b>
MCTPST-201	Polymer Characterization	100
MCTPST -202	Polymer additives	100
MCTPST -203	Polymer processing Technology	100
MCTPST -204	Polymer Rheology & Speciality Polymers	100
MCTPST -205	Training / Project Report	100
MCTPST -206	Practical -101,102,103 & 104 + viva voce	250+50
	<b>Total</b>	<b>800</b>

# M.Voc. Chemical Technology (Polymer Science & Technology)

## SEMESTER II

### MCTPST-201: Polymer Characterization

**1. Importance of Quality control and Characterization of molecular weight:**

Importance of specification & standards in quality control of polymers, Preparation of polymer test specimens and conditioning, determination of molecular weight by Ultra Centrifugation, Gel Permeation Chromatography. End Group Analysis, Ebulliometry, Cryoscopy, Osmometry, and viscometry.

**2. Material Characterization Test:**

Introduction, Melting point, Softening point, Thermal conductivity, Shrinkage, Melt Flow Index test, Particle size, Density, and bulk factor, Water and Moisture absorption.

**3. Mechanical, Electrical and Flammability Test:**

Introduction, Hardness, Tensile strength, Compression strength, Flexural strength, Impact strength, Dielectric strength, Dielectric constant, Insulation resistance and arc resistance, Ignition properties, Oxygen index test and smoke generation tests

**4. Chemical and Weathering Properties:**

Immersion test, Stain resistance test, Solvent stress cracking resistance test, Environmental stress cracking resistance test, Accelerated weathering test, Outdoor weathering of polymers.

**Reference Books:-**

1. Handbook of plastics test method, R. P. Brown, Longman Scientific and Technical.
2. Handbook of plastics testing technology, Vishu Shah, John Wiley & Sons, New York.
3. ASTM, BIS, ISO standards.
4. Instrumental methods of Analysis, Will and Merritt, CBS Publisher, New Delhi.
5. Principles of Instrumental Analysis, Douglas A. Skoog, F. James Holler and Timothy A. Nieman,
6. Encyclopedia of Polymer science and Engineering, Wiley Inter science, New York.

# M.Voc. Chemical Technology (Polymer Science & Technology)

## SEMESTER II

### MCTPST-202: Polymer Additives

#### **General aspects of Additives:**

Technical requirements of Additives, unavoidable side effects, Deterioration of properties and methods of incorporation of Additives into plastics

#### **Lubricants internal and external:**

General principles, external and internal lubricants of plastics to processing, thixotropic agents, mold releasing agents, evaluation of lubricants and effects on plastics properties. Plasticizers, Theory of plasticization, primary and secondary plasticizers, classification of plasticizers, plasticization efficiency and their evaluation, plasticizers anomalies and anti-plasticization, loss of plasticizers and effects on plastics properties

#### **Fillers and reinforcements:**

Introduction, general characteristics of fillers and reinforcements, mechanical and thermal properties of filled polymers. Classification of fillers and semi reinforcements, source, properties and application in plastics processing.

Principles of filler selection, incorporation of filler into plastics matrix. Coupling agents, types, and action mechanism, evaluation of fillers and reinforcement and effects on plastics properties

#### **Specific Purpose Additives:**

**Stabilizers-** Primary, and secondary stabilizers, Metal deactivators, Light stabilizers, synergistic stabilizers, Evaluation of processing stabilizers and effects on plastics properties.

**Anti-ageing additives** - Introduction, antioxidants, classification, action mechanism, synergistic and antagonistic effects of antioxidants combination. Ultra violet protective agents- types, action mechanism and effects on plastics properties. Optical property modifiers - Brightening agents, Inorganic and Organic pigments, Criteria for selection of pigments,

#### **Reference Books:-**

1. The role of additives in plastics, L. Mascia, Edward Arnold.
2. Additives of plastics, Stepek, Springer Verlag, New York.
3. Plastics additives and modifiers, Jesse Edenbaum, Van Nostrand Reinhold, New York.
4. Plastics materials, J.A. Brydson, Butterworth Science, London.
5. Additives for Plastics Handbook, Elsevier Advanced Technology, John Murphy.
6. Polymer modifiers and additives, Marcel Dekker, John T. Lutz, Richard F. Grossman.
7. Plastics Additives Handbook, 5th Ed., Hans Zweifel, Hanser Gardner
8. Comprehensive polymer science, Pergamon, New York.
9. Engineering materials Handbook, Vol, 1-3, ASTM International, USA.
10. Plastics Engineering Handbook, Joel Frados, Van Nostrand Reinhold, New York

## M.Voc. Chemical Technology (Polymer Science & Technology)

### SEMESTER II

#### MCTPST-203: Polymer Processing and Technology

1. **Principles of the processing of plastics:** Introduction, Melt processing of thermoplastics and melt processing of thermosetting plastics. Introduction to mixing, Types of mixers- Twin drum tumbler, ribbon blender, high speed mixer, ball mill and Cowles dissolver
2. **Compression, Extrusion, Blow & Rotational Moulding:** Fundamental principles, Materials- factors to be considered while processing, Techniques of preheating, Comparison with transfer moulding, Troubleshooting for compression, extrusion, blow & rotational moulding
3. **Injection moulding:** Fundamental principles, Materials- factors to be considered while processing. Types of moulding machines and moulding process. Specifications of injection moulding machine, Injection unit- screw, nozzles, heating cylinders. Clamping unit, Mould cycle and Troubleshooting, Gas injection moulding, Injection moulding of thermosets
4. **Calendaring, Casting, Thermoforming:** Fundamental principles, Materials- factors to be considered while processing, Process, Machinery & equipments, Moulds, Heating & cooling of moulds, Finishing and troubleshooting

#### Reference Books:-

1. Polymer Processing, Morton & Jones, Chapman & Hall.
2. Plastics Engineering, R. J. Crawford, Maxwell Macmillan International.
3. Plastics Engineering Handbook, M.L. Berins, Van Nostrand Reinhold, New York.
4. Plastics Engineering Handbook, Joel Frados, Van Nostrand Reinhold, New York.
5. Plastics Processing Data Hand Book, Dominick. V. Rosato and Donald V. Rosato, Van Reinhold Nostrand, New York.
6. Plastics materials & Process, H. Goodman, Van Nostrand Reinhold Company, New York.
7. Plastics materials and processes, Seymour S. Schwartz and Sidney, H. Goodman, Van Nostrand Reinhold.

# M.Voc. Chemical Technology (Polymer Science & Technology)

## SEMESTER II

### MCTPST-204: Polymer Rheology and Speciality polymer

#### **Introduction to Rheology:**

Different parameters, Rheological equation of state, Newtonian and Non-Newtonian, Importance aspects of rheology, Importance of rheology on polymer processing, shear thinning behavior, influence of temperature and molecular structure. Flow properties- flow through circular tube, flow between parallel plates, Die Swell, and Melt fracture, Sharkskin, Orientation and Shrinkage, Frozen in orientation, Weissenberg effect, and entrance effect

#### **Rheology in polymer processing:**

Introduction, Low flow process, Mixing process, Constrained flows, Free surface flows, Bulk deformations, Injection moulding, Blow moulding, Film blowing and Sheet extrusion.

#### **Rheology of Individual Polymers:**

Individual polymers like polyethylene, propylene, polystyrene, poly vinyl chloride, nylons, poly acetals

**High temperature and fire resistant polymers:** Introduction, Improving low performance plastics for high temperature use, Polymers for low fire-hazards, Polymers for high temperature resistance-Fluoropolymers, Aromatic polymers, Poly ethers, Polyphenylenesulphide, Polysulphones, Polyketones and Heterocyclic polymers.

**Hydrophilic polymers:** Natural polymers-Carbohydrates, Proteins, Semisynthetic polymers, Synthetic polymers- Hydrogel polymers, Polyacrylamide hydrophilic polymers, Polyvinyl alcohol, Polyvinyl pyrrolidone, Superabsorbent polymers.

**Ionic polymers:** Introduction, synthesis, physical properties and applications

**Polymers with electrical & electronic properties:** Conducting polymers- conducting mechanisms, Polyacetylene, Polyparaphynelenes, Polypyrroles, Polyaniline, Photoconducting polymers, Polymers in optoelectronics, Polymers with piezoelectric, pyroelectric and ferro electric properties, Photoresists for semiconductor fabrication.

#### **Reference Books:-**

1. Polymer and Composite Rheology, Rakesh K. Gupta Marcel Dekker Inc., New York
2. Polymer Melt Rheology, F. N. Cogswell, George Godwin Ltd., London
3. Rheology of Polymer Systems, Carreau, De Kee, Chhabra, Hanser Gardner Publication Inc., Cincinnati.
4. Melt Rheology and its role in Plastics processing, John M. Dealy and Kurt. F. Wissbrun, Van Nostrand Reinhold, New York.
5. Plastics Rheology in Plastics Quality Control, John M. Dealy and Peter C. Saucier, Hanser Gardner Publication Inc., Cincinnati.
6. Specialty Polymers, R.W. Dyson, published by Chapman and Hall, New York.
7. Encyclopedia of polymer science and Engineering, Wiley Inter science, New York.
8. Comprehensive polymer science Sir, Geoffrey Allen and Sunder L. Aggrawal, Pergamon press, New York.
9. Engineering materials Handbook, Vol, 1-3, ASTM International, USA.
10. Plastics Materials, J. A. Brydson, Butterworth, London.
11. Inorganic Polymers, James E. Mark, Harry R. Allcock, Robert West, Prentice Hall, NJ, USA

## **M.Voc. Chemical Technology (Polymer Science & Technology)**

### **SEMESTER II**

#### **MCTPST-205: Training / Project Report**

**Training / Project Report based on following subjects.**

- Polymer Characterization
- Polymer Additives
- Polymer Processing and Technology
- Speciality Polymers

## **M.Voc. Chemical Technology (Polymer Science & Technology)**

### **SEMESTER II**

#### **MCTPST-206: Laboratory course**

**Laboratory course of M.Voc. Chemical Technology (Polymer Science & Technology) includes practical based on following subjects.**

- Polymer synthesis and Characterization
- Polymer Additives
- Polymer Processing and Technology
- Speciality Polymers

# Saurashtra University

## M. Voc. Chemical Technology (Polymer Science & Technology)

SEMESTER END UNIVERSITY EXAMINATION

THEORY QUESTION PAPER STYLE- Semester I & II

Time: 2:30 hrs

Theory- Total Marks-70

**Que.:1 Objective type Q & A - 14 Marks**

Any **SEVEN** out of ten Questions - Each carrying **2 marks**- Total- 14 marks

**Que.:2 Subjective type Q & A - 14 Marks**

Any **TWO** out of three Questions - Each carrying **7 marks**- Total- 14 marks

**Que.:3 Subjective type Q & A - 14 Marks**

Any **TWO** out of three Questions - Each carrying **7 marks**- Total- 14 marks

**Que.:4 Subjective type Q & A - 14 Marks**

Any **TWO** out of three Questions - Each carrying **7 marks**- Total- 14 marks

**Que.:5 Subjective type Q & A - 14 Marks**

Any **TWO** out of three Questions - Each carrying **7 marks**- Total- 14 marks

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PRACTICAL - Semester I	PRACTICAL - Semester II
Days: 02 Time: 6 hrs/day	Days: 03 Time: 6 hrs/day
Practical - 250 Marks Viva voce - 50 Marks	Practical - 250 Marks Viva voce - 50 Marks
	Training Report - 50 marks Viva voce - 50 Marks



**Saurashtra University**  
**M. Voc. Chemical Technology**  
**(Polymer Science & Technology)**

**INTERNAL EVALUATION - THEORY**

**Semester I & II**

**Marks per Paper 30 marks**

<b>SN</b>	<b>Detail</b>	<b>Marks</b>
1	MCQ – Objective test	10
2	Attendance & Theoretical Assignment/ Seminar	10
3	Theoretical &/or Practical Assignment	10
<b>Total</b>		<b>30 marks</b>

**No Internal Evaluation for Practical & Project/Training Components**