RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Scheme of

POSTGRADUATE DEGREE COURSE

M.Tech. I to IV Semester

Production Engineering

(Effective from academic session: 2020-21)

Rajasthan Technical University, Kota
Akelgarh, Rawatbhata Road, Kota-324010

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Semester - I

SN	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	1MPD1-01	Machining Processes and Analysis	3	0	0	3	30	70	100	3
2	PCC	1MPD1-02	Automation and Computer Aided Manufacturing	3	0	0	3	30	70	100	3
3	PEC	1MPD2-11	Casting and Welding Technologies	3	0	0	3	30	70	100	3
		1MPD2-12	Industrial Robotics								
		1MPD2-13	Simulation Modeling and Analysis								
4	PEC	1MPD2-14	Plastic Manufacturing Processes	3	0	0	3	30	70	100	3
		1MPD2-15	Metrology & Computer Aided Inspection								
		1MPD2-16	Quality Systems								
5	MCC	1MCC4-21	Research Methodology and IPR	2	0	0	2	30	70	100	2
6	PCC	1MPD1-06	Machining Processes and Analysis Lab	0	0	4	4	60	40	100	2
7	PCC	1MPD1-07	CAM Lab	0	0	4	4	60	40	100	2
8	SODECA	1MPD5-00	SOCIAL Outreach Discipline & Extra Curriculum Activities							100	2
			Total					**270**	**430**	**800**	**20**

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Semester - II

SN	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	2MPD1-01	Modern Machining Processes	3	0	0	3	30	70	100	3
2	PCC	2MPD1-02	Metal Forming Analysis	3	0	0	3	30	70	100	3
3	PEC	2MPD2-11	Fabrication Techniques of Advance & Smart Materials	3	0	0	3	30	70	100	3
4		2MPD2-12	Computer Integrated Manufacturing Systems								
5		2MPD2-13	Operations and Supply Chain Management								
6	PEC	2MPD2-14	Rapid Product Development Technologies	3	0	0	3	30	70	100	3
7		2MPD2-15	Lean, Six Sigma and Sustainable Manufacturing								
8		2MPD2-16	Design of Experiments								
9	MCC	2MCC3-XX	Audit Course-I	2	0	0					
10	PCC	2MPD1-06	Modern Machining Processes Lab	0	0	4	4	60	40	100	2
11	PCC	2MPD1-07	Metal Forming Analysis Lab	0	0	4	4	60	40	100	2
12	REW	2MPD4-50	Mini Project	0	0	4	4	60	40	100	2
13	SODECA	2MPD5-00	SOCIAL Outreach Discipline & Extra Curriculum Activities							100	2
			Total					**300**	**300**	**800**	**20**

Semester - III

SN	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Credits
				L	T	P	Exam Hrs	IA	ETE	Total	
1	PEC	3MPD2-11	Micro and Precision Manufacturing Systems	3	0	0	3	30	70	100	3
2		3MPD2-12	Mechatronic Systems Design and Applications								
3		3MPD2-13	Innovation and Entrepreneurship for Engineers								
4	MCC	3MCC3-XX	Open Elective	3	0	0	3	30	70	100	3
5	MCC	3MCC3-XX	Audit Course-II	2	0	0					
6	REW	3MPD4-60	Dissertation-I / Industrial Project	0	0	20		240	160	400	10
			Total					**300**	**300**	**600**	**16**

Semester - IV

SN	Course Type	Course Code	Course Name	Contact Hours per Week			Marks				Cr
				L	T	P	Exam Hrs	IA	ETE	Total	
1	REW	3MPD4-70	Dissertation-II	0	0	32		360	240	600	16
			Total					**360**	**240**	**600**	**16**

1MPD1-01: Machining Processes and Analysis

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course. Machining; Plastic Deformation, Tensile Test, Stress and Strain	2
2	Types of machining processes; Chip formation; Orthogonal and Oblique Cutting; Types of Chips; Built-up edge formation.	2
3	Reference planes; Tool specification: American System (ASA), continental or Orthogonal System (ORS), International or Normal Rake system (NRS); Tool angle relationships in ORS, ASA and NRS; Selection of Tool Angles; Multiple-point cutting tools: twist drill, helical milling cutter	4
4	Merchant's Circle Diagram; Co-efficient of Friction: Determination of stress, strain and strain rate; Measurement of shear angle; Thin Zone model: Lee and Shaffer's Relationship.	4
5	Nature of sliding friction; Friction in Metal Cutting: Sticking and Sliding Zones, Analysis of Stress Distribution on the tool face: Zorev's model; Determination of mean angle of friction.	3
6	Rake angles in oblique cutting: Analytical determination of Normal Rake angle, velocity rake angle and effective rake angle; their relationship; shear angles in oblique cutting; velocity relationship; Force relationships in oblique cutting.	4
7	Turning, shaping and planning, Slab milling, Drilling: Machining Parameters, force magnitudes, power consumption, material removal rate, time per pass.	4
8	Basic methods of measurement: Axially Loaded members, Cantilever Beam, Rings and Octagon, dynamometer requirements; machine tool dynamometers.	2
9	Tool angles; Measurement of cutting forces in turning and grinding; Measurement of temperature; chip thickness ratio; grain concentration in grinding.	3

10	Minimum Production Cost Criterion; Maximum Production Rate Criterion, and Maximum Profit Rate Criterion. Restrictions on cutting conditions: maximum power restriction, speed restriction, force and vibration restriction, surface finish restriction.	**4**
11	Distinct regions of heat generation; Equations of Heat Flow: heat Flow due to conduction, heat flow due to transportation, heat absorbed and heat generated; Average Shear Plane temperature; Average Chip-tool interface Temperature; Experimental determination of cutting temperatures.	**4**
12	Introduction: Types of abrasive machining processes; Grinding; types and characteristics; characteristics and specification of grinding wheels; Mechanics of Grinding Process; Determination of chip length in Grinding; Size effect; Wheel wear; Thermal Analysis; Honing and Lapping.	**4**
	Total	**40**

TEXT BOOK	
1	A.Ghosh and Asok Mallik, "Machining Science" Affiliated East-West Press
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	E.J.A. Armarego and R.H.Brown-The machining of Metals
2	G Boothroyd-Fundamentals of Metal Machining and Machine tools
3	M.C.Shaw-Metal Cutting Principle
4	G.K.Lal and S.K.Choudhury-Fundamental of Manufacturing Processes

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1MPD1-02: Automation and Computer Aided Manufacturing

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Automation: Automation production system, Mechanization and automation, Types of automation, Automation strategies, Mechanical, electrical, hydraulic and Pneumatic automation devices and controls, Economics of automation.	6
3	Computer Numerical Control (CNC): Introduction, Numerical Control, Numerical Control Modes, Numerical Control Elements, NC Machine Tools. CNC Hardware Basics: Structure of CNC Machine Tools, Spindle Design, drives, Actuation Systems, Feedback Devices, Axes-standards. CNC Tooling: Cutting tool materials, Turning-Tool geometry, Milling Tooling Systems, Tool Presetting, Automatic Tool Changers, Work holding, cutting – process parameter selection. CNC Machine Tools and Control Systems: CNC machining Centers, CNC Turning Centers, High Speed Machine Tools, Machine Control Unit, Support Systems. Touch-Trigger Probes.	10
4	CNC Programming: Part programming Fundamentals, manual part-programming methods, preparatory functions, Miscellaneous functions, Program number, tool-length compensation, canned cycles, and cutter-radius compensation. Turning-Centre Programming: Comparison between machining centres and turning centres, tape formats, axes system, general programming functions, motion commands, cut planning, thread cutting, canned cycles. Advanced part-programming methods: polar coordinates, parameters, looping and jumping, subroutines, mirror imaging and scaling, special canned cycles. Computer –Aided Part Programming: concept of CAP, APT language structure, geometry commands, motion commands, postprocessor commands, compilation control commands, repetitive programming, complete part program in APT, CAM systems.	12
5	Information Requirement of Manufacturing: Discrete part Manufacture, information requirements of a production organization, manufacturing strategies, integration requirements. Computer Aided Process Planning: Process planning, computer	11

	aided process planning, CAPP implementation techniques, concurrent engineering and design for manufacturing, advanced manufacturing planning. Production Planning and Control: introduction, production planning, capacity planning, master production schedule, material requirement planning (MRP), production activity control (PAC), optimised production technology (OPT), manufacturing Resource Planning (MRP II), Just in Time (JIT).	
	Total	**40**

TEXT BOOK	
1	P.N. Rao, CAD/CAM: Principles and applications, 3rd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Yoram Koren, "Computer Control of Manufacturing Systems", McGraw Hill Book Co. New Delhi, 1986
2	Radhakrishnan P., "Computer Numerical Control Machines", New Book Agency, Calcutta, 1991
3	P.N. Rao, N.K. Tewari, T.K. Kundra “Computer Aided Manufacturing” Tata McGraw Hill Publishing Co. Ltd
4.	Mikell P. Groover, “Automation, Production Systems and Computer-Integrated Manufacturing, 2nd Edition, Pearson Education Asia, 2001.

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1MPD2-11: Casting and Welding Technologies

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Core making processes - design for moulding and casting - different moulding and casting processes-function of the gating system-permanent mould casting-centrifugal casting- investment casting-mercast casting-continuous casting-low pressure casting.	10
3	Melting and quality control of various steels and non-ferrous alloys - casting defects - fettling, inspection and testing of castings - Manufacturing of Cast irons - Design for casting.	7
4	Arc welding power sources-Different arc welding processes-solid state welding process- soldering, Brazing and adhesive bonding – metal surfacing and spraying-thermal cutting processes.	6
5	Welding metallurgy – weldability criteria – Different types of joint configuration-different types of welding position-design of weldments and joints.	6
6	Inspection and testing of welding and casting – Defects, Destructive tests - Non destructive testing techniques – surface treatments-safety aspects in welding processes- specific welding applications and innovations.	10
	Total	40

TEXT BOOK	
1	Scrope Kalpakjian,, “Manufacturing processes for Engineering Materials”, Addision Wesley, 1997.
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	R.S. Parmar “Welding processes and technology” Khanna Publishers
2	Heine, Loper and Rosenthal Principles of Metal Castings TMH
3	A.Ghosh and Ashok Mallik, “Machining Science” Affiliated East-West Press

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

1MPD2-12: Industrial Robotics

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course. Fundamentals of robotics: Automation, Robot Anatomy, work volume, robot drive systems, control systems, precision of movement, end effectors, robotic sensors, robot applications.	4
2	**Robot Technology: The Robot and its peripherals:** Control systems and components, robot motion and analysis and control, Robot End Effectors, sensors in robotics Machine vision.	6
3	**Robot Programming and Languages:** Methods of robot programming, lead through programming, A robot program as a path in space, Motion interpolation, capabilities and limitations of leadthrough programming. The textual robot languages, generations of programming languages, Robot language structure, motion commands, End Effectors and sensor commands, program control and subroutines, monitor mode commands. Artificial Intelligence.	12
4	**Robot Applications in Manufacturing**: Material Transfer and machine loading/unloading: General considerations in robot material handling, material transfer applications and machine loading/unloading. Processing operations like- spot welding, continuous arc welding spray coating and other processing operations using robots, Assembly and Inspection	12
5	**Implementation Principles and Issues:** An Approach for implementing Robotics, safety, training, maintenance and quality. Social issue and the future of robotics: Social and labor issues, robotics Technology of the future and future applications.	6
	Total	40

TEXT BOOK	
1	Groover, Weiss, Nagel, Odrey and Dutta, "Industrial Robotics Technology, Programming and Applications (McGraw Hill Education.)
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Pessen, David W.(1990), "Industrial Automation, Circuit Design & Components", (John Wiley& Sons, Singapore)
2	Koren, Yoram "Robotics for Engineers", (McGraw Hill)

1MPD2-13: Simulation Modeling and Analysis

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course. **Physical modeling:** Concept of system and environment, continuous and discrete system, linear and nonlinear system, stochastic activities, static and dynamic models, principles used in modeling, Basic simulation modelling. Role of simulation in model evaluation and studies, Advantages and Disadvantages of simulation. Modeling of Systems, iconic analog. Mathematical Modeling.	8
2	**Computer system simulation:** Technique of simulation, Monte Carlo method, experimental nature of simulation, numerical computation techniques, continuous system models, analog and hybrid simulation, feedback systems. Buildings simulation models of waiting line system, Job shop, material handling and flexible manufacturing systems	8
3	**Probability concepts in simulation:** Stochastic variables, discrete and continuous probability functions mainly Normal, lognormal, Weibull, exponential, Uniform, Poisson, Binomial, Triangular, Erlang etc. Random Numbers: Properties, Generations methods, Tests for Random number- Frequency test, Runs test, Autocorrelation test. Random Variate Generation: Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, Direct transformation for Normal and log normal Distributions, convolution methods- Erlang distribution, Acceptance Rejection Technique	8
4	**Input Modelling:** Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis. Verification and validation: Design of simulation experiments, validation of experimental models, testing and analysis.	8

5	**Output Analysis**: Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations. Selection of Simulation Software, Simulation packages, Trend in Simulation. Do modeling using ARENA software which is freely available. Some more suggested simulation packages are Promodel, Quest, Witness, Extend, Simio etc. Students can learn any one of them.	**8**
	Total	**40**

TEXT BOOK	
1	Simulation Modelling and Analysis by Law, A.M. & Kelton , McGraw Hill, 2nd Edition
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Simulation Modeling and Analysis with ARENA, Altiok and Melamed, Academic Press
2	Simulation Modeling and ARENA, Rossetti and Taha, John Wiley and Sons
3	Discrete-Event System Simulation, Banks and Carsan, Prentice Hall of India
4	Simulation with ARENA, Keltan, Sadowski and Turrock, McGraw Hill

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1MPD2-14: Plastic Manufacturing Processes

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Classification of plastic materials - physical and mechanical properties - selection of plastics for various applications - advantages and limitations of using plastics.	5
3	Viscoelastic behavior - mathematical models for viscoelastic behavior -deformation behavior of plastics - reinforced plastics - analysis of polymer melt flow	10
4	Polymer processing techniques such as extrusion, compression and transfer molding - Injection molding - blow molding - thermoforming -rotational molding – calendaring - Bag molding- reaction molding- Computer application in plastic molding.	12
5	Methodical mold design - determination of economical number of cavities - temperature control of injection molds - calculation of mold opening force and ejection force - die design for simple components.	12
	Total	40

TEXT BOOK	
1	E.B Seamour, Modern Plastics Moulding, John Wiley

REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	S Kalpakjian, S. R. Schmid, Manufacturing Engineering & Technology, Pearson Education Canada
2	A.W. Birley, B. Howarth, Hana, "Mechanics of plastics processing properties

1MPD2-15: Metrology & Computer Aided Inspection

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course. Metrology and Techniques: Standards in metrology, definitions, Traceability, Characteristics Length & Angular measurements-Review of standard instruments, GD and tolerance procedure-Review of dimension & form tolerance and methods of measurement, Tolerance analysis, Surface metrology-Instruments, Methods and new approaches.	8
2	Laser Applications in Metrology: LASER light source, LASER interferometer, LASER alignment telescope, LASER micrometer, On-line and in-process measurements of diameter, Roundness and surface roughness using LASER, Micro holes and topography measurements.	8
3	Special Measuring Instruments and Techniques: Optoelectronic devices, contact and non-contact types, Applications in on-line and in-process monitoring systems, Tool wear measurement, Surface measurement, Machine vision, shape identification, Edge detection techniques, Normalisation, gray scale correlation, Template Techniques, Surface roughness using vision system, Interfacing robot and image processing system.	8
4	Co-ordinate Measuring Machine: Types of CMM, Probes used, Applications, Non-contact CMM using electro optical sensors for dimensional metrology, Non-contact sensors for surface finish measurements, statistical evaluation of data using computer, Data integration of CMM and data logging in computers.	8
5	Sensors in Inspection: Manufacturing applications of photo detectors, deflection methods-beam detection, Reflex detection, & Proximity detection, Applications of Inductive and Capacitive proximity sensors, Understanding microwave sensing applications laser sensors and limit switches. Advanced sensor technology-Bar code systems, Principles and applications of Colour sensors, electro-magnetic identifier, Tactile sensors, Ultrasonic sensors, Odour sensors	8
	Total	**40**

TEXT BOOK	
1	Fundamentals of dimensional Metrology T. Busch and R. Harlow Delmar, 3e
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Engineering Metrology G. Thomas and G. Butter Worth PUB
2	Sensors and Control systems in Manufacturing Sabne Soloman McGraw Hill Book.

1MPD2-16: QUALITY SYSTEMS

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction to Quality Management**: Quality – Concept, Different Definitions and Dimensions, Inspection, Quality Control, Quality Assurance and Quality Management, Quality as Wining Strategy, Views of different Quality Gurus, Quality Cost.	4
3	**Process Quality Improvement:** Introduction, Graphical and statistical techniques for process Quality Improvement, Graphical tools for data representation, 7QC tools. Control Charts for Attributes and Variables, Random and assignable causes of variations, Type I & Type II errors. Process capability analysis. Pattern Analysis, Advanced Control Charting Techniques	5
4	Acceptance sampling, OC curve, Acceptance Sampling plans and its design, ISO 2500, MIL-STD-105E, Continuous sampling Plans, Sequential Sampling	4
5	Gage and Measurement system analysis, Analysis of Variance (ANOVA), Design and analysis of experiment (DOE), Introduction to TQM	4
6	**Leadership,** Lean and JIT Quality Philosophy, Benchmarking, Process failure mode and effect analysis (PFMEA), Service Quality, Six sigma for process Improvement, ISO 9001, ISO 14000 and QS 9000, Quality audit, Quality Circles.	9
7	**Product Quality Improvement:** Quality Function Deployment, Robust Design and Taguchi Method	08
8	**Design Failure** Mode and Effect Analysis, Product Reliability Analysis, Six sigma in product development	05
	Total	40

TEXTBOOK	
1	Amitava Mitra, Fundamentals of Quality Control and Improvement, Prentice Hall
REFERENCE BOOKS	
1	Douglas C. Montgomery, Introduction to Statistical Quality Control, Wiley.
2	R.P.Mohanty and R.R.Lakhe, TQM in Service Sector, Jaico Pub.
3	Douglas C. Montgomery, Design & Analysis of Experiments, 5th Edition, Wiley-India
4	Total Quality Management, Dale H. Besterfield et. al, Pearson.

1MPD1-06: Machining Processes and Analysis Lab

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P **End Term Exam: 4 Hours**

SN	List of Experiments
1	Measurement of forces in case of milling and grinding operations.
2	Measurement of surface roughness in case of milling and grinding operations.
3	Measurement of temperature in case of milling and grinding operations.
4	Exercise on Measurement of Specific cutting energy in turning Process.
5	Exercise on Temperature measurement in drilling.
6	Force analysis in turning.
7	To investigate the effect of material removal rate (MRR), Tool Wear and Surface roughness on workpiece in turning.

Note: The above list is suggestive. Experiments/case studies may be added relevant to the theory courses taught in the semester.

1MPD1-07: CAM Lab

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P **End Term Exam: 4 Hours**

SN	List of Experiments
1	Practice in part programming and operation of CNC turning machines making use of subroutine techniques and cycles for rotational components. Students need to develop manual part program using G&M code for given rotational components.
2	Practice in part programming and operation of CNC Milling machines making use of subroutine techniques and cycles for prismatic components. Students need to develop manual part program using G&M code for given prismatic components.
3	Practice in part programming and operating a machining center, tool panning and selection of sequences of operations, tool setting on machine, practice in computer assisted part programming using APT programming.
4	Practice in Robot programming and its languages. Robotic simulation using software. Robot path control, preparation of various reports and route sheets.
5	Simulation of computer aided manufacturing system using simulation software such as ARENA or Xcos.
6	Practice in coding a CAPP program for a given part produced through machining processes using higher level languages such as C++, python, Prolog etc.
7	Problems on MRP-I, MRP-II to be solved as case study in which data may be procured from local MSME units.

Note: The above list is suggestive. Experiments/case studies may be added relevant to the theory courses taught in the semester.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

2MPD1-01: Modern Machining Processes

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course. Introduction to manufacturing processes: Overview of non conventional machining processes with (AJM, USM, ECM, EDM, EBM, LBM, AFM, MRF, MAF, MFP and MRAFF etc.)	4
2	Introduction to nanofinishing and need of nanofinishing, Abrasive Flow Finishing (AFF), Introduction to AFF and self deformable feature, AFF machine elements, Magnetic Abrasive Finishing (MAF), Introduction to MAF, Elements of MAF, Setup and process parameters for AFF and MAF, Parametric analysis and applications of MAF and AFF.	4
3	Non-Traditional Machining Processes(Mechanical): Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining, and Abrasive Water Jet Machining; Process details, parametric effects, recent advancements and modelling.	6
4	Non-Traditional Machining Processes(Thermal): Electro discharge Machining, Plasma Arc Machining, Electron Beam Machining, and Laser Beam Machining; process, parameters, recent advances and modeling.	8
5	Chemical and Electrochemical processes; Chemical Machining, Electro Chemical Machining and Electrochemical grinding.	4
6	Hybrid-type systems; Electro Chemical Discharge Machining, Ultrasonic-assisted Electro Discharge Machining, ELID during grinding and other types, High Production Rate Machining and Grinding; Designing suitable tooling, cutting fluid application; alternative processes- hot machining, stretch machining, etc.; obstacles faced and possible remedies.	8
7	Micro and Nano machining, Environment friendly machining. Intelligent Manufacturing Systems: Fuzzy, Neural Networks, Genetic Algorithms to be applied in smart / digital manufacturing. Industry 4.0: Cyber Physical Manufacturing System.	6
	Total	40

TEXT BOOK	
1	V.K.Jain, Advance Machining Processes, Allied Publisher Bombay
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	"Modern Machining Processes" - P.C. Pandey and H.S. Shan, Tata McGraw-Hill Publication
2	Ghosh and Mallik, Manufacturing Science, EWP Private Ltd.
3	H.A.G. El-Hofy , "Advanced Machining Processes – Nontraditional and Hybrid Machining Processes" McGraw Hill
4	The Science and Engineering of Micro-fabrication, Stephen P. Campbell, Oxford University

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2MPD1-02: Metal Forming Analysis

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course. Different metal forming processes, importance of plasticity in the course.	2
2	Fundamentals of plasticity, yield and flow, anisotropy, instability, limit analysis, slipline field theory. Applications to forging, wire and tube drawing, deep drawing, extrusion and rolling. High velocity forming.	3
3	Review-Analysis of stress: transformation relations, principal stresses and directions, maximum normal and shear stresses, invariants, hydrostatic and deviatoric parts; Analysis of (infinitesimal) strain: transformation relations, principal strains, invariants, hydrostatic and deviatoric parts; (Infinitesimal) rotation, Stress-strain relations for isotropic, linearly elastic material.	4
4	Experimental observations on plasticity: yielding, strain-hardening, viscoplasticity, temperature softening, Baushinger effect, hysteresis, incompressibility of plastic deformation, anisotropy, plastic instability.	3
5	Yield criterion for isotropic materials: von Mises and Tresca yield criterion, their geometric interpretation, convexity of the yield surfaces, experimental validation.	3
6	Change in yield criteria due to isotropic hardening: strain hardening and work hardening hypotheses, experimental validation of the hypotheses.	2
7	Plastic stress-strain relations for isotropic materials: plastic potential and associated flow rule, incremental and rate forms of elasto-plastic stress-strain relations, simplifications for non-hardening and rigid-plastic materials (Prandtl- Reuss and Levy-Mises relations),Objective measures of stress rate and incremental stress.	5
8	Anisotropy: strain rate ratio, normal and planer anisotropies, Hill's anisotropic yield criterion.	1
9	Approximate methods of solving plasticity problems: upper and lower bound methods, slip line field equations, different boundary value problems of slip line method, one example of all 3 methods.	3

10	Slab method for sheet and wire drawing processes for predicting drawing force and die pressure, comparison with Wistreich experimental results, optimum die angle, maximum reduction for non-hardening material, upper bound method for sheet/wire drawing, slip-line method for sheet drawing, correction for hardening effect in upper bound and slip line methods.	**4**
11	Slab method for extrusion of rod and sheets for predicting extrusion pressure, upper bound method for sheet/wire extrusion, dead-metal zone for square die, slip-line method for sheet extrusion.	**4**
12	Slab method for plane strain rolling for predicting roll force and roll torque, limiting reduction, roll diameter to sheet thickness ratio and friction coefficient. Slab method for sheet and disc forging processes for predicting forging force, sticking radius, slab method for hollow disc forging, neutral radius, upper bound method for sheet and disc forging with and without bulge, slip-line method for sheet forging.	**5**
13	Slab method for the flange analysis in deep drawing, limiting drawing ratio for non-hardening materials.	**1**
	Total	**40**

TEXT BOOK	
1	Metal Forming: Processes and Analysis by B. Avitzur, McGraw-Hill Book Co., 1968
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	The Mathematical Theory of Plasticity by R. Hill, Oxford University Press, 1950
2	Engineering Plasticity by W. Johnson and P.B. Mellor, von Nostrand Co. Ltd, 1972
3	Theory of Plasticity by J. Chakrabarty, McGraw-Hill Book Co., International Edition, 1987
4	Continuum Theory of Plasticity by A.S. Khan and S. Huang, John Wiley and Sons
5	G.W Rowe, Introduction to the Principles of Metalworking, Hodder & Stoughton Educational
6	George Ellwood Dieter, “Mechanical Metallurgy” McGraw-Hill

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

2MPD2-11: Fabrication Techniques of Advance & Smart Materials

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Polymers - molding of thermoplastics - plastic sheet forming process - machining of thermoplastics - Thermosetting plastics - properties, molding processes and machining - other processing methods for plastics - plastic component design.	7
3	Rubber: Manufacturing process - Manufacturing techniques, materials design, sizing, components, building, moulding and vulcanising of tyres - Belting – manufacture and types of hose.	9
4	Types, processing and manufacturing techniques of Glass vessels	7
5	Ceramic materials - Processing of ceramic products	6
6	Composite materials, Fiber, particulate, whisker reinforced ceramics, properties of reinforcements and matrix. Manufacturing Techniques and applications of different Composites namely PMC, MMC and CMC.	10
	Total	40

TEXT BOOK	
1	E. P. DeGarmo, J. T Black, R. A. Kohser, Materials and Processes in Manufacturing, Prentice Hall of India
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Blow C M,, “Rubber Technology and Manufacturing”, Newman Butterworths, 1977
2	Vanviack L.H, “Physical Ceramics for Engineers”, Addision Wesley Publicxation

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

2MPD2-12: Computer Integrated Manufacturing Systems

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Evaluation, hardware and software of CIM - Concurrent engineering - Advance modeling techniques- Numerical control, Computer Numerical Control, Direct Numerical Control, Adaptive Control, Communication methods and communication standards.	8
3	Materials handling and Identification Technologies: introduction to material handling, material transport systems, automatic guided vehicles, automatic storage and retrieval systems, automatic data capture.	8
4	Manufacturing Systems: Introduction to manufacturing systems, single station manufacturing cells, group technology and cellular manufacturing, manual assembly lines, transfer lines and similar automated manufacturing systems, automated assembly systems. Flexible Manufacturing Systems - computer control and functions - Planning, scheduling and control of FMS - general considerations - selection, evaluation and control. FMS planning and implementation issues, quantitative analysis of FMS, CAD/CAM considerations - planning FMS database. Examples of FMS installations -Artificial Intelligence and CIM systems.	13
5	Computer aided Quality Control Systems: introduction to quality control assurance, statistical process control, inspection principles and practices, inspection technologies, coordinate measuring machine, non-contact inspection methods, and integration of CAQC. Manufacturing Support systems: product design and CAD/CAM in the production system, lean production and agile manufacturing Computer Integrated Manufacturing: Historical background, integration, CIM implementation, benefits of CIM.	10
	Total	40

TEXT BOOK	
1	Mikell P Groover,, "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall,2007
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Paul Ranky, "Computer Integrated Manufacturing", Prentice Hall, 2005
2	Donatas T I junclis, Keith E Mekie, "Manufacturing High Technology Hand Book", Marcel Decker
3	P.N. Rao, CAD/CAM Principles and applications, McGraw Hill Book Co. New Delhi

2MPD2-13: Operations and Supply Chain Management

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Introduction to operations management for competitiveness of corporate - Product life cycle - types of productive systems - process life cycles and technology.	4
3	Generic enterprise strategies - Role of productivity improvement- components of operations strategy and its implementation, -Utility theory.	7
4	Forecasting - inventory planning and control - MRP - operations scheduling. Product and process design and technological choice - capacity planning - MRP-II - location theory and distribution - work measurement - facility layout and assembly line balancing.	10
5	Historical evolution of SCM- Inbound logistics, Operations, Outbound logistics.	6
6	Forecasting- Inventory strategy- Transportation strategy- Warehouse management- Information strategy for SCM - Performance management- Organization design and structure for effective supply chain- Supply chain integration and coordination strategies.	12
	Total	40

TEXT BOOK	
1	E.E. Adam, Jr. and R.J. Ebert, "Production and Operations Management" Prentice Hall Publication
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Sunil Chopra, Peter Meindl and Kalra, “Supply Chain Management, Strategy, Planning, and Operation”, Pearson Education
2	R. Panneerselvam, Production and Operations Management, Prentice Hall India Learning Private Limited

2MPD2-14: Rapid Product Development Technologies

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Overview of Rapid Product Development:** Product Developing Cycle, Components of RPD, Classification of manufacturing processes. Preprocessing: Solid Modeling, Data exchange formats, STL file format, RP Preprocessing.	4
3	**Rapid Prototyping (RP):** Introduction to RP, Need of RP; Basic Principles of RP, Steps in RP, Process chain in RP in integrated CAD-CAM environment, Advantages of RP, Classifications of different RP techniques, Selection of RP processes, Issues in RP, Emerging trends.	7
4	**RP Techniques:** Solid RP, liquid RP techniques and Powder RP Techniques - Process Technology and Comparative study of Selective laser sintering, Selective powder binding, etc.	8
5	**Rapid Tooling (RT):** Introduction to RT, Indirect RT processes – silicon rubber molding, epoxy tooling, spray metal tooling and investment casting. Direct RT processes – laminated tooling, powder metallurgy based technologies, welding based technologies, direct pattern making, emerging trends in RT.	5
6	**Reverse Engineering:** Geometric data acquisition, 3D reconstruction.	5
7	**Applications and case studies:** Engineering applications, Medical applications	5
8	**Special Topic on RP:** Programming in RP, Modelling, Slicing, Internal Hatching, Surface Skin Fills, Support Structure. Overview of the algorithms for RP&T and Reverse Engineering.	5
	Total	40

TEXT BOOK	
1	Chua, C.K., Leong, K.F., Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley and Sons Inc., 2000.
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1.	Noorani, R., Rapid Prototyping: Principles and Applications, John Wiley & Sons, Inc., New Jersey, 2006.
2.	Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory and Practice", Springer
3.	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing by Brent Stucker, David W. Rosen, and Ian Gibson, Springer
4.	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Gibson, Ian, Rosen, David, Stucker, Brent, Pearson.
5.	Pham, D.T., Demov, S.S., Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer-Verlag London Limited, 2001.
6.	Hopkinson, N., Hague, R.J.M. and Dickens, P.M., Rapid Manufacturing and Industrial Revolution for the Digital Age, John Wiley and Sons Ltd, Chichester, 2005.

2MPD2-15: Lean, Six Sigma and Sustainable Manufacturing

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Objectives of lean manufacturing - key principles and implications of lean manufacturing - traditional versus lean manufacturing characteristics - concept of takt time, continuous flow, continuous improvement, single piece flow.	8
3	Overview of six sigma concept - definition, origin, terms - Foundations of lean six sigma –four keys, five laws of lean six sigma -types of lean six sigma - DMAIC versus DMADV –lean six sigma project selection - Team stages, characteristics of effective teams - six sigma training plan - Six sigma metrics- Common implementation issues and management strategies- Implementation steps.	12
4	Concepts of sustainability and sustainable development – Need for sustainable development - Components of sustainability- Social, Economic, Environmental dimensions - Linkages between technology and sustainability - Sustainable Manufacturing –Scope, Need and Benefits.	9
5	Tools and Techniques of Sustainable Manufacturing- Environmental Conscious Quality Function Deployment, Life cycle assessment, Design for Environment - Design for recycling- Environmental, Economic, Societal and Business indicators - Concept Models and Various Approaches, Product Sustainability and Risk/Benefit assessment– Corporate Social Responsibility.	10
	Total	40

TEXT BOOK	
1.	G. Atkinson, S. Dietz, E. Neumayer, Handbook of Sustainable Manufacturing. Edward Elgar Publishing Limited
2.	Askin R G, Goldberg J B, Design and Analysis of Lean Production Systems, John Wiley and Sons Inc.
3.	Gopalakrishnan N., Simplified Six Sigma methodology, tools and implementation, PHI Learning Pvt Limited.
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Hobbs P. Dennis, Lean Manufacturing Implementation, Cengage Learning.
2	Jay Arthur, Lean Six Sigma –Demystified, Tata McGraw Hill Companies Inc
3	Rogers, P.P., Jalal, K.F. and Boyd, J.A., An Introduction to Sustainable Development, Earthscan, London.

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2MPD2-16: Design of Experiments

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Classification of experimental designs, Analysis of variance (ANOVA), ANOVA for detecting sources of variation – Statistical procedure for one- way ANOVA, Procedure for two-way ANOVA	10
3	Planning & management of experiments;- Conventional method for experiment-One factor at a time (OFAT) experiment - Concept of design of experiments - Common terms - Designed experiment - Full factorial experiments - main effect analysis, interaction analysis and results.	10
4	Fractional factorial experiments - Resolution of design - screening DoE, practicing with excel and statistical software - Optimizing using Response Surface Methodology (RSM).	10
5	Taguchi Methods - Difference between conventional DoE and Taguchi methods -Orthogonal arrays - Taguchi's Robust parameter design -Noise factors, S/N ratio - Selection of right orthogonal array.	9
	Total	40

TEXT BOOK	
2	Phillip, J. Ross Taguchi Techniques for Quality Engineering, The Tata McGraw-Hill.
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	Douglas C Montgomery, Design and Analysis of Experiment John Wiley & Sons
2	Ranjit Gupta, "Design of Experiments (DOE) Using the Taguchi Approach"- John Wiley & Sons

2MPD1-06: Modern Machining Processes Lab

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P **End Term Exam: 4 Hours**

SN	List of Experiments
1	To investigate the effect of material removal rate (MRR), Tool Wear and Surface roughness on workpiece and tool on Electrical Discharge Machining (EDM) and rapid EDM drilling machine
2	Micro drilling using Electrochemical Discharge Machining (ECDM).
3	Machining practice and parametric analyses on USM, EDM, ECM, AJM.

Note: The above list is suggestive. Experiments/case studies may be added relevant to the theory courses being taught in the semester.

2MPD1-07: Metal Forming Analysis Lab

Credit: 2 **Max. Marks: 100(IA:60, ETE:40)**

0L+0T+4P **End Term Exam: 4 Hours**

SN	List of Experiments
1	Analysis of Forming Process, Slab method, Upper & lower bound, FEM based simulation, slip line theory
2	Use of CAE platform for Die Design and Simulation.
3	Exercises in modelling and drafting of mechanical components - Assembly using parametric and feature based packages like Autodesk Inventor® / HyperWorks® etcas per availability.
4	Analysis of mechanical components – Use of software like Hyperworks® etc., Exercises shall include analysis of: a) Mould flow analysis b) Forming analysis.

Note: The above list is suggestive. Experiments/case studies may be added relevant to the theory courses being taught in the semester.

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

3MPD2-11: Micro and Precision Manufacturing Systems

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	Overview of Microsystems: Microsystems, typical Microsystems products, evolution of micro fabrication, Micro systems and micro electronics, multidisciplinary nature of Microsystems design and manufacturing, Microsystems and miniaturization, applications of Microsystems in the automotive industry and other industries. Working Principles of Microsystems: introduction, Microsensors, Microactuation, MEMS with Microactuators, Microaccelerometers, Microfluidics.	9
3	Microsystem Fabrication Processes: introduction, Photolithography (overview, photoresists and application, light sources, photoresist development, photoresist removal and postbaking), Ion implantation, Diffusion, Oxidation (thermal oxidation, silicon dioxide, thermal oxidation rates, oxide thickness by color), Chemical Vapor Deposition (working principle of CVD, Chemical reactions in CVD, rate of deposition, enhanced CVD), physical vapour deposition – sputtering, deposition by Epitaxy, Etching (chemical etching, plasma etching), summary of Microfabrication. Overview of Micromanufacturing: introduction, Bulk Micromanufacturing (overview of etching, isotropic and anisotropic etching, wet etchants, etch stop, dry etching, comparison of wet versus dry etching), surface Micromachining (general description, process in detail, mechanical problems associated with surface micromachining), The LIGA process (General description of LIGA process, materials for substrates and photoresists, electroplating, the SLIGA process.	10
4	Precision manufacturing- Introduction, concept of accuracy, tolerance and fits - influence of different factors on the maintainability of accuracy of the machine tools and the product - compensation of thermal errors and location errors, -effects of vibration and tool wear, -dimensioning and dimensional chains.	10
5	Nano finishing- magnetorheological finishing process-micro/nano finishing with flexible flow of abrasives- Electrolytic In-process Dressing (ELID) Grinding. Optical microscopy- confocal laser scanning microscopy- Scanning Electron Microscope (SEM)-Atomic Force Microscope (AFM).	10
	Total	40

TEXT BOOK	
1	Tai-Ran Hsu, "MEMS & Microsystems design and Manufacturing", 2002, McGraw Hill Education (India) Private Limited
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	I. Fujimasa, "Micromachines: A New Era in Mechanical Engineering", Oxford Science Publications
2	R.L. Murty, "Precision Engineering in Manufacturing", New Age International Publishers
3	V.K.Jain, "Introduction to Micromachining", Narosa Publishing House, 2010

3MPD2-12: Mechatronic Systems Design and Applications

Credit: 3 **Max. Marks: 100(IA:30 ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course. Overview of Mechatronics: Historical perspective, Definition, Applications, Block diagram of Mechatronic system, Functions of Mechatronics Systems, Design process, systems, measurement systems, control systems, programmable logic controller, examples of mechatronic systems. Sensors and Transducers: Performance terminology, Displacement, Position, and Proximity Sensors, velocity and motion, Force and torque sensors, fluid Pressure, liquid Flow, liquid level, Temperature, Light sensors, Smart material sensors, Micro and Nano sensors, Selection criteria for sensors.	10
2	Signal conditioning, Operational amplifier, protection, filtering, wheatstone bridge, pulse modulation. Digital Signals, Analogue and digital signals, digital-to-analogue and analogue-to-digital converters, multiplexers, data acquisition, digital signal processing. Digital Logic, logic gates, applications of logic gates, sequential logic Data presentation systems: displays, data presentation elements, magnetic recording, optical recording, displays, data acquisition systems, measurement systems, testing and calibration.	8
3	Pneumatic and hydraulic actuation systems: actuation systems, pneumatic and hydraulic systems, directional control valves, pressure control valves, cylinders, servo and proportional control valves, process control valves, rotary actuators. Mechanical actuation systems: mechanical systems, types of motion, kinematic chains, cams, gears, ratchet and pawl, belt and chain drives, bearings, mechanical aspects of motor selection. Electrical actuation systems: electric systems, mechanical switches, solid-state switches, solenoids, DC motors, AC motors, and stepper motors.	8
4	Basic System Models: mathematical models, mechanical system building blocks, electrical systems building blocks, fluid system building blocks, and Thermal system building blocks. System Models: Engineering systems, rotational – translational systems, electromechanical systems, linearity, and hydraulic-	8

	mechanical systems. Dynamic responses of systems: modeling dynamic systems, terminology, first-order systems, second order systems, performance measures of second order system and system identification System Transfer Functions: Transfer function, first –order systems, second order systems, systems in series, systems with feedback loops, effect of pole location on transient response. Frequency response: sinusoidal input, phasors, frequency response, bode plots, performance specifications, and stability.	
5	Closed-loop controllers: continuous and discreet control processes, terminology, two-step mode, proportional mode, derivative control, integral control, PID controller, digital controllers, control system performance, controller tuning, velocity control and adaptive control. Microprocessors: control, microprocessor systems, microcontrollers, and applications. Programmable logic controllers: Basic PLC structure, Input/output processing. Mechatronic systems: mechatronic designs, case studies.	**6**
	Total	**40**

TEXT BOOK	
1	W. Bolton, Mechatronics, Electronic control systems in mechanical and electrical engineering, Pearson Education, 5/e, 2011.
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1	David G. Alcaiatore and Michel B. Histand, Introduction to Mechatronics and Measuring Systems, Mc. Graw Hill Int. Edition, 3/e,
2	James J Allen, Micro Electro Mechanical Systems Design, CRC Press.
3	Craig K. C. and Stolfi, F. R., Introduction to Mechatronic System Design with Applications, IEEE Educational Activities Department,.
4	Robert H. Bishop. The Mechatronics Handbook, CRC Press, 2/e
5	K P Ramachandran, G K Vijayraghavan and M S Balasundaram, “Integrated mechanical electronic systems” Wiley India Edition, 2008

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

3MPD2-13: Innovation and Entrepreneurship for Engineers

Credit: 3 **Max. Marks: 100(IA:30, ETE:70)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1.	**Introduction:** Objective, scope and outcomes of the course.	**1**
2.	**Entrepreneurship:** Concept and Definitions; Entrepreneurship and Economic Development; Types of Entrepreneurs; Factor Affecting Entrepreneurial Growth – Economic, Non-Economic Factors; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs; Manager Vs. Entrepreneur, types of entrepreneurships, Entrepreneurial myths.	**5**
3.	**Opportunity Identification and Product Selection:** Entrepreneurial Opportunity Search and Identification; Criteria to Select a Product; Conducting Feasibility Studies; Sources of business ideas, launching a new product; export marketing, Methods of Project Appraisal, Project Report Preparation; Project Planning and Scheduling. Sources of finance for entrepreneurs. Procedure for Export and Import. Handicraft business opportunities in India.	**8**
4.	**Support Institutions and Management of Small Business:** MSME-Definition and significance in Indian economy, Registration, NOC from Pollution Board; Major problems faced by MSME; MSME Schemes, Challenges and Difficulties in availing MSME Schemes, Development Commissioner (MSME); Department of Industrial Policy and Promotion (DIPP); Director of Industries (DIC); KVIC, Coir Board; SIDBI; RIICO, SIDCO; NSIC, RSIC; Entrepreneurship development institutes: NIESBUD, IIE, NIMSME, EDI etc; State Financial Corporation SFC; Venture Capital: Concept, venture capital financing schemes offered by various financial institutions in India, Legal issues related to forming business entity, Requirements for formation of a Private/Public Limited Company. Steps in registration of firms and partnership.	**10**
5.	**Introduction to IPR and patents:** Basic concept of intellectual property Rights: Patents, design, trademark, GI, Copyright. Indian patent system and salient features of patent Act 1970. WTO-TRIPS agreement: Development of TRIPS Complied Regime in India. Patent Databases & Patent Information System: WIPO, IPINDIA, USPTO, Google Patents etc. Novelty searches. Subject matters of patentable and non-patentable in India. Procedure of patent filing, PCT application, provisional application, date of priority.	**8**
6.	**Startup**: Stages in transforming idea to a startup, Idea – Create, develop and validation. Prototype testing, Developing the product, developing the team, creating traction for the product, pitching the startup, Sources for funding of a startup, Pre Seed funding – Business angles, accelerators, Seed Funding - Angles, venture capitalists, crowd funding, syndicate investing, SME lending, grants, Accelerator funding. Mergers and acquisition.	**8**
	TOTAL	**40**

TEXT BOOK	
1	Entrepreneurship development small business enterprises, Poornima M Charantimath, Pearson.
2	Understanding Patent Law, Vishnu S. Warrier, LexisNexis.
REFERENCE BOOKS	
SN	**Name of Authors /Books /Publisher**
1.	Entrepreneurship, Roy Rajiv, Oxford University Press.
2.	Innovation and Entrepreneurship, Drucker. F, Peter, Harper Business.
3.	Entrepreneurship, Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, Tata Mc-Graw Hill Publishing Co. Ltd.
4.	Enterpreneurship Development, S.S.Khanka, S.Chand & Co.
5.	Small-Scale Industries and Entrepreneurship, Vasant Desai, Himalaya Publishing House.
6.	Entrepreneurship Management, Cynthia, Kaulgud, Aruna, Vikas Publ
7.	Entrepreneurship: Ideas in Action, Cynthia L. Greene, Thomson Asia Pvt.
8.	Patent Law in India, M. B. Rao , Manjula Guru, Kluwer Law International
9.	Intellectual Property Law, P Narayan, Eastern Law House
10.	Intellectual Property Rights: Drafting,Interpretation of Patent Specifications and Claims, N.S. Rathore, New India Publishing Agency
11.	Handbook on Patent Law - The Patents Act, 1970, LexCampus
12.	The Law of Intellectual Property Rights : Introductory, WTO, Patent Laws, Shiv Sahai Singh, Eastern book Company.
13.	Patents Act, 1970, SCC Editorial, Eastern book Company.