

**POST GRADUATE DIPLOMA
IN
PLASTICS TESTING & QUALITY MANAGEMENT
(PGD-PTQM)**



**SYLLABUS
&
CURRICULUM
(JULY 2015)**

Academic Cell
Central Institute of Plastics Engineering & Technology
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POST GRADUATE DIPLOMA IN PLASTICS TESTING & QUALITY MANAGEMENT**(PGD-PTQM)****I SEMESTER
Theory**

S. No.	Subject	CH	TH	EH	Marks	
					INT	EXT
PTQM101	Plastics Materials and its Applications - I	64	16	03	40	60
PTQM102	Plastics Processing Technology – I	64	16	03	40	60
PTQM103	Plastics Testing – I	64	16	03	40	60
PTQM104	Quality Management	32	08	1.5	20	30
PTQM105	Fundamentals of Polymer Science	32	08	1.5	20	30
PTQM106	Additives and Compounding	32	08	1.5	20	30
Total Theory Hours (20 weeks – 18 hrs a week)		360		13.5	450	
Practical Work						
PTQML 101	Practical – I - Plastics Testing Lab – I 20 week-10 hrs a week	200		08	100	100
PTQML 102	Practical – II Plastics Processing Lab – I 20 weeks 8 hrs a week	160		04	100	100
	Library – 20 weeks 4 hrs a week	80		--		
Total		440			400	

**II SEMESTER
Theory**

S. No.	Subject	CH	TH	EH	Marks	
					INT	EXT
PTQM201	Plastics Materials and its Applications II	64	16	03	40	60
PTQM202	Plastics Testing – II	64	16	03	40	60
PTQM203	TQM Tools and Techniques	64	16	03	40	60
PTQM204	Plastics Processing Technology – II	32	08	1.5	20	30
PTQM205	Plastics Testing – III	32	08	1.5	20	30
PTQM206	Organization and Management	32	08	1.5	20	30
Total Theory Hours(20 weeks 18 hrs a week)		360		13.5	450	
Practical Work						
PTQML 201	Practical – III - Plastics Testing Lab – II 20 week 8 hrs a week	160		08	100	100
PTQML 202	Practical – IV - Plastics Testing Lab – III 20 weeks 6 hrs a week	120		06	100	100
PTQMS 203	Seminar – 20 weeks 4 hrs a week	80			100	
	Library – 20 weeks 4 hrs a week	80				
Total Hours		440			500	

**III SEMESTER
Project work**

PTQMP	Project Work					
	In plant training in industry **					
Total Hours (20 weeks 40 hours a week)		800				
PTQMP 301	Project Evaluation & Viva voce			8	100	100
PTQMP 302	Industrial Training Report				100	
Total Hours					300	

CH-Contact Hours

TH- Tutorial Hours

EH- Examination Hours

** Minimum of 6 week

**PGD- PTQM
I SEMESTER**

PTQM 101- PLASTICS MATERIALS AND ITS APPLICATIONS - I**80 hours****Unit – I Natural Polymers****(08Hours)**

History – basic chemistry of polymers - nomenclature of Polymers – Sources of Raw Materials – Methods of Manufacture – General Characters & Properties, processing behaviour and applications of natural polymers such as Shellac Resin – Natural Rubber – Casein.

Thermoplastic Materials**Unit – II : Commodity Plastics - Olefin & Styrene Plastics****(24 Hours)**

Sources of Raw Materials – Method of Manufacture – General Characteristics Structure & Properties – Processing Behaviour and applications in key sectors agriculture, aerospace, automobiles, building & construction, electrical, electronics, telecommunication, packaging, medical, sports, water management,

Low Density Polyethylene, Linear Low Density Polyethylene, High Density Polyethylene, High Molecular weight High Density Polyethylene, Polypropylene (Homo & Copolymer), Polystyrene, High Impact Polystyrene, Acrylonitrile Butadiene Styrene , Styrene Acrylonitrile Expanded Polystyrene

Unit – III Commodity Plastics - Vinyl & Cellulosic Plastics**(20 Hours)**

Sources of Raw Materials – Method of Manufacture – General Characteristics & Properties – Processing Behaviour and applications of

Polyvinyl chloride & Chlorinated Polyvinyl chloride, Polyvinylidene Chloride, Polyvinyl Acetate, Polyvinyl Alcohol, Cellulose Nitrate, Cellulose Acetate, Cellulose Acetate Butyrate, Regenerated Cellulose, Polymethyl Methacrylate, Polyacrylonitrile

Unit – IV Engineering Plastics**(28 hours)**

Sources of Raw Materials – Method of Manufacture – General Characteristics Structure & Properties – Processing Behaviour and applications in key sectors aerospace, automobiles, building & construction, electrical, electronics, telecommunication, medical, sports, water management etc.

Polyoxymethylene, Polyamide (PA6, PA66, PA610, PA11, PA12 and PA46), Polyesters (PET, PBT), Poly Carbonate , Polyphenylene Oxide, UHMWHDPE, Polytetrafluoroethylene, Polyvinyl fluoride, Polyvinylidene fluoride, Thermoplastics Polyurethane

Text/ Reference Books

1. Plastics Materials – J.A. Brydson.
2. Plastic Materials Hand Book – A.S. Athalye

Note: Minimum of one assignment and one periodical test is mandatory from each unit.

**PGD- PTQM
I SEMESTER**

PTQM 102: PLASTICS PROCESSING TECHNOLOGY – I

80 hours

Unit – I Introduction

(8 Hours)

Basic Principles of Melt Processing of Thermoplastics – Effect of Polymer Properties on Processing - Thermal Behaviour of Polymer Melt, flow behaviour of polymer melts - Rheology of Ideal Fluids and Polymers – Newtonian & Non-Newtonian fluids, Different Types of Processes and Limitations - Process Flow Charts – Selection of Process – Degradation – molecular orientation – Processing advantage of Plastics over conventional Materials and different grades of plastics.

Unit – II

Injection Moulding Process

(28 hours)

Basic Process Principles, Machine rating and Specifications - Types of Machines – Construction - Parts and its functions – Start up and shut down procedure - Operation procedure - projected area , Press capacity, clamping system Type of Screws and its function- Process variables - Heating System - Ejection system – Back Pressure - Suck back - Drooling - Nozzle Types - Moulding cycle - Shot weight -Purging - Material recommendation - grades

Microprocessor controlled Injection Moulding- Interaction of process variables- injection moulding operation- theoretical concepts and their relationship to processing- Shrinkage – Annealing - Dimensional Control - Moulding Records - Trouble Shooting – handling of finished products

Advance Injection Moulding- structural foam moulding-gas assisted injection moulding-faults, causes and remedies-Thin wall product moulding, multi material and multi colour moulding, thermo set injection moulding, All Electric Injection Moulding, Statistical quality control and process control

Thermoset Injection Moulding – Processing behaviour of thermosets, process principles, variables, Automation - Troubleshooting –

Injection Moulds: Types of Injection Moulds - Two Plate Mould - Three Plate Mould - Cavity & Core finishing – Gate Types - Runners – Hot Runner Moulds –Insulated Runner Mould system.

Unit III

(24 hours)

Extrusion

Introduction - principles - classification of extruders –drive mechanism - single screw extruder - specification - screw nomenclature - types of screws - L/D ratio, compression ratio-back pressure - factors governing back pressure - output and factors affecting output-heating & cooling systems - breaker plate - screen pack & its functions - screw & hopper cooling-die entry effects and die exit instabilities - shark skin, melt fracture & bambooing.

Twin screw extruder - principle - types - process - merits & demerits - Vented barrel extruder - hopper loading devices - Drying equipments - Process, machinery - downstream equipments- Tube/pipe-sizing take off equipment, extrusion coating, wire & cable covering, , cooling, takeoff equipment - dies for producing products such as - film - blow film, cast film - Sheets - Tubes and pipes, corrugated pipes - Mono filaments - Box strapping - Wire & Cable Coating - Lamination, Printing on film, sealing and bag making

Unit IV

(12 hours)

Blow moulding

Basic principles – Process - Construction , Parts and functions , Material requirement – Specification - Types of Blow Moulding - Processing parameters - Parison Programming - machine features - Design guideline for product performance & Appearance – Dies construction - Cycle time – Limitation - Part trimming & handling – blowing the parison - Melt Behavior – Clamping - Heating & cooling system -Faults - Causes & Remedies.

Injection Blow Moulding-Stretch Blow Moulding -parison control, blow mould construction, cooling methods, mould venting, blow moulding of complex shapes like fuel tanks, irregular shaped containers with handles, limitation in blow moulding, decoration of blow moulding products, hot stamping-multi colour printing-faults, causes and remedies, advanced blow moulding techniques

Unit V

(8 hours)

Automation

Use of Robots in part handling, Robotics used in high production moulding process, Automated Conveyor system, Automatic material handling systems,

Text / Reference Books

1. Injection Moulding Theory & Practice – Rubin, Irvin.
2. Plastics Engineering Hand Book – Society of Plastic Industry Inc.
3. Plastics Processing Data Hand Book – D.V. Rosato.
4. Plastics Materials & Processing – Brent Strong.
5. Industrial Robot Handbook - Richard K. Miller, CMfg.E, Springer Science+Business Media, LLC
6. Total Quality Process Control for Injection Molding, 2nd Edition, M. Joseph Gordon, Jr.

**PGD- PTQM
I SEMESTER**

PTQM 103: PLASTICS TESTING - I**80 hours****Unit – I Concepts of Testing & Identification of Plastics****(16 Hours)**

Basic concepts of testing - Specification and Standards - National and International Standards
- Test specimen preparation - Pre-conditioning and test atmosphere, measuring instruments
Vernier Calliper, Micrometer, Thickness Gauge, Pie Tape, Go No Go Gauges etc.

Identification of plastics by simple tests - Visual examination - Density - Melting point -
Solubility test - Flame test and burning characteristics - Chemical tests.

Specific gravity - Density by density- gradient column - Bulk density - Particle size by sieve
analysis - Moisture analysis

Unit – II Mechanical Properties**(28 Hours)**

Short-term Mechanical Properties: Tensile properties - Flexural properties - Compressive
properties - Shear properties - Impact properties - Tear resistance - Hardness tests - Abrasion
resistance - Friction properties

Long-term Mechanical Properties - Creep - Stress relaxation.

Unit – III Thermal Properties**(20 Hours)**

Introduction – Short Term Test – Determination of Heat Distortion Temperature (HDT), Vicat
Softening Temperature (VST) – Long Term Heat Resistant Tests – Thermal Conductivity –
Thermal Expansion – Brittleness Temperature, DSC, TGA, DMA

Unit – IV Material Characterization**(16 Hours)**

Introduction - Melt Flow index – Viscosity – Dilute Solution Viscosity –Molecular weight
calculation, Material Characterization Tests for Thermosets – Apparent (bulk) Density, Bulk
Factor, Cup & Spiral Flow Test, Dynamic Viscosity (Brook field viscometer)

Text / Reference Books

1. Text Book on Fundamentals of Plastics Testing - Prof. (Dr.) S.K..Nayak
2. Plastics Testing Technology Hand Book – Vishu Shah
3. Simple Methods for Identification of Plastics – Brawn R. B.

**PGD-PTQM
I SEMESTER**

PTQM 104: QUALITY MANAGEMENT**40 hours****Unit I****(10 hours)**

Introduction to Quality - Basic concepts Quality– Definitions - Quality of Design vs Conformance; Quality costs; variation concept; Investigational methods; quality assurance functions and their evaluations, quality improvement and cost reduction, quality and management, quality poicies

Unit II**(10 hours)**

Leadership – Definitions, characteristics of Quality Leaders, concepts, Ethics, Role of TQM leaders, implementation , Quality council, core values and concepts, quality statements, strategic planning , decision making

Customer satisfaction- customer perception of quality, feedback, customer complaints, service quality, translating needs to requirements, customer retention,

Employee involvement- motivation, employee survey, empowerment , teams, suggestion system, rewards and recognition, gains, performance appraisal, unions and employee involvement,

Unit III**(10 hours)**

Continuous process improvement- introduction , process, Juran trilogy, improvement strategies, types of problems, PDSA cycle, problem solving method, kaizen, reengineering, six sigma,

Supplier relation, sourcing, supplier selection, supplier certification , supplier rating, relationship development

Unit IV**(10 hours)**

Performance measure- basic concepts, strategy, performance measure presentation, quality costs, Malcom Baldrige quality awards,

Text / Reference Books

1. Quality planning and analysis J. M. Juran
2. Total quality management Dale H. Besterfield
3. Total Quality Management by S K Bhat
4. Quality control and Total Quality Management by P L Jain

Note: Minimum of one assignment and one periodical test is mandatory from each unit.

**PGD- PTQM
I SEMESTER**

PTQM 105: Fundamentals of Polymer Science **40 hours**

Unit I **(10 hours)**

Introduction to Polymer Science

The science of large molecules – Definitions – Monomers & its requirement- Broad Classification of Polymers - Types based on Structure, Processing and Applications - Molecular Force and Chemical Bonding in Polymers – Polymer structure – Homo Polymers and Copolymers – Geometric Isomerism – Tacticity – Nomenclature – Molecular Weight and Distribution and its effect on Properties and Processing of Polymers- Thermal Transition – T_g & T_m.

Unit II **(10 hours)**

Polymerisation

Chain growth Polymerization – Addition Polymerisation – Reaction Mechanism - Free Radical Reaction – Ionic Reaction – Coordination Polymerization – Ring – Opening Polymerization - Condensation Polymerization – Degree of Polymerisation – Polymerization Techniques – Bulk, Solution, Suspension, Emulsion Polymerization Techniques and Co-polymerization.

Unit III **(10 hours)**

Polymer Structure and Properties

Structure – Property Relationship – Molecular Weight and Poly Dispersity Index (PDI) - Effect of Polymerization on PDI – Polymer solutions and solubility – General Rules for Polymer solubility – solubility Parameters, Properties of Dilute solutions - Solid state properties – State of Polymer – Crystalline, Amorphous, Semi-crystalline, Liquid crystalline – Requirement of Crystallinity – factors affecting crystallinity. Deformations in Polymer – Mechanical properties - Stress – Strain behavior – Polymer Fracture and Toughness – Cracking & Cracking – Thermal & Electrical properties.

Unit IV **(10 hours)**

Polymer Characterization

Identification and Characterization of Polymers – Simple Spectroscopic Methods – Molecular Weight Determination – Measuring Dilute Solution Viscosity – Gas Chromatography – Gel Permeation Chromatography – Melt Flow Characteristics – Thermal characteristics DSC, TGA, dynamic mechanical analysis

Text / Reference Books

1. Polymer Science – Gowariker V.R. & others.
2. Text book of Polymer Science – Billmeyer F.W.

Note: Minimum of one assignment and one periodical test is mandatory from each unit.

**PGD- PTQM
I SEMESTER**

PTQM 106: ADDITIVES AND COMPOUNDING**40 hours****Unit I****(8 hours)****Introduction to Additives**

Introduction -- technical requirements, objectives – classification, chemistry and mechanism, limitations of polymeric materials, additive types , general effect on properties

Unit II**(12 hours)****Additives**

Antioxidants - Stabilizers (Heat & UV) - Processing aids and flow promoters, Plasticizers - Impact Modifiers - Lubricants - Slip and Anti-block agents - - Blowing agents - Flame Retardants - Anti-static & Conductive additives - Nucliating agents - Colourants - Additives for Recycling

Fillers & Reinforcement for composites – Natural Fiber – Cellulose, Jute, Coir, Linen, Vegetable Fiber, Banana fibre etc. properties and applications

Synthetic Fibers : Glass Fiber , Carbon Fiber , Aramide Fiber, Polymeric Fiber , Metallic Fiber etc. Properties & Applications – Coupling Agents – Curing Agents Nano fillers

Unit III**(8 hours)****Compounding of additives**

Selection of polymers - selection of compounding ingredients - methods of incorporation of additives into polymeric materials- possibilities and limitations of mixing and compounding, Compounding of PVC, PE and PP - mixing types, solid additives, morphology of filler, compatibilizers – mechanism and theory, filler surface modification and interfacial agents, dispersion of polymer and nanoparticles in polymer melt.

Unit IV**(12 hours)****Mixing machinery and devices**

Mixing and mixing equipments. Principles - Operating characteristics - Machine construction - Specifications - Process control systems and working details of Batch mixers and continuous mixers - High speed mixer - Two roll mill - Banbury Mixer - Ribbon blender - Planetary mixers - Single Screw extruder - Twin Screw extruder

Continuous mixers, co-kneaders, mixing mechanism in kneaders, residence time and distribution, feeders, distributive mixing sections, cavity mixers, pin mixers, slotted flight mixers, variable mixers, dispersive mixing, blister ring, planetary gear mixers, CRD mixers.

Text / Reference Books

- 1.Hand Book on Plastics Additives.
- 2.Plastic Materials - J.A. Brydson

Note: Minimum of one assignment and one periodical test is mandatory from each unit.

PGD- PTQM

I SEMESTER

PTQM L 101- PLASTICS TESTING LAB

Sl. no.	Experiment/Exercise	Exercise Code No.	No. of Hours	Remarks
1.	Familiarization with measuring instruments	PT-01	08	
2.	Dimension measurements with vernier caliperse Digital and analog	PT-02	12	
3.	Dimension measurements with screw gauges flat edge and ball end	PT-03	12	
4.	Thickness measurements with Thickness gauge in microns	PT-04	08	
5.	Identification of plastics by simple methods and burning characteristics	PT-05	16	
6.	Determination of Density	PT-06	16	
7.	Determination of Melt flow index of plastics materials	PT-07	16	
8.	Determination of Moisture Content	PT-08	16	
9.	Determination of Filler Content	PT-09	16	
10.	Study of Mechanical properties of plastics & test methods	PT-10	40	
11.	Determination of Hardness(Rockwell, shore A&D, Barcol)	PT-11	16	
12.	Specimen preparation by punching	PT-12	08	
13.	Specimen preparation by Contour cutter	PT-13	16	
	Practical tests on testing		08	
			200	

**PGD- PTQM
I SEMESTER**

**PTQM L 102- PLASTICS PROCESSING LAB
(20 weeks 08 hrs a week)**

Sl. no.	Name of M/c/ Equipment/ Mould	Description of Practical Exercise to be done*	Exercise Code No.	No. of Hours	Remarks
1.	Introduction	Introduction to Plastics Processing Machineries	PP 01	08	
2.	Shop-floor and Machine safety	Machine, mold, tools handling and safety measures on the shop-floor.	PP-02	08	
3.	Hand operated Injection Moulding Machine	(i) Study of Machine in Idle-Run Observation (IRO) , Parts & functions, operating principle, Free sketch of Machine-parts eg. Nozzle, Torpedo, Hopper, Rack & Pinion Barrel etc., shot capacity definition (ii) Operation practice to produce moulding on different hand injection moulds. Recording the observation and results in practical record books.	PP-03 PP-04	12 12	
4.	Injection Moulding Semi Automatic	(i) Study of Semi Automatic Injection Moulding M/cs of all types in IRO. Comparative study of Pneumatic type & Hydraulic type of M/cs, Operating Principle of M/cs. Line-diagrams of M/cs with nomenclature of parts, M/cs specifications. (ii) Operation of Pneumatic & Hydraulic type of Semi automatic Injection moulding M/cs, to produce components in different moulds. Cycle-time analysis, observations of Process-Parameters & Procedure to be recorded	PP-05 PP-06	12 16	
5.	Injection Moulding M/c.- Automatic	(i) Study of M/c Parts & function, Study of clamping systems on M/cs, Technical specification of Machine, study of process sequence in Machine, Study & definitions of terms related to M/c operation e.g. M/c Day light, Locating-Ring Dimensions, ejector-stroke, Tie-Bar distance, M/c Platen sizes & mould clamping arrangements. Definitions of all Processing Parameters & study of controls in M/cs. (ii) Idle-run observation (IRO) & study of Injection Unit, Clamping Unit, Process- Control knobs, safety precautions, start-up Procedure, Shut-down Procedure, Sketch of Machine	PP-07 PP-08	24 12	

		Platens, Clamping system, type of nozzle used in M/c etc., study of Hydraulic System used in the M/c. M/c Operation-Practice, Process parameter setting for a particular mould on the Machine, Operation of Machine in Hand, Semi Automatic & Automatic-mode to produce components, observations of all parameters, cycle-time analysis, use of different plastics material for moulding & comparison, Moulding faults analysis for causes and remedies.			
6.	Extrusion Processes on Extruders	(i) Study of Extruders in IRO, Free sketch of machines, their parts and parts-function, List of products manufactured by Extrusion-Process. Study of different types of extrusion process. (ii) Operation-Practice by Trainee on setting up of Process-parameter to produce Blown-Film on Film-plant, observations on extruder output, size of film produced and technical specifications of machines to be recorded.	PP-09	08	
			PP-10	08	
7.	Blow Moulding Hand Operated	(i) Study of Hand Blow Moulding M/cs, Free-sketch of M/c with parts & study of part-function, Specification of M/c, Study of Parison-die with sketch. (ii) Die-centering practice by Trainees, operation of Hand Blow Machines, to produce components observations, cycle-time analysis Procedure of operation and observations.	PP-11	04	
			PP-12	04	
8.	Blow-Moulding Semi Automatic	Technical specification of M/c, Mould clamping on M/c, operation Practice with different moulds, Familiarization with control-switches/ valves on the M/c, cycle-time analysis & procedure of operation of M/c.	PP-13	08	
9.	Rotational Moulding	Machine-study in IRO, Process Principle & sequence of operation, Raw materials used, Mould-clamping practice on the M/c, operation practice to produce Roto moulded components, Cycle-time analysis, Comparison of process with other processing processes.	PP-14	08	

10.	Thermoforming (Vacuum forming)	Study of Process Principle, type of moulds & material used, Familiarization with the M/c controls for operation, Operation Practice by trainee, observation on Cycle-time, processing-defects & remedies.	PP-15	08	
11.	Compression & Transfer Moulding-Semi Automatic	(i) Technical specification of M/c, Mould clamping on M/c, Parameter setting, operation-practice on different compression & Transfer Moulds, Cycle-time analysis, observation & Procedure of start-up & shut down of M/c.	PP-16	4	
		(ii) Setting up procedure for operation of M/c, safety precautions, Type of Mould Clamping arrangement available on M/c-Platen, Mould Clamping procedure on M/c, Operation of M/c by setting the optimum Temperature, curing time, clamping force, ejector-stroke etc. on continuous basis, Analysis of Product defects & remedies, Analysis of Cycle-time, Practice on operation of compression & Transfer moulds with thermoset materials.	PP-17	4	
		Practical Test in processing		08	
				160	

* Practical exercises on operation of machines shall be done as per the operating-manual instruction of the respective Machinery

**PGD- PTQM
II SEMESTER**

PTQM 201: PLASTICS MATERIALS AND ITS APPLICATIONS – II **80 hours**

Unit I **(20 hours)**

Thermoset Plastics

Source of Raw Materials – Methods of Manufacture – General Characters & Properties – Processing Behaviour and Applications of Phenol Formaldehyde – Urea Formaldehyde – Melamine Formaldehyde – Unsaturated Polyesters – Alkyd Resins – Epoxy Resin – Polyurethane – Silicones

Unit II

Speciality Polymers **(20 Hours)**

Sources of Raw Materials – Method of Manufacture – Special Characteristics and Properties – Processing Behaviour and applications of

Polysulphone, Polyphenylene sulphide, Polyarylsulphone, Polyether Ketone, Polyether Ether Ketone, Polyimide, Polyamideimide, Liquid Crystal Polymers and Metallocene Polymers etc.

Unit III **(16 hours)**

Thermoplastic Elastomers

Polyurethane Elastomers, Polyolefin Elastomers, Polyester Elastomers, Styrene Elastomers Polyamide Elastomers

Unit IV **(12 hours)**

Polymer blends and alloys

Introduction to polymer blends and alloys - Definitions and nomenclature - advantages of blends and alloys, how to select blend components , preparation of blends and alloys, economy of blending, properties and applications, parameters for compatability, PVC-Nitrile rubber, ABS-PVC and PP-EPDM etc.

Unit V **(12 hours)**

Bio degradable and Bio Plastics

Principle and Mechanism of Plastics degradation, Natural Bio-degradable Polymers - Synthetic Bio-degradable Polymers - Water soluble Polymers. Bio plastics types, properties and applications

Case studies on applications of above materials

Text/ Reference Books

3. Plastics Materials – J.A. Brydson.
4. Plastic Materials Hand Book – A.S. Athalye.

Note: Minimum of one assignment and one periodical test is mandatory from each unit.

**PGD- PTQM
II SEMESTER**

PTQM 202: PLASTICS TESTING – II **80 hours**

Unit – I **(16 Hours)**

Electrical & Optical Properties

Dielectric strength - Dielectric constant and Dissipation factor - Insulation resistance - Volume and Surface resistivity - Arc resistance - Antistatic tests.

Refractive index - Luminous transmittance - Clarity and Haze - Photo-elastic properties - Colour measurements and Gloss.

Unit – II **(20 Hours)**

Chemical & Permanance Properties

Introduction –Resistance to chemicals - Immersion test – Stain Resistance of Plastics – Environmental Stress Cracking Resistance (ESCR), Water absorption-gas permeability-water vapour permeability.

Flammability

Introduction – Flammability - UL94 Flammability Test – Ignition Properties – Limited Oxygen Index Test– Smoke Density Test — Flammability of Cellular Plastics

Unit – III **(16 Hours)**

Weathering Properties

Introduction – environmental factors affecting plastics – Accelerated weathering tests – outdoor weathering of plastics – Resistance of plastics to biological systems.

Unit – IV **(20 Hours)**

Bio-degradability Testing

Test methods and standards for bio-degradable plastics - Criteria used in evaluation of bio-degradable plastics - Description of current test methods.

Unit V **(8 hours)**

Failure Analysis

Introduction – Types of failure – Analyzing Failures – Non Destructive Testing (NDT) – Ultrasonic methods & its application in plastics, Gamma & Beta Transmission – Laser – X-ray Fluorescence.

Text / Reference Books

1. Text Book on Fundamentals of Plastics Testing - Prof. (Dr.) S.K. Nayak
2. Plastics Testing Technology Hand Book – Shah Vishu

Note: Minimum of one assignment and one periodical test is mandatory from each unit.

**PGD- PTQM
II SEMESTER**

PTQM 203: TOTAL QUALITY MANAGEMENT TOOLS AND TECHNIQUES 80 hours

Unit I (12 hours)

Total Quality Management - Concepts of Quality Management, Quality circles, organization of TQM, ISO 9000 and TQM, Concept of TPM, Kaizen, - PDCA, Total Employee Involvement (TEI), POKAYOKE, Failure proofing, JIT manufacturing, Six sigma

Quality Circles - concept, characteristics, Brain storming method for solving Q.C. Problems.

Unit II (16 hours)

QC tools

Cause and effect analysis, Pareto Diagram, Graphs, Check sheets, Histograms, Scatter diagrams, Control charts

Unit III (20 hours)

Statistical Methods

Hypothesis, Design experiments, Correlation analysis, Regression analysis, Orthogonal Polynomials, Binomial probability, Analytical methods, Multi variation analysis, Optimization methods

Unit IV (12 hours)

New QC tolls

Relation diagram, Systematic diagram, Matrix diagram, Affinity diagram, Arrow diagram, Process decision, Matrix data analysis

Unit V (20 hours)

Sample technique methods and Program charts

Sampling techniques, Sample inspection, Sensory inspection, Reliability engineering

Methods of peripheral to QC

IE techniques, VE techniques, OR techniques, Idea generating strategies

Usage of QC Tools

Step formula and QC tools, Understanding and set targets, Plan activities, Cause analysis, Implementation and counter measurement, Check results, Standardization

Text / Reference Books

1. Quality planning and analysis J. M. Juran
2. Total quality management Dale H. Besterfield
3. Total Quality Management by S K Bhat
4. Quality control and Total Quality Management by P L Jain

Note: Minimum of one assignment and one periodical test is mandatory from each unit

**PGD- PTQM
II SEMESTER**

PTQM 204: PLASTICS PROCESSING TECHNOLOGY – II

40 hours

Unit I

(08 hours)

Compression moulding & Transfer moulding

Principle – Process - Machine Specification - Material Recommendation and flow properties - Bulk factor - Moulding powders - Preforms & Preheating Techniques - Process Variables - Pressure requirements, Flash Mould - Positive mould - Semi Positive mould - Flow Characteristics & Curing Time - Mould Heating & Cooling System - Types of Processes - moulding faults, correction and Trouble Shooting - Moulding of Thermoplastic & Thermoset Material, Finishing of mouldings

Principles of transfer moulding-advantages over compression moulding-Equipment used-Types of Transfer moulding, Moulds, Press capacity-Integral moulds and auxiliary ram moulds-Moulding cycles-Tool costs-Moulding tolerances - Materials Theoretical calculation of pressures-Line pressures- Injection ram pressure-clamping-Heating requirements-Finishing of moulded parts—Moulding faults - causes and remedies.

Unit II

(08 hours)

Rotational Moulding

Basic principle - Material selection and Estimation through trial analysis - Type of machines - Process variables - Charge size - wall thickness control - Heating and Cooling system Process requirement for the moulding of water tank - Dust Bin etc. Application of Rotational Moulding - Ejection and Finishing – Faults - Causes and Remedies - Merits and Demerits of Rotational Moulding Process

Unit III

(08 hours)

Thermoforming

Basic principles – Advantages - Material Selection - Thermoforming machine – Single Stage - Multi Stage - Sheet fed machines - Packaging Machines - Mould Material - Thickness Control - Types of Forming – Vacuum Forming – Free Forming - Plug-assist-forming - Drape forming - Matched die forming - Snap back forming - Dual sheet forming - Skin & Blister pack forming - Types of heating - process variables - Forming of Disposal Cups & tumblers - Refrigerator Panels & Automobile Body – Faults - Causes & Remedies

Calendering

Basic principles-Process variables- Process Description - Materials used - Advantages - Types of Calender Rolls - Heating & Cooling System - Roll Bending - Complete Description of Calendering line with their function — Winding Types and Method - Finishing – Trouble Shooting and applications

Unit IV

(08 hours)

FRP

Introduction - FRP processing methods - contact moulding - hand layup, spray up method - vacuum bag and pressure bag moulding, filament winding, centrifugal casting, pultrusion, matched die moulding and advanced techniques.

Secondary Processing Techniques: powder coating, casting, machining & joining of plastics-Decoration of Plastics-Metalizing-Printing & Painting etc-Post moulding operations techniques , In mould labelling

Unit V

(08 hours)

Plastics waste management

Basic principles-mechanical recycling-chemical recycling-incineration, Pyrolysis-mixed waste recycling-value addition, application and development for recycled materials.

Text / Reference Books

1. Compression Moulding – Iyengar, A.I.
2. Technical Manual on Plastics Processing – CIPET
3. Plastics Engineering Hand Book – Society of Plastics Industry Inc.
4. Plastics Materials & Processing – Strong A Brent.

Note: Minimum of one assignment and one periodical test is mandatory from each unit.

**PGD- PTQM
II SEMESTER**

PTQM 205: PLASTICS TESTING – III

40 hours

Product Testing

Unit – I

(08 Hours)

Testing of Plastics Pipes as per national and international standards, sample preparation, conditioning, failure analysis, effect on water with atomic absorption spectroscopy, Joints testing, welding strength and quality, welded joints preparation

Unit II

(08 Hours)

Testing of Water Tanks, Containers, Films and Woven sacks, seem strength, denier, gas permeation through films, water vapour permeation, film puncture, film tear various methods, coefficient of friction

Unit III

(08 Hours)

Testing of Irrigation laterals, Emitters, filters , water quality, fibre reinforced products, shear strength of reinforced products, abrasion,

Unit IV

(08 hours)

ISO 9000 & Implementation: ISO standards for quality systems, Concept and role of ISO 9000, elements of ISO 9000, steps for implementation of quality system - preparatory step, implementation step, registration & quality system certification.

Quality Audits - Objectives, Types of audits, Benefits of becoming an ISO 9000 company.

Unit V

(08 hours)

ISO/IEC 17025 Quality Management system for laboratories, concept, elements of ISO/IEC 17025, steps for implementation, preparation of documents, implementation, registration, system certification, OSHAS, ISO-TS 16949 procedures and documentation

Text / Reference Books

1. Text Book on Fundamentals of Plastics Testing - Prof. (Dr.) S.K. Nayak
2. Plastics Testing Technology Hand Book – Shah Vishu
3. Bureau of Indian standards
4. ASTM D Vol. 4
5. ISO 17025
6. ISO 9000

Note: Minimum of one assignment and one periodical test is mandatory from each unit.

**PGD- PTQM
II SEMESTER**

PTQM 206: ORGANISATION AND MANAGEMENT

40 Hours

Unit I

(08 Hours)

Principles of Management

Introduction – meaning of management: - Management as an art of getting things done, management as a process, management as an activity, Management and administration – Development of management theory: - Taylor’s scientific management.

Functions of Management

Planning, Organizing, Staffing, Directing, Controlling, Decision making

Organizational Structure

Definition of organization, different types of organizational structure: -line, functional, line & staff organization (brief description with advantages & disadvantages), Leadership, Motivation and Communication

Unit II

(08 Hours)

Human Resource Management

Concept of HR Management – Development of HR Management – Components of HRD – Job analysis – Job description – Job specialization, Manpower planning – Requirements of manpower planning – Factors affecting the manpower planning – Job evaluation – Steps required for job evaluation – Methods for job evaluation – Merit rating – objectives and methods – performance appraisal. Training – Importance of training – Methods of training – advantages of training.

Unit III

(08 Hours)

Material Requirement Planning (MRP)

MRP objectives & functions – Terminology – MRP systems – MRP outputs – Management information from MRP – Lot sizing considerations – Examples – applications – introduction to MRP – II - Just in time (JIT).

Unit IV

(08 Hours)

Industrial Psychology

Meaning, importance of good working conditions and environment: - physical working conditions, psychological working conditions, working conditions related to time, related to social situation. Behavioural dynamics: - self concept and self understanding, inter personal needs, developing interpersonal relationship: - developing mutual expectations, honouring psychological contacts, developing trust & influence, projecting positive qualities and hiding negative points – developing better behaviour and qualities a TQM approach: - conducting ‘SWOT’ analysis for self understanding, prepare incremental projects to reduce weakness and threats – mission statement

Unit V**(08 Hours)****Environmental Pollution and Control**

Ecology and Eco system, Impact of industrial development on environment, Causes and effects of air and water pollution on plant, animal life and material, Characteristics of industrial and municipal waste, Treatment processes:- Primary, secondary and tertiary, Sources of air pollutants on human beings, Effects of air pollutants on human beings, Prevention and control of air pollution, Solid waste management, Environment pollution control legislation and functions of pollution control boards, Causes of noise pollution and its control.

Text / Reference Books

1. O.P. Khanna, Industrial Engineering and Management, Revised Edition – 2004, Dhanpat Rai Publications (P) Ltd., 67/4 Madras House, Daryaganj, New Delhi 110 002.
2. Industrial Engineering & production management – Martand.T.Telsang S.chand & Company.
3. Industrial Engineering & Management - O. P. Khanna..
4. Entrepreneurship Development - Jagmer Singh Saihi.
5. Industrial Management & Engineering Economics - Banga & Sharma.

Note: Minimum of one assignment and one periodical test is mandatory from each unit.

**PGD- PTQM
II SEMESTER**

PTQM L 201: PLASTICS TESTING
(20 weeks 8 hrs a week)

- 160 Hours

Sl. No.	Experiment/Exercise	Exercise Code No.	No. of Hours	Remarks
1.	Determination of Viscosity and Molecular weight	PT-14	08	
2.	Determination of K-value for PVC resin	PT-15	12	
3.	Determination of Ash Content	PT-16	08	
4.	Determination of Carbon Black Content and Dispersion in Olefin Plastics	PT-17	12	
5.	Determination of environmental stress cracking resistance for Polyethylene	PT-18	12	
		PT-19	08	
6.	Determination of Melt Flow Index of different Plastics	PT-20	16	
7.	Materials and Grades	PT-21	08	
8.	Study of Weathering properties	PT-22	12	
9.	Determination of Burst strength & tear strength of films	PT-23	12	
10.	Determination of Bulk density for powder material	PT-24	08	
11.	Testing of Electrical properties of Plastics materials	PT-25	16	
12.	Optical properties of Plastics materials	PT-26	08	
13.	Specimen preparation by Injection moulding,	PT-27	12	
14.	Specimen preparation by compression moulding.	PT-28	08	
	Practical test on Testing	----	08	
			160	

**PGD- PTQM
II SEMESTER**

PTQM L 202: PLASTICS TESTING
(20 weeks 6 hrs a week)

- 120 Hours

Sl. No.	Experiment/Exercise	Exercise Code No.	No. of Hours	Remarks
1.	Introduction to product testing	PT-29	08	
2.	Testing of HDPE Pipes	PT-30	12	
3.	Testing of RPVC Pipes	PT-31	12	
4.	Testing of Water Storage Tanks/Containers	PT-32	12	
5.	Testing of Films/Sheets	PT-33	08	
6.	Testing of HDPE/PP Woven Sacks/Tapes	PT-34	12	
7.	Testing of Bottles/Vanaspati, Ghee, Milk Packing	PT-35	12	
8.	Determination of Mechanical, Thermal, Electrical & Chemical Properties of Plastic Products	PT-36	16	
9.	Compounding, Blending using Two Roll Mill and	PT-37	08	
10.	Specimen preparation from products	PT-38	12	
11.	Documentation of test records in industries as per BIS	PT-39	08	
	Practical test on Testing		08	
			120	