



RAJASTHAN TECHNICAL UNIVERSITY, KOTA
Teaching & Examination Scheme
M. Tech.: Industrial Engineering and Management

Scheme of POSTGRADUATE DEGREE COURSE

M.Tech. I to IV Semester

Industrial Engineering and Management



(Effective from academic session: 2020-21)

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

Office of Dean Academic Affairs
Rajasthan Technical University, Kota



RAJASTHAN TECHNICAL UNIVERSITY, KOTA
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TEACHING SCHEME

1st Year – I Semester

S N	Course Type	Course Code	Course Name Title	Contact hrs/week			Exam Hrs	Marks			Credits
				L	T	P		IA	ETE	Total	
1	PCC	1MIM1-01	Statistics for Management	3	0	0	3	30	70	100	3
2	PCC	1MIM1-02	Operations Research	3	0	0	3	30	70	100	3
3	PCC	1MIM1-03	Quality Systems	3	0	0	3	30	70	100	3
4	PEC	1MIM2-11	Project Management	3	0	0	3	30	70	100	3
		1MIM2-12	Maintenance and Reliability Management								
		1MIM2-13	Management Information System								
5	MCC	1MCC3-21	Research Methodology and IPR	2	0	0	2	30	70	100	2
6	PCC	1MIM1-06	Industrial Engineering lab	0	0	4	4	60	40	100	2
7	PCC	1MIM1-07	Statistical Analysis & OR Lab	0	0	4	4	60	40	100	2
8	SODE CA	1MIM5-00	Social Outreach discipline & Extra Curriculum Activities							100	2
TOTAL								270	430	800	20

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1st Year – II Semester

SN	Course Type	Course Code	Course Name Title	Contact hrs/week			Exam Hrs	Marks			Credits
				L	T	P		IA	ETE	Total	
1	PCC	2MIM1-01	Operations Management	3	0	0	3	30	70	100	3
2	PCC	2MIM1-02	Managerial Accounting Finance and Economics	3	0	0	3	30	70	100	3
3	PCC	2MIM1-03	Computer Integrated Manufacturing	3	0	0	3	30	70	100	3
4	PEC	2MIM2-11	Lean Manufacturing & Supply Chain Management	3	0	0	3	30	70	100	3
5		2MIM2-12	Total Quality Management								
6		2MIM2-13	Advanced Operations Research & Simulation Modeling								
7	MCC	2MCC3-XX	Audit Course-I	2	0	0					
8	PCC	2MIM1-06	Operations Management Lab	0	0	4	4	60	40	100	2
9	PCC	2MIM1-07	CIM Lab	0	0	4	4	60	40	100	2
10	REW	2MIM4-50	Mini -Project	2	0	4	4	60	40	100	2
11	SODE CA	2MIM5-00	Social Outreach discipline & Extra Curriculum Activities							100	2
TOTAL								300	400	800	20

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2nd Year - III Semester

SN	Course Type	Course Code	Course Name Title	Contact hrs/week			Exam Hrs	Marks			Credits
				L	T	P		IA	ETE	Total	
1	PEC	3MIM2-11	Enterprise Resource Planning and E-Commerce	3	0	0	3	30	70	100	3
2		3MIM2-12	Industry 4.0								
3		3MIM2-13	Innovation and Entrepreneurship for Engineers								
4	MCC	3MIM3-XX	Open Elective	3	0	0	3	30	70	100	3
5	MCC	3MCC3-XX	Audit Course-II	2	0	0					
6	REW	3MIM4-60	Dissertation -I/Industrial Project	0	0	20		240	160	400	10
TOTAL								300	300	600	16

2nd Year - IV Semester

SN	Course Type	Course Code	Course Name Title	Contact hrs/week			Exam Hrs	Marks			Credits
				L	T	P		IA	ETE	Total	
1	REW	2MIM4-70	Dissertation Phase-II	0	0	32		360	240	600	16
TOTAL								360	240	600	16

L: Lecture, T: Tutorial, P: Practical, Cr: Credits
ETE: End Term Exam, IA: Internal Assessment

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1MIM1-01: STATISTICS FOR MANAGEMENT

SN	Contents	Hours
1	Introduction: This course aims to introduce students to use quantitative techniques for effective decisions–making; model formulation and applications that are used in solving business decision problems.	1
2	Random Variable, Probability and laws of Probability, Conditional and joint Probability, Bayes Theorem.	4
3	Discrete and continuous probability distribution.	5
4	Sampling and sampling distributions, Central limit theorem and its applications	4
5	Estimation. Testing of hypothesis, type I and type II errors, Testing equality of means of two sample and more than two samples.	5
6	Correlation & Regression Analysis.	4
7	Linear Models and ANOVA, ANCOVA,	5
8	Design of Experiment (Complete and Incomplete Block designs), Factorial Experiments.	5
9	Some exposure to statistical and optimization software like MINITAB, SPSS, Solver, LINGO etc	2
	Total	40

TEXTBOOK

1	Statistics for business and management by David R. Anderson, Danis J. Sweeney, Thomas A. Williams, Jeffrey D. Camm, & James J. Cochran.
2	Statistics for Management, by Rubin & Levin, Pearson,

REFERENCE BOOKS

1	Bluman, Alan G.: Elementary Statistics - A brief version. Third Edition, McGrawHill 2006.
2	Bowerman, Bruce L. and O'Connell, Richard T.: Business Statistics in Practice, 4th edition, McGraw-Hill 2007.



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1MIM1-02: OPERATIONS RESEARCH

S N	Contents	Hours
1	Introduction: Objective, scope and outcome of the course. To provide exposure to Operations Research Tools and Techniques, and model real life problems as optimization problems.	1
2	Historical evolution of OR, Application of OR, Strengths and limitations of the OR tools/models, Formulation of real-life problems as linear programming problems, Solution of LP by using Graphical method.	5
3	Simplex Method, Big M Method, Dual Simplex Method; Duality Concepts; Sensitivity Analysis	5
4	Transportation, Transshipment and Assignment Problems, solution procedure and its applications	4
5	Integer Programming and methods of solving integer programming problems	3
6	Queuing Theory: Introduction, structure of a queuing system, performance measures, probability distribution in queuing, Queuing models: single server and multiple servers. Finite calling population queuing models	5
7	Decision Theory and Decision Trees. Game Theory (zero and non-zero sum) and its applications	5
8	Replacement Models. Replacement of Items that Deteriorate whose maintenance costs increase with time without change in the money value. Replacement of items that fail suddenly: individual replacement policy, group replacement policy.	5
9	Concept of Simulation, Monte Carlo method, Generation of Random numbers, Applications of Simulation	5
	Some exposure to optimization software (TORA, Solver, LINGO)	
	Total	40

TEXTBOOK

1	Hillier F.S. and Liebermann G.J., Introduction to Operations Research, McGraw Hill, 2002.
2	Taha H A , Operations Research: An Introduction, Prentice Hall of India.

REFERENCE BOOKS

1	Quantitative Techniques in Management by N.D.Vohra – published by Tata McGraw Hill.
2	Operations Research by P. K. Gupta & Hira, S. Chand Publications.
3	Introduction to Management Science - quantitative approaches to decision making by Anderson, Sweeney, and Williams – published by Thomson South Western – India Edition.



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1MIM1-03: QUALITY SYSTEMS

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course.	01
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.



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1MIM2-11: PROJECT MANAGEMENT

SN	Contents	Hours
1	Introduction: Objective, scope and outcome of the course. To present the concepts, techniques, and tools for managing projects effectively in terms of time, quality and cost, and also to develop skills in techniques for planning, estimating, monitoring and controlling cost, schedules, risk and performance parameters.	1
2	Systems approach to project management, project feasibility studies, project appraisal, project selection, market and demand analysis, technical analysis	8
3	Project cash flows, time value of money and cost of capital.	8
4	Project organization, cost estimation and budgeting, resource planning,	8
5	Procurement and mobilizations, roles and responsibilities, and contract administration.	8
6	Project scheduling, CPM and PERT techniques, project risk analysis and management, project crashing and scheduling with limited resources. Project monitoring and control and earned value analysis.	7
	Total	40

TEXTBOOK

1	Projects: Planning, Analysis, Selection, Financing, Implementation, and Review, Prasanna Chandra, Projects, McGraw Hill Education; Eighth edition (1 July 2017)
2	Engineering Project Appraisal, Martin Rogers and Aidan Duffy, Wiley-Blackwell; 2 edition, 2012

REFERENCE BOOKS

1	Kerzner, H., Project Management – Systems Approach to Planning, Scheduling and Controlling, 2001.
2	Meredith and Mantel, Project Management, 2001.
3	PMI, A Guide to Project Management Body of Knowledge, 2000.
4	Wiest, J.D. and Levy, F.K., A Management Guide to PERT / CPM, 2001.



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1MIM2-12: MAINTENANCE AND RELIABILITY MANAGEMENT

SN	Contents	Hours
1	Introduction: To discuss the role of maintenance management for competitive advantage, structuring the maintenance function; preventive, predictive and productive maintenance strategies and policies for managing operations, productivity, quality and growth. Understanding the basic principles of reliability engineering and its application to system requirements, design, manufacturing, and testing.	1
2	Objective of Maintenance; Maintenance Policies; Availability, Maintainability and Effectiveness of equipment;	5
3	Quantitative aspects of maintenance; Various aspects of preventive, predictive, productive and Total Productive Maintenance(TPM);	5
4	Replacement policies; Maintenance budgeting and cost control; Concept of World Class Maintenance to enable the organization to make its products and services competitive in terms of price, quality, on –time delivery and total customer support.	5
5	Maintenance Audit; Computer aided maintenance management system ; Case studies on total productive Maintenance; Markov Model and Application of Markov Processes in Maintenance	5
6	Maintenance Performance Indicators; Application of reliability theory in Maintenance	4
7	Introduction to Engineering Reliability, Basic Probability Theory, Application of Binomial Distribution, Network Modeling & Evaluation of Simple Systems,	5
8	Network Modeling & Evaluation of Complex Systems, Probability Distributions in Reliability Evaluation, Reliability Evaluation Using Probability Distributions,	5
9	Discrete Markov Chains, Continuous Markov Processes, Approximate System Reliability Evaluation, Monte Carlo Simulation.	5
	Total	40

TEXTBOOK

1	K Venkataraman, Maintenance Engineering and Management, Prentice Hall of India, 2007
2	Charles E.Ebeling, “An introduction to Reliability and Maintainability engineering”, Tata McGraw Hill, 2000.

REFERENCE BOOKS

1	Nakijima S., TPM Development Programme: Implementing total Productive Maintenance, Productivity Press,Canbridge.
2	Terry W., Computerised Maintenance Management Systems, Industrial Press , New York.
3	Lindley R.Higgins & R.Keith Mobley, “Maintenance Engineering Handbook”, McGraw Hill,
4	Suzuki T., TPM in process industries , Productivity Press, Portland, Oregon

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1MIM2-13: MANAGEMENT INFORMATION SYSTEMS

SN	Contents	Hours
1	Introduction: Organisations and Computing: Introduction, Modern Organisation-IT enabled- Networked-Dispersed- Knowledge Organisation, Information Systems in Organisations- what are information systems?, Brief history of computing- ENIAC: Way to commercial computers- Advent of artificial intelligence	1
2	Managing Information Systems in Organisations: Introduction, Managing in the Internet Era, Managing Information Systems in Organisation-the IT interaction model, Challenges for the manager	5
3	Data and Information: Introduction, data and information- types of information technology, types of information systems- transaction processing systems- management information systems	5
4	Decision making and communication: Introduction, Decision making with MIS- Tactical decisions-operational decisions-strategic decisions, IT strategy: Introduction, Information goods-properties-technology lock-in and switching costs-network externalities-positive feedback-tippy markets, information systems and competitive strategy- value chain	5
5	Business Process Integration with IT: Introduction, Business Process Integration- Business processes-example of a complex process, Motivation for Enterprise Systems, Enterprise Resource Planning systems- finance and accounting module-human resource management module-manufacturing and operations module- sales and marketing module	5
6	SCM, CRAM and International Systems: Introduction, Supply Chain Management Systems, Customer Relationships Management Systems, Challenges of Enterprise Systems Implementations- Managing the implementation, International Information Systems-Outsourcing and off-shoring	5
7	Electronic Commerce: Introduction, E-commerce Technology, doing business over internet- networks-electronic data interchange (EDI)-online payment technology- Mobile commerce- ecommerce-portals- search engines-direct selling- auctions- aggregators, E-business	5
8	Decision Support Systems: Introduction, Understanding DSS- MIS and DSS- Decision making-types of decisions, Analytics and Business Intelligence- BI techniques. Ethical Issues: Introduction, Key issues- Privacy-Workplace Monitoring- Power over users	3
9	Managing Data Resources: Introduction , The Need for Data Management- History of data use, Challenges of Data Management- data independence-reduced data redundancy- data consistency- data access- data administration-managing concurrency, Database Concepts- fields, records and files- basic architecture, Data Warehouses- data mining uses, Entity Relationship diagram, SQL	6
	Total	40

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TEXTBOOK	
1	James O'Brien, George Marakas, Management Information Systems
2	R. Kelly Rainer, Brad Prince, Hugh J. Watson, Management Information Systems, J Wiley
REFERENCE BOOKS	
1	Kenneth C. Laudon, Jane P. Laudon, Management Information Systems, Managing the Digital Firm, Pearson Edu.
2	Management Information Systems 7th Edition by Ken J. Sousa

1MIM1-06: INDUSTRIAL ENGINEERING LAB

SN	List of Experiments
1	Distribution Verification: a) Verification of Normal Distribution b) To find the distribution of numbered cardboard chips by random drawing one at a time with replacement. Make 25 subgroups in size 5 and 10 find the type of distribution of sample average in each case. c) Verification of Poisson Distribution
2	Central Limit Theorem: a) To show that a sample means for a normal universe follow a normal distribution. b) To show that the sample means for a non-normal universe also follow a Normal Distribution given the distribution of universe as: i) Uniform ii) Poisson.
3	Case Study on Process Control using Shewhart Control Chart: X bar and R charts
4	Case Study on Machine and Process Capability Analysis using probability plot and capability indices
5	Attribute Control Chart a) Verify the Binomial Distribution of the number of defective balls by treating the balls with a red colour to be defective. b) Plot a P-chart by taking a sample of n=20 and establish control limits.
6	Operating Characteristics Curve: a) Plot the operating characteristics curve for single sampling attribute plan for n = 20 ; c = 1 , 2 , 3 , 4 . Designate the red ball to defective. b) Compare the actual O.C. curve with theoretical O.C. curve using approximation for the nature of distribution.
7	To design acceptance sampling plan for predefined value of AQL/Producers risk and LTPD/Consumers risk
8	Case study on estimation of equipment error of measurement
9	Case Study on Parameter Design
10	Case Study on DOE

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



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1MIM1-07: STATISTICAL ANALYSIS & OR LAB

Note: In this lab students are required to perform experiments using software packages like MSEXCEL/Solver, LINGO /SYSTAT /R/TORA/SAS/MINITAB/Design Expert

SN	List of Experiments
1	a) To develop tables and charts for categorical and numerical data: Bar Chart, PIE Chart, Pareto Diagram, Steam and Leaf display, Frequency distribution, Histogram, Scatter plot and Time Series plots for the given dataset. b) To compute the numerical descriptive statistics, covariance and coefficient of correlation for the given raw data and to construct Box and Whisker plot
2	To construct contingency table, compute conditional, marginal probability and use Bayes theorem for the given data and interpret results
3	To construct the distribution plot for discrete distribution and continuous distribution probability distributions and infer results.
4	Using the given survey data, construct the 95% confidence interval estimate of population characteristics for each variable and draw conclusions
5	a) To use p-value approach to hypothesis testing to test a mean or proportion: One sample test. b) To use hypothesis testing for comparing between difference between means, proportions and variances of two populations
6	To carry out One-way ANOVA and Two-way ANOVA
7	Use of OR Techniques - A case study of Insulator India Ltd. (Product Mix problem)
8	Use of OR Techniques - A case study of ECS Corporation. (Transportation problem)
	To generate random number for system simulation and to carry out Monte Carlo simulation
9	To carry out Simulation of Queuing Systems/Inventory Systems etc.
10	To use integer programming for a given case.

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



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2MIM1-01: OPERATIONS MANAGEMENT

SN	Contents	Hours
1	Introduction: The objective of the course is to develop familiarity with the concepts of production systems their constraints, and their linkages with the overall business strategy; planning and control of operations; optimal utilization of resources and interfaces of operations management with other managerial areas.	1
2	Operations Management and its scope, Historical Evolution, Competitiveness, Strategy and Productivity, improving productivity. Motion and Time Study, Problem solving process, Work Method Design, Process analysis, Work measurement: Time Study, Rating, Allowances, Stopwatch time study, predetermined time standards, standard data, Work sampling, Applications. Introduction to Human Factors.	5
3	Demand Management and Forecasting; Strategic Importance, Approaches to Forecasting, Qualitative and, Quantitative Methods, Accuracy and monitoring the forecast.	4
4	Capacity Planning: Introduction to capacity, Capacity Strategy, Measures of capacity, factors determining effective capacity, developing capacity strategies, and evaluating alternatives.	3
3	Facilities Planning: Strategic Facilities Planning; Facilities Location: Facility Location Problems; Single Facility Location Problem; Multi facility Location Problem; Process Selection, Layout Planning: Basic Layout types, Designing Product Layout: Line balancing, Systematic Layout planning procedure, Flow, Space and Activity Relationships, Computer-Aided Layout Planning; Materials Handling (MH): MH System design, Unit Loads, MH Equipment's, Principles of MH. ASRS, AGV; Introduction to Warehouse Layout planning; Storage and Retrieval Systems; Warehouse Management.	5
5	Aggregate Planning and Master Scheduling: Planning and Scheduling, Objectives of Aggregate Planning, Strategies of Aggregate Planning, Master Scheduling	5
6	Materials Management: Scope, Purchasing Process, Make or Buy decisions, Inventory Management: Classification, Functions of inventories, Dependent and independent demand, Inventory costs. Economic Order Quantity Models: Basic EOQ Model, Economic Run Length Model, Quantity discount Model. Reorder Point Models, Service levels and safety stock, Fixed Order Interval Model. Single Period Model: Continuous and discrete stocking levels. Selective Inventory Control. Materials and Capacity requirements planning(MRP/CRP): MRP inputs and outputs, Bill of Materials (BOM), System parameters and Lot sizing techniques, MRP Logic. CRP activities. Basic concept of MRP II & ERP	5
7	Operations Scheduling and Control: Functions and objectives, Scheduling in High volume and Low volume systems, Order Release. Loading and Assignment: Gantt Charts, Infinite and finite loading, Sequencing: Priority rules: SPT, FCFS, EDD, CR, S/O, RUSH. Johnson's Rule, Scheduling in Services	5
8	Project Management Introduction, Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT	4

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9	Lean Manufacturing and Agile Manufacturing, Just-In-Time: Introduction, Characteristics of JIT, Key Processes to Eliminate Waste, Implementation of JIT, Pre-requisites for implementation, JIT Inventory and Supply Chains	5
	Total	40

TEXTBOOK	
1	Operations Management, (Latest Edition), William J. Stevenson, Tata McGraw Hill education Private Limited.
REFERENCE BOOKS	
1	Operations & Supply Management, (Latest Edition), Chase, R. B. Aquilano, N. J. Jacobs, F. R. Boston, McGraw-Hill.
2	Operations Management: Processes and Supply Chains, (latest Edition), Krajewski, Ritzman, L. P. and Malhorta, M.J., Pearson.
3	Operations Management, (Latest Edition), Heizer, Jay; Render, Barry, Upper Saddle River, N.J.: Prentice-Hall.
4	Introduction to Work Study: International Labor Office (ILO), Geneva.
5	Motion and Time Study Design and Measurement of Work: Ralph M. Barnes, Wiley, The University of California

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2MIM1-02: MANAGERIAL ACCOUNTING FINANCE AND ECONOMICS

SN	Contents	Hours
1	Introduction: To make students identify and analyze tools to understand, evaluate and analyse the financial information available in Financial Statements and other sources of Financial Information like Directors Report, Management Discussion & Analysis and enable them to develop the insights into corporate finance & corporate dynamics.	1
2	The nature and purpose of Accounting, Basic accounting concepts. Components of financial statement: The Balance Sheet, The Income Statement and The Cash Flows.	5
3	Standards in understanding financial statements. Performance evaluation of a business using financial statements.	5
4	Financial Statement Analysis. Compare financial performance both inter and intra business. Introduction to Corporate Finance: Goals of Financial Management, Conflicts between Company Stakeholders, Financial Markets.	5
5	Time Value of Money: FV/PV of Cash Flows and Cash Flow Streams.	5
6	Compounding/Discounting, Multiple Compounding and Discounting, Different compounding periods.	5
7	Amortized Loans. Bonds and their valuation: Terminology and characteristics of bonds, Bond valuation, Bond yields.	5
8	Stocks and their valuation: Terminology and characteristics of stocks, Stock valuation models, Growth opportunities & PVGO model. Risk and Return: Expected Rate of Return, Standard Deviation of Returns.	5
9	Relationship between Risk and Return. The Capital Asset Pricing Model: Measuring Portfolio Risk, Diversification. The Capital Asset Pricing Model (CAPM)	4
	Total	40

TEXTBOOK

1 | Ross, Westerfield, Jaffee: Corporate Finance, 11th. edition

REFERENCE BOOKS

1 | Richard Brealey, Stewart Myers, Franklin Allen: Principles of Corporate Finance, 11e. McGraw Hill

2 | Robert N Anthony, David F Hawkins and Kenneth A Merchant (AHM), Accounting: Text and Cases



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2MIM1-03: COMPUTER INTEGRATED MANUFACTURING

SN	Contents	Hours
1	Introduction: To provide an exposure of Information and communication Technology and application of computer for automation of manufacturing tasks. To summarize and examine the importance of Additive Manufacturing technology from business competitiveness point of view.	1
2	Introduction to NC, CNC, DNC machine tools, Constructional features of NC Machine Tools, CNC Tooling and Fixturing,	4
3	CNC Programming: Basic and Advanced, Computer Assisted Part Programming, System Drives and Devices, Interpolators: Software and Hardware,	5
4	CNC Controller, Adaptive Control System, Machining Centre, Turning Centre, Communication Networks and Virtual NC Systems.	5
5	Components of CIM, Data base For CIM, Planning, Scheduling and Analysis of CIM systems. Manufacturing Automation, Automation strategies,	5
6	Automated Flow lines, Line Balancing, Automated Assembly systems, Automatic Material Handling and Storage systems, Automated Inspection systems,	5
7	Group Technology, Cell Design, Cellular Manufacturing Systems, Computer Aided Process Planning.	5
8	CNC programming for turned and milled components and auto CNC programming using software.	5
9	Additive Manufacturing (AM) need, definition, generic AM process steps, Classification of AM Processes, Metal Systems, Need for time compression in product development, traditional Vs. Rapid Prototyping, applications, Related Technologies like CNC & reverse Engineering,	5
	Total	40

TEXTBOOK

1	Yoram Koren, Computer Control of Manufacturing Systems, McGraw Hill International, Singapore, 2006
2	Mikell P Groover, Automation, Production Systems and Computer Integrated Manufacturing, 3rd Edition, Prentice Hall Inc., New Delhi, 2007.

REFERENCE BOOKS

1	John Stenerson and Kelly Curran, Computer Numerical Control: Operation and Programming, PHI, New Delhi, 2009
2	TC Chang, RA Wysk and HP Wang, Computer Aided Manufacturing, PHI, New Delhi, 2009.
3	James V. Valentino and Joseph Goldenberg, Introduction to Computer Numerical Control, 5th Edition, Prentice Hall, Englewood Cliff, New Jersey, 2012.
4	Nanua Singh, System Approach to Computer Integrated Manufacturing, Wiley & Sons, 1996.
5	Adedeji B. Badiru, Vhance V. Valencia, David Liu, Additive Manufacturing Handbook: Product Development for the Defense Industry, CRC Press; 1 edition, CRC Press, 2017.
6	Ian Gibson· David Brent Stucker, Additive Manufacturing Technologies 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Second Edition, Springer, 2015

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2MIM2-11: LEAN MANUFACTURING & SUPPLY CHAIN MANAGEMENT

SN	Contents	Hours
1	Introduction: To appraise and apply lean manufacturing techniques and justify their applications in different manufacturing systems. To provide an understanding and cross functional perspective of Supply Chain and strategic implications of the best practices in Supply Chain Management.	1
2	Introduction to the Production System and the Role of Inventory, Value and waste, Muda, Mura, and Muri, Value added and non-value-added activities, Waste elimination, Value stream mapping. Flow production, Pull production system, Continuous improvement, Decentralized Pull Systems	3
3	Small lot production, Setup time reduction, Maintaining and improving the equipment, Focused factory. Cellular manufacturing, Standard operations, Quality at source, Mixed model scheduling	2
4	Single Stage Inventory Control, Multi-Stage Production Systems: Materials Requirements Planning for Dependent Demand, Multi-Stage Models. Lean Manufacturing and the Just-in-Time Philosophy, Shop Scheduling, Shop Floor Control: Systems and Extensions.	3
5	BUILDING A STRATEGIC FRAMEWORK TO ANALYZE SUPPLY CHAINS: Understanding the Supply Chain, Supply Chain Performance: Achieving Strategic Fit and Scope, Supply Chain Drivers and Metrics.	6
6	Designing the supply chain network: Designing Distribution Networks and Applications to Online Sales, Network Design in the Supply Chain, Designing Global Supply Chain Networks.	6
7	PLANNING AND COORDINATING DEMAND AND SUPPLY IN A SUPPLY CHAIN: Demand Forecasting in a Supply Chain, Aggregate Planning in a Supply Chain, Sales and Operations Planning in a Supply Chain, Coordination in a Supply Chain.	7
8	PLANNING AND MANAGING INVENTORIES IN A SUPPLY CHAIN: Managing Economies of Scale in a Supply Chain: Cycle Inventory, Economic Order Quantity, Managing Uncertainty in a Supply Chain: Safety Inventory, Expected Shortage per Replenishment Cycle, Evaluating Safety Inventory for Slow-Moving Items, Linking Product Availability to Profits, Optimal Level of Product Availability, An Intermediate Evaluation, Expected Profit from an Order, Expected Overstock /Under stock from an Order.	8
9	Transportation in a Supply Chain, Managing cross functional drivers in a supply chain: Sourcing Decisions in a Supply Chain, Pricing and Revenue Management in a Supply Chain, Sustainability and the Supply Chain.	4
	Total	40



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TEXTBOOK	
1	Supply Chain Management: Strategy, Planning, and Operation, Sunil Chopra, Peter Menidle, Prentice Hall.
2	Nicholas John, Lean Production for competitive advantage, - a comprehensive guide to lean methodologies and management practices, productivity press, 2011.
REFERENCE BOOKS	
1	Principles of Supply Chain Management: A Balanced Approach. 4th ed. Wisner, J. D., Tan, K.-C., & Leong, G. L. Nelson, Cengage.
2	Supply Chain Design and Management: Strategic and Tactical Perspectives, Academic Press, San Diego, Manish Govil and Jean-Marie Prop.
3	Integral Logistics Management: Operations and Supply Chain Management within and Across Companies, Paul Schönsleben, CRC Press, Taylor & Francis Group.
4	Designing and Managing the Supply Chain (Latest Edition), David Simchi-Levi, Philip Kaminsky, Simchi-Levi, McGraw Hill.
5	Essentials of Supply Chain Management, Michael H. Hugos, John Wiley & Sons.
6	Askin and Goldberg, Design and Analysis of Lean Production Systems, John Wiley and Sons. 2003.
7	Hayes, R.H., Pisano, G.P., Upton, D.M. and Wheelwright, S.C. (2005), Operations, Strategy, and Technology: Pursuing the Competitive Edge, John Wiley and Sons.
8	Womack and Jones, Lean Thinking, Simon and Schuster. 2003



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2MIM2-12: TOTAL QUALITY MANAGEMENT

SN	Contents	Hours
1	Introduction: To introduce the Quality Management Concepts, Strategies, Models and Methodologies etc. for understanding the subject scope in the areas and for effective decisions in the areas of Quality Improvement of a processes, products and services.	1
2	Introduction to TQM: Definition, Basic approach, TQM Guru's, framework, benefits.	4
3	Leadership: Characteristics of Quality Leadership, Leadership Concepts, The 7 Habits of Highly Effective People, Deming Philosophy, Role of TQM Leaders, Strategic Planning, Customer Satisfaction: Introduction, Customer Perception of Quality, Service Quality, Translating Needs into Requirements, Customer Retention.	5
4	Continuous Process Improvement: Introduction, Process, The Juran Trilogy, Improvement Strategies, Types of Problems PDSA Cycle, Problem-Solving Method, DMAIC, Kaizen, Reengineering, six sigma.	4
5	Supplier Partnership: Principles of Customer/Supplier Relationship Partnering, Sourcing Supplier, Selection, Supplier Certification, Supplier Rating. Performance Measures: Basic Concepts, Strategy, performance measure presentation, Cost of Quality, Malcolm Baldrige and Rajiv Gandhi Quality Award.	4
6	Lean Enterprise: Historical Review, Lean Fundamentals, Value Stream Map, Implementing Lean, Benefits. Six Sigma: Historical Review, Statistical Aspects, Improvement Methodology, Organizational Structure Benefits. Benchmarking: Benchmarking Defined, Reasons to Benchmark, Process, deciding what to benchmark, Pitfalls and Criticisms. Quality Function Deployment: The QFD Team, QFD Process.	5
7	Quality Management Systems: Benefits of ISO Registration, ISO Series of Standards, ISO 9001 Requirements, Implementation, Documentation. Environmental Management Systems: ISO 14000 Series Standards, Concepts of ISO 14000/14001, Requirements, Benefits, Integrating QMS and EMS. Other EMS Systems.	5
8	Total Productive Maintenance: The Plan, Learning the New Philosophy, Promoting the Philosophy, Training, Improvement Needs, Goal,	4
9	Management Tools: Forced Field Analysis, Nominal Group Technique, Affinity Diagram, Interrelationship Digraph, Tree Diagram, Matrix Diagram, Process Decision Program Chart, Activity Network Diagram	4
10	Taguchi's Quality Engineering: Introduction, Loss Function, Orthogonal Arrays, Signal-to-Noise Ratio, Parameter Design,	4
		40



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TEXTBOOK	
1	Dale H. Besterfield, Total Quality Management, Pearson edu.
2	R Kesavan, C Elanchezhian, B Vijaya Ramnath , Total Quality Management, I K International Publishing House
REFERENCE BOOKS	
1	James R. Evans, Total Quality-Management, Organization and Strategy
2	Joel E. Ross, Susan Perry , Total Quality Management-Text, Cases, and Readings
3	David L. Goetsch, Stanley Davis, Quality Management for Organizational Excellence-Introduction to Total Quality
4	Erick Jones, Quality Management for Organizations Using Lean Six Sigma Techniques, CRC press
5	John S Oakland, Peter Morris, Total Quality Management-A pictorial guide for managers



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2MIM2-13: ADVANCED OPERATIONS RESEARCH & SIMULATION MODELING

SN	Contents	Hours
1	Introduction: General description of Operations Research and Simulation modelling	1
2	Probability concepts: Random Variables, discrete and continuous probability distribution mainly Binomial, Normal, Weibull, exponential, Uniform, Poisson, Erlang	2
3	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 modeling, Role of simulation in model evaluation and studies, Advantages and Disadvantages of simulation.	2
4	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. Building simulation models of waiting line system, Job shop, material handling and flexible manufacturing systems	4
5	Random Numbers: Properties, Generations methods, Tests for Random number-Frequency test, Runs test, Autocorrelation test. Random Variate Generation: Inverse Transform Technique- Exponential, Uniform, Weibull, distributions.	4
6	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.	6
7	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.	6
8	Integer Programming: Integer programming models - Relaxations - Branch-and-bound algorithm - Better and ideal formulations - Cutting planes. Dynamic programming: Dynamic programming models and applications - Graphical representation - Optimality principle, deterministic dynamic programming, probabilistic programming	5
9	Markov chains Stochastic processes - States, Markov Chains - Transition matrices - Types of chains - Steady-state probabilities. Metaheuristics: Nature of Metaheuristics, introduction to Tabu Search, Simulated Annealing, Genetic Algorithms and other nature inspired methods	6
10	Nonlinear Programming: Nonlinear models, Review of linear algebra and calculus, Local and global solutions, Feasible directions, Improving directions, one variable unconstrained optimization, multivariable unconstrained optimization, Karush-Kuhn-Tucker conditions for constrained optimization, quadratic programming, separable programming, Geometric programming, convex programming and non convex programming.	6
	Total	40



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TEXTBOOK	
1	Simulation Modeling and Analysis, Law A.M., McGraw Hill.
2	Frederick S. Hillier, Gerald J. Lieberman, Introduction to Operations Research, McGraw Hill
REFERENCE BOOKS	
1	Discrete-Event System Simulation, Banks and Carsan, PHI
2	Simulation Modeling and Analysis with ARENA, Altiook and Melamed, A P
3	Simulation with ARENA, Keltan, Sadowski and Turrock, McGraw Hill
4	Simulation Modeling and ARENA, Rossetti and Taha, John Wiley
5	Narsingh Deo, Systems Simulation with Digital Computer, PHI Publication
6	Richard Bronson, Schaum's Outline of Operations Research , TMH
7	Paul Goodwin, Decision Analysis for Management Judgment
8	Warren B. Powell, Approximate Dynamic Programming: Solving the Curses of



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2MIM1-06: OPERATIONS MANAGEMENT LAB

SN	List of Experiments
1	Case Study on Operations Decision Making using Breakeven Analysis and Decision Theory
2	Case Study on Work System Design
3	Case Study on Demand Forecasting
4	Case Study on Location Planning.
5	Case Study on Layout Analysis.
6	Case study on "SLP" Systematic Layout Planning.
7	Case Study on Optimal Capacity Planning
8	Production - Inventory control game: "ILO CONTROL".
9	Case study on ABC analysis.
10	Case Study on Aggregate Production Planning

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

2MIM1-07: CIM LAB

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	Study of Flexible Manufacturing system and practice programming of integration of various components of FMS namely CNC machines, AS/RS system, Robots, AGV and conveyor belt.
8	Study of Flexible Manufacturing system and practice programming of integration of various components of FMS namely CNC machines, AS/RS system, Robots, AGV and conveyor belt.
9	To model a part using CAD software (Solidwoks/NX Academia) and generate tool path using GrabCAD for 3D printing.
10	To prepare CAD model for an assembly using CAD software (Solidwoks/NX Academia) and generate tool path using GrabCAD for 3D printing.

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

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3MIM2-11: ENTERPRISE RESOURCE PLANNING

SN	Contents	Hours
1	Introduction: To understand the business processes from areas such as sales, marketing, procurement, manufacturing, and accounting and to demonstrate how ERP system can support and optimize the inherent business processes. To learn how to manage the supply chain of a company using an ERP system in simulated, real-time environment and understand E-commerce and decision making process.	1
2	Introduction to ERP systems and understanding of business Processes (Procure to pay and Order to Cash) connection between business processes and ERP systems.	2
3	Business Process Reengineering and Enterprise Resource Planning Systems, Implementation and Evaluation of ERP systems, Integrated Business Processes, various modules viz: Sales and Marketing, Accounting and Finance, Production and Materials Management, Human Resources,	4
4	Project Systems, Customer Service; Managing an ERP Project, ERP Life Cycle, Case Studies. ERP Implementation : Gap Analysis, Hidden Cost, Vendors, Consultants, Human Resource. Post Implementation Phases: Re-Engineering, Configuration, Implementation, Team Training, Testing, Going Live and End User Training, Post Implementation (Maintenance Mode).	5
5	Introduction: E-commerce, Business Analytics, Business Models and Strategic Analysis, Business Analysis & technical Analysis. Technology Infrastructure for E-commerce, E-commerce Security and Payment Business. Concepts and Social Issues in E-commerce, E-marketing, E-commerce Policies and IPR.	5
6	E-service B2B, E-commerce and Supply Chain, Auctions in E-commerce Portals and Online Communities Digital Products/Media. Enterprise integration architecture: Overview - Current integration architecture assessment - Service integration architecture - Information integration architecture - Process integration architecture, enterprise integration solutions - Application integration - Information integration.	6
7	Enterprise Integration: enterprise integration drivers, requirements and strategies - The business imperative for enterprise integration - Business drivers and requirements - Enterprise integration strategy, Introduction to Blockchain Technology, Cryptocurrency, Industry 4.0	6
9	ERP and E-commerce: Future Directives in ERP, ERP and Internet, Critical Factors Guiding Selection and Evaluation of ERP, Strategies for Successful ERP Implementation, Critical Success Factors in ERP Implementation, Failure Factors in ERP Implementation, Integrating ERP into Organisation.	6
Total		40

TEXTBOOK

1	Alexis Leon ERP Demystified 3 Edition (Paperback) Tata McGraw - Hill Education, 2014.
2	Jagan Vaman Nathan ERP in Practice: ERP Strategies for Steering Competence & Competitive Advantage 1st Edition (Paperback) Tata McGraw Hill Education 2007.

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REFERENCE BOOKS	
1	Glynn C. Williams Implementing SAP ERP Sales and Distribution 1 Edition, TMH
2	Janice Reynolds(2000), The complete E-commerce book, Google book publisher
3	Dave Chaffey(2002), E-business and E-commerce Management, 2006, PHI.
4	Don Tapscott, and Alex Tapscott, Blockchain Revolution, ISBN-13: 978-0241237854, Portfolio Penguin Publishers

3MIM2-12: INDUSTRY 4.0

SN	Contents	Hours
1	Introduction: This course is designed to offer learners an introduction to Industry 4.0 (or the Industrial Internet), its applications in the business world. Learners will gain deep insights into how smartness is being harnessed from data and appreciate what needs to be done in order to overcome some of the challenges.	1
2	Introduction to Industry 4.0 ,The Various Industrial Revolutions, Digitalisation and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, The Journey so far: Developments in USA, Europe, China and other countries,	6
3	Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.	6
4	Road to Industry 4.0 : Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services, Smart Manufacturing, Smart Devices and Products, Smart Logistics, Smart Cities, Predictive Analytics.	6
5	Related Disciplines, System, Technologies for enabling Industry 4.0, Cyberphysical Systems, Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Mobile Computing, Related Disciplines, Cyber Security.	7
6	Role of data, information, knowledge and collaboration in future organizations, Resource-based view of a firm, Data as a new resource for organizations, Harnessing and sharing knowledge in organizations, Cloud Computing Basics, Cloud Computing and Industry 4.0	7
7	Business issues in Industry 4.0, Opportunities and Challenges,2 Future of Works and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world	7
	Total	40

TEXTBOOK	
1	Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, 2017, Apress
2	Ustundag, Alp, Cevikcan, Emre, Industry 4.0: Managing The Digital Transformation, Springer Publications

REFERENCE BOOKS	
1	Christoph Jan Bartodziej, The Concept Industry 4.0 An Empirical Analysis of Technologies and Applications in Production Logistics, Springer Gabler
2	Journal Articles, NIST templates and IEEE Standards, Industry 4.0 Standards, Industrial IOT Standards, Reports

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3MIM2-13: INNOVATION AND ENTREPRENEURSHIP FOR ENGINEERS

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



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TEXTBOOK	
1	Entrepreneurship development small business enterprises, Poornima M Charantimath, Pearson.
2	Understanding Patent Law, Vishnu S. Warriar, LexisNexis.
REFERENCE BOOKS	
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	Entrepreneurship 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