NATIONAL INSTITUTE OF TECHNOLOGY, HAMIRPUR (HP) – 177 005

B.Tech. Mechanical Engineering, Third Year [6th Semester]

Sr. No.	Course No.	Subject	L	T	P	Hours	Credits
1.	[ME-361]	Automobile Engineering	4	0	0	4	4
2.	[ME-362]	Machine Design	4	0	0	4	4
3.	[ME-363]	Computer Aided Manufacturing	4	0	0	4	4
4.	[ME-364]	Operations Research	3	1	0	4	4
5.	[ME-365]	Product Life Cycle Management	3	1	0	4	4
6.	[ME-360]	Open Elective	3	0	0	3	3
7.	[ME-366 (P)]	Automobile Engg. Lab.	0	0	2	2	2
8.	[ME-363 (P)]	CAM Lab.	0	0	2	2	2
					Total =	27	27

Open Elective – II [ME-360]

   (a) Energy Conservation and Maintenance

   (b) Computer Graphics and Rapid Prototyping

   (c) Noise Control

   (d) Element of Mechanical Engineering

   (e) Product Design and Value Engineering

   (f) Production Planning and Control

AUTOMOBILE ENGINEERING

ME –361
                                                                   L   T   P   Cr
                                                                    4   0   0   4

1. **INTRODUCTION** : Components of an automobile, the basic structure, power plant, transmission system, auxiliaries, controls, superstructure, classification of automobiles, car body styles.

2. **THE CHASIS CONSTRUCTION**: Conventional construction, sub frames, defects in frames, frameless construction, vehicle dimensions.

3. **CLUTCHES**: Requirements of clutch, principle of friction clutches, dry friction clutches, clutch components, clutch plate, clutch facing, other clutch components, types of clutches-single plate, multi plate, semi centrifugal and centrifugal, clutch operation, wet clutch, Clutch trouble shooting.

4. **TRANSMISSION**: Necessity of transmission, functions of transmission, types of transmission, manual transmission, sliding mesh gear box, constant mesh gear box, synchromesh gear box, selector mechanism, transfer box, automatic transmission, epicyclic gear box, principle of automatic transmission.

5. **PROPLER SHAFT AND REAR BOX**: Propeller shaft, universal joints, final drive, differential rear axle, rear axle drives, rear axle shaft supporting, rear axle casing, improvements in four wheel drive.

6. **SUSPENSION SYSTEM**: Objects of suspension, basic requirements, function of suspension springs, types of suspension springs, leaf springs, torsion bars, rubber springs, plastic suspension, shock absorbers, independent suspension, stabilizer or anti-roll device, air suspension, hydraulic suspension, suspension system trouble shooting.

7. **FRONT AXLE AND STEERING**: Front axle, factors of wheel alignment, factors pertaining to wheels, steering geometry, correct steering angle, steering mechanisms, cornering force, self-righting torque, understeer and oversteer, steering linkages, steering gears, steering ratio, reversibility, power steering, advanced steering systems, steering trouble shooting.

8. **WHEELS AND TYRES**: Types of wheels, wheel dimensions, tyre, desirable tyre properties, types of tyres, carcass types, comparison of radial and bias-ply tyres, tyre materials, considerations in tread design, tyre selection, tyre designations, factor affecting tyre life, precautions regarding the tyres.

9. **BRAKES**: Principle, braking requirements, brake efficiency and stopping distances, fading of brakes, weight transfer, wheel skidding, types of brakes, drum brakes-brake shoes, brake linings, disc brakes, mechanical brakes, hydraulic brakes, brake fluid, electric brakes, engine exhaust brakes, air brakes, hand brake, hill holding device, bleeding of brakes.

10. **BODY AND SAFETY CONSIDERATIONS AND MODERN DEVLOPMENTS IN AUTOMOBILES**: Requirements of automobile body, materials for body work, rust protection, safety considerations, crash worthiness, MPFI, CRDI, TDCI Systems, ABS Systems.

RECOMMENDED BOOKS

1. Automobile Engineering Vol. I & II   Kirpal Singh, Standard Publishers, Delhi
2. Automotive Mechanics   Joseph Heitner, East West Press, Delhi
3. Automotive Mechanics   Crouse, TMH, Delhi
4. Automobile Engineering   R.B. Gupta, Satya Prashan, New Delhi
5. Automobile Engineering   R.K.Rajput, Luxmi Publications, New Delhi
6. Automobile Engineering   K.M.Gupta, Luxmi Publications, New Delhi.

MACHINE DESIGN

ME – 362
               L   T   P/D   Cr
               4   0   0   4

1. **DESIGN PRINCIPLES**: Mechanical Engg. Design, phases of Design, design considerations, factor of safety, stress concentration, methods of reducing stress concentration, Notch sensitivity, Types of loading, Fatigue, Cyclic stresses, Fatigue Strength, S.N. Curves, Endurance limit & modification factors, Determination of fatigue strength, Soderberg's line for design, Goodman's line for design, Gerber's curve for design.

2. **DESIGN OF PERMANENT JOINTS**: Riveted joints, welded joints.

3. **DESIGN OF SPRINGS**: Closed and open coiled springs, strength and stiffness, optimum design of helical springs, helical torsion springs, leaf springs, Helical springs of non-circular wires.

4. **DESIGN OF SHAFTS**: Design of circular shafts under pure torsion, shear stress, solid and hollow shafts, design of shafts for strength and deflection, Combined loading due to torsion and bending of shafts, principal stress and maximum stress, equivalent bending moment and twisting moment.

5. **DESIGN OF GEARS**: Nomenclature of Spur, Helical, Bevel, and Worm gears, Lewis equation and Lewis form factors, velocity factors, working stress in gear teeth dynamic loads on gear teeth design of gears for wear.

6. **DESIGN OF I.C. ENGINE PARTS**: Design of cylinder, piston, connecting rod and crankshaft.

7. **BALL AND ROLLER BEARING**: Types, static life, Static and dynamic load capacity, Equivalent Dynamic Load, selection of bearings.

8. **JOURNAL BEARINGS**: Introduction to lubrication, Types of Lubrication, Reynolds equation, Operating and Performance parameters, Hydrodynamic bearings: Thrust pad and Journal bearing, Sommerfeld number, L/d ratio, clearance ratio, minimum film thickness, design procedure for Thrust and Journal Bearings, Contamination in lubricating oil, bearing materials, hydrostatic bearings.

RECOMMENDED BOOKS
1. Mechanical Engineering Design   Shigley & Mischke
2. Machine Design, An integrated approach   Norton
3. Fundamentals of Machine Component Design   Juvinal & Marshek
4. Machine Design   Pandya & Shah
5. Machine Design   Patel, Sikh & Pandya
6. Design of M/c Elements   V.B.Bhandari
7. Fundamentals of Machine Elements   Hamrock, Schmid & Jacobson
8. Machine Design   Sadhu Singh
9. Machine Design   R.K.Jain

HAND BOOKS
1. Design Data Book   PSG College of Technology Coimbatore.
2. Handbook of properties of Engineering Materials & Design   Abdulla Shariff.
    Data for Machine Elements
3. Hand Book of Mechanical   Design Maitra
4. Design Data Book   Mahadevan

****

COMPUTER AIDED MANUFACTURING

ME – 363   L   T   P/D   Cr
                                                                 4   0   0   4

1. **INTRODUCTION**: Historical background, role of computers in manufacturing, automation, Types of automation, Automation strategies.

2. **NUMERICAL CONTROL IN CAM**: Introduction, fundamentals of NC, Need of NC machine tool, Elements of NC machine tools, Axes of NC machines, NC machine tools, tooling for NC machines, Steps in NC manufacturing, advantages of NC system, applications of NC systems, economic of NC manufacturing, machining centers.

3. **COMPUTER NUMERICAL CONTROL**: Principle of operation of CNC features of CNC systems, development in CNC systems, adaptive control, direct numerical control (DNC), standard communication interfaces, programmable logic controllers (PLCs), communication networks, configuration of CNC system.

4. **CNC PART PROGRAMMING**: Introduction, Manual part programming: structure and format of part program NC programming codes, programming for two axis control system, programming for three axis control system, Computer aided CNC part programming: Need of Computer aided part programming, computer aided Part Programming languages: Automatically programmed tools programming (APT) and Compact-II, CAD/CAM-Based part programming.

5. **INTRODUCTION TO ROBOT TECHNOLOGY IN CAM**: Group Technology and Cellular manufacturing: Introduction, Part families, parts classification and coding, production flow analysis, machine cell design, Computer aided process planning (CAPP): Types of process planning system, Advantages of CAPP.

6. **COMPUTER AIDED QUALITY CONTROL (CAQC)**: Use of computers in QC, Computer aided inspection (CAI): contact inspection methods, non contact inspection, in process gauging, online inspection and quality control, Machine Vision system, Computer aided testing (CAT).

7. **FLEXIBLE MANUFACTURING SYSTEM**: Introduction to FMS (building blocks of FMS), different types of flexibilities in FMS, type of FMS, Machining system of FMS, Tool management systems, work piece handling system, FMS Control, Lay out considerations in FMS Advantages of FMS. Introduction to computer integrated manufacturing systems (CIMS), the future automated factory; trends in manufacturing, human factors in future automated factory, the social impact.

RECOMMENDED BOOKS
1. Automation: Production Systems & CAM   Groover, Eaglewood
2. An introduction to Automated Process Planning   Chand & Wysk , T.K.Kundra
3. System approach to Computer Integrated Design and   Nanua Singh
    Manufacturing
4. FMS   R.Maleki
5. CNC Machines   Pabla, BS & Adinathan
6. CAD/CAM   Suresh Dalela & PK Jain.

****

OPERATIONS RESEARCH

ME – 364

L	T	P/D	Cr
4	0	0	4

1. **INTRODUCTION**: Nature and development of operation research, some mathematical preliminaries, general methodology of operation research, application of operation research to industrial problems, a survey.

2. **LINEAR OPTIMIZATION MODELS**: Formulation of linear programming deterministic models; graphical solution; simplex algorithm, computational procedure in simplex, duality and its concept, dual linear programming, appl1cation of simplex technique to industrial problem.

    Assignment Models; formulation of assignment problems, methods for solutions; transportation problems; methods for obtaining optimal solution; degeneracy in transportation problems; transshipment problems.

3. **GAME PROBLEMS**: Introduction and scope of game problems in business and Industry; Mini-max criterion and optimal strategy, solution of two person zero sum game; game problem as a special case of simplex.

4. **NET WORK TECHNIQUES**: Basic principles of network construction, CPM/PERT and solution of simple problems.

5. **QUEING PROBLEMS**: Queuing systems and concepts; classification of queuing situations; solution of queuing problems, single channel, single stage, finite and infinite-queues with Possion arrival and exponential service time; applications to industrial problems, simulation techniques.

6. **SEQUENCING MODELS**: Processing of 'n' jobs through two machines, processing of 'n' jobs through three machines, processing of 'n' jobs through 'm' machines.

BOOKS RECOMMENDED
1. Operation Research   Hira Gupta.
2. Operation Research   Loomba
3. Operation Research   H.A.Taha.
4. Fundamentals of Operation & Research   AC Koff & Sasiene
5. Linner Programming   L.S.Srinath.

****

PRODUCT LIFE CYCLE MANAGEMENT

ME – 365

L	T	P	Cr
3	1	0	4

1. Product Life Cycle Management: - Need for PLM, Components of PLM, Product Data and Product workflow, Drivers for Change.

2. The PLM Strategy, Developing a PLM Strategy, A Five-step process.

3. Strategy Identification and Selection Strategy Elements, Implications of Strategy Elements, Policies, Strategy Analysis, Communicating the Strategy.

4. Change Management for PLM, Configuration management, cost of design changes, schemes for concurrent engineering.

5. Design for manufacturing and assembly, robust design, failure mode and effect analysis.

6. Modeling, Current concepts, part design, sketching, use of datum's construction features, free ovulation, pattering, copying and modifying features, reference standards for datum specification, Standards for Engineering data exchange.

7. Tolerance mass property calculations, rapid prototyping and tooling, finite modeling and analysis, general procedure, analysis techniques.

8. Finite element modeling. Applicability of FEM, Static analysis, thermal analysis, dynamic analysis.

REFERENC E BOOKS:

1. John Stark, Springer-Verlag," Product Lifecycle Management Paradigm for 21st century Product Realization", London, 3rd printing (2006).441pp. ISBN 1-85233-810-5.
2. Zeid, "CAD/CAM Theory and Practice", Mc Graw Hill.,1991
3. Mark Henderson & Philip Wolfe, "Computer Integrated Design and Manufacturing", Bedworth Mc Graw hill inc., 1991.
4. Engineer, "Part modeling Users Guide", 1998.

****

ENERGY CONSERVATION AND MAINTENANCE

ME – 360 (a)	L	T	P	Cr
	3	0	0	3

1. **ENERGY MANAGEMENT**: Concept of energy management, energy demand and supply, economic analysis; Duties and responsibility of energy managers.

2. **ENERGY CONSERVATION**: Basic concepts, Energy conservation in household, transportation, agricultural, service and industrial sectors, Lighting, HVAC systems.

3. **ENERGY AUDIT**: Definition, need, and types of energy audit; Energy management (audit) approach: Understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements; Fuel & energy substitution; Energy audit instruments; Energy Conservation Act; Duties and responsibilities of energy managers and auditors.

4. **MATERIAL AND ENERGY BALANCE**: Facility as an energy system; Methods for preparing process flow; material and energy balance diagrams.

5. **ENERGY ACTION PLANNING**: Key elements; Force field analysis; Energy policy purpose, perspective, contents, formulation, ratification; Organizing the management: location of energy management, top management support, managerial function, roles and responsibilities of energy manager, accountability; Motivation of employees: Information system-designing barriers, strategies; Marketing and communicating: Training and planning.

6. **ENERGY CONSERVATION IN PLANT SERVICE SYSTEMS**: Centrifugal pumps: Energy consumption & saving potentials; Design consideration minimizing over design; Case studies Fans & Blowers: Specification, safety margin, choice of fans-controls, design considerations. Air compressor & compressed air systems: Selection of compressed air layout, Design consideration. Refrigeration & Air conditioning: Heat load estimation, methods of minimizing heat loads, optimum selections of equipments; Case studies, Energy conservation in cooling towers & spray ponds; Case studies.

7. **THERMAL ENERGY MANAGEMENT**: Energy conservation in boilers, steam turbines and industrial heating systems; Application of FBC; Cogeneration and waste heat recovery; Thermal insulation; Heat exchangers and heat pumps; Building Energy Management.

RECOMMENDED BOOKS

1.	Energy Management Principles	C B Smith
2.	Energy Auditing and Conservation; Methods, Measurements, Management & Case Study	Hamies
3.	Energy Management and Conservation	D Patrick & S W Fardo
4.	Heating and Cooling of Buildings: Design for Efficiency	J.Krieder & A.Rabi
5.	Principles of Energy Conservation	Archie, W Culp
6.	P. Energy Management	O'Callaghan

****

COMPUTER GRAPHICS AND RAPID PROTOTYPING

ME- 360 (b)

L	T	P/D	Cr
3	0	0	3

1. **INTRODUCTION AND OVERVIEW OF GRAPHICS SYSTEMS**: Computer-aided design, Presentation Graphics, Computer art, entertainment, education and training, visualization, image processing, graphical user interfaces, Video display devices, Raster scan systems, Random scan systems, Graphics monitors and workstation, Input devices, hard copy devices, graphics software.

2. **OUTPUT PRIMITIVES**: Point, and lines, line drawing algorithms, loading the frame buffer, line function, circle generating algorithm, ellipse generating algorithms, other curves, pixel addressing, filled area primitives.

3. **ATTRIBUTES OF OUTPUT PRIMITIVES**: Line attributes, curve attributes, area fill attributes.

4. **TWO-DIMENSIONAL GEOMETRIC TRANSFORMATIONS**: Two-dimensional translation, rotation, scaling, matrix representation and homogeneous co-ordinates, composite transformations, other transformations-reflection, shear transformation between co-ordinate systems.

5. **TWO DIMENSIONAL VIEWING**: The viewing pipeline, viewing co-ordinate reference frame, window to viewport coordinate transformations, clipping operations, point clipping, line clipping, polygon clipping.

6. **THREE DIMENSIONAL GEOMETRIC AND MODELING TRANSFORMATION**: Translation, rotation, scaling, reflection, shear, composite transformations, three-dimensional modeling and co-ordinate transformations.

7. **RAPID PROTOTYPING**: Details/methods of Rapid prototyping, Basic principles of RP, Different RP Techniques, Advantages of RP, CAD modeling, CAE Analysis

RECOMMENDED BOOKS
1. Computer Graphics   Hearn & Baker
2. Geometric Modeling   Vera B. Anand

****

NOISE CONTROL

ME – 360 (c)
          L   T   P   Cr
          3   0   0   3

1. **INTRODUCTION**: Fundamentals of vibration, vibration of membranes and plates, Acoustic wave equation, acoustic energy and sound Intensity, Propagation of sound.

2. **ACOUSTIC WAVES**: Elastic behavior of fluids, Plane wave equation, Velocity of sound in fluids, Energy density of Plane waves, Acoustic density, Decibel scales, Transmission phenomenon, spherical acoustic wave.

3. **RESONATORS AND FILTERS**: Helmholtz Resonator, Acoustic impedance, Reflection of waves in pipe, Expansion chamber type of filters.

4. **SPEECH, HEARING, AND NOISE**: Mechanism of hearing, Thresholds of ear, Loudness.

5. **ARCHITECTURAL ACOUSTICS**: Sound intensity in a Live room, Decay of sound, Measurement of Reverberation time, Sound absorption coefficients, Sound absorbing materials for noise reduction.

6. **NOISE ENGINEERING**: Machinery Noise, Reduction of Noise, Reduction of noise and its control, Design for less noise, Enclosures, Silencers, barriers etc. Noise control in industry, Addition of Sound levels, Calculation of SPL.

7. **NOISE MEASUREMENTS**: The range of quantities encountered in Sound, Decibel scale. Frequency / octave bands, Microphones, Sounds Level Meter, Frequency analyzers, fault detection from noise analysis, Diagnostic Maintenance, Measurement environment, Anechoic chamber.

RECOMMENDED BOOKS
1. Mechanical Vibrations   G.K.Grover,
2. Vibration Theory & Applications   W.T.Thomson
3. Vibration & Noise for Engineers   K.K.Pujara & R S Pujara
4. Fundamentals of Acoustics   Kinsler & Frey
5. Acoustics of Ducts and Mufflers   Munjal
6. Noise and Vibration Control Engineering   Beranek
7. Noise Pollution and Control Strategy   Singal
8. Mechanical Vibrations and Noise Engineering   Ambekar

****

ELEMENTS OF MECHANICAL ENGINEERING

ME – 360 (d)   L   T   P/D   Cr
                                                               3   0   0   3

1. **INTRODUCTION**: Plain motion, kinematic concepts of links; basic terminology and definitions; inversion of kinematic chain, Chebyshev spacing of precision points, Absolute and relative motion, instantaneous centers, velocity and acceleration polygons.

2. **POWER TRANSMISSION and FRICTION DEVICES**: Flat belts, V-belts, length of belts, transmission of power by belts, condition for maximum power transmissions, initial tension, Coulomb friction, pivots and collars, power screws.

3. **GOVERNORS**: Functions, Difference between Governor and Flywheel, Various Terms Used, Types of Governor- Watt, Porter, Proell & Hartnell; Inertia Governor, Sensitiveness and Stability of Governor; Isochronous Governor, Hunting, Effort and Power of a Porter Governor, Controlling Force Diagrams For Porter and Spring Controlled Governor, Coefficient of Insensitiveness.

4. **SIMPLE STRESSES AND STRAINS**: Types of stresses and strains; Factor of safety; Thermal Stress & Strain, Stresses on oblique plane under biaxial loading, biaxial stresses combined with shear stresses, Principal stresses and planes, Determination of Principal stresses, Mohr's circle-biaxial state of stress accompanied with shear stress.

5. **COMPRESSOR**: Classifications, single and multistage reciprocating compressor, effect of inter cooling, volumetric efficiency.

6. **STEAM GENERATORS and TURBINE**: Classification and description of generators, Position of steam turbine in power industry; types and application. Impulse turbine; pressure and velocity compounding; velocity diagram; work output, losses and efficiency, Reaction turbines, velocity diagram, Degree of reaction, work output losses and efficiency, Governing of turbine.

7. **HYDRAULIC TURBINES**: Classification, Euler's equation for turbines, velocity triangle for single stage axial and radial machines, Impulse and reaction turbines, Pelton, Francis & Kaplan turbine. Power and efficiency calculations, draft tube, cavitation, water turbine governing.

RECOMMENDED BOOKS
1. Machines and Mechanisms   David H. Myszka
2. Theory of Machines   Sarkar
3. Theory of Machines   S. S. Rattan
4. Theory of Machines   Abdulta Sharif
5. Turbo Machine   Shephard
6. Turbines, Compressors & Fans   Yahya
7. Hydraulic Machines   J. Lal
8. Strength of Material   Timoshenko
9. Strength of Material   Sadhu Singh

****

PRODUCT DESIGN & VALUE ENGINEERING

ME – 360 (e)   L   T   P/D   Cr
                                          3   0   0   3

1. **INTRODUCTION**: Introduction to Product Design, Design by Evolution and Innovation, Essential factors of product design, Production consumption cycle, Flow and value addition in Production consumption cycle.

2. **FUNCTIONAL & AESTHETICS CONSIDERATION**: Basic design considerations, Role of Aesthetics in product design, Basic concept and elements of Visual design, Functional design practice.

3. **MANUFACTURING CONSIDERATION**: Producibility Requirements in the design of machine components, Forging design, Pressed component design, Design for machining, Ease of location and Clamping, Some additional aspects of production design, Design of powder metallurgical parts, Redesigning on basis of production consideration.

4. **VALUE ENGINEERING**: Concept of value, cost and price, customer and value, philosophy and objectives of value analysis, types of value, areas of application of value engineering, limitations of value analysis, difference between value engineering and cost reduction techniques; Tool of technology in value analysis, method & engineering, cause and effect diagram, SWOT analysis, break even analysis, systems approach; Job plan for value analysis approach: Information phase, Function Phase, Creation Phase, Evaluation Phase, Recommendation Phase, Implementation Phase, Audit Phase; Value Engineering Cell, value manual, composition of cell, Cost cutting, various cost cutting techniques; Case studies in value engineering and analysis from manufacturing and service industries.

RECOMMENDED BOOKS

1. Product Design and Development   Kail T. Ulrich & Steven D. Eppinger
2. Product Design and Engineering   A.K. Chitale & Gupta
3. Product Design and Process Engineering   Niebel & Draper
4. Design of Systems and Devices   Middendorf Marcel Dekker
5. Value Engineering SAVE   Mudge
6. Techniques of Value Analysis and Value Engineering   Miles Lawerence
7. Value Engineering in Manufacturing   ASME
8. Value Engineering Theory   Parker, D.E.

****

PRODUCTION PLANNING AND CONTROL

ME – 360 (f)

L	T	P	Cr
3	0	0	3

1. **INTRODUCTION**: Types and Characteristics of Production Systems – (i) Continuous or Process Production (ii) Mass Flow Line Production. PPC Phases – Planning Phase, Action Phase, Control Phase, Implications for Production planning & Inventory Control.

2. **FORECASTING**: Definition and Concept, Purpose of Sales Forecasting, Basic elements of sales forecasting, Techniques of Forecasting – Time Series Analysis ; Delphi Method, Forecasting by moving average, Weighted Moving Average, Exponential Smoothening, Correlation Analysis and Linear Regression Analysis.

3. **INVENTORY CONTROL & MANAGEMENT**: Inventory Control, Types Of Inventory, objectives of Inventory Control, Economic Order Quantity (EOQ) Inventory Models, ABC Analysis – Need and Procedural Steps: Material Requirement Planning (MRP) – Function – Inputs to MRP, Bill of Material (BOM).

4. **PROCESS PLANNING**: Introduction and Concept, Information Required to Process Planning, Process Planning Procedure, Make or Buy decisions, Process Analysis, Process chart – Outline and Symbols, Automated Process Planning – Computer Assisted Process Planning (CAPP), Group Technology (GT).

5. **PRODUCTION SCHEDULING**: The Production Environment, Controlling Continuous Production, Sequencing and Line Balancing Methodologies, Master Production Schedule (MPS) – Managing the Master Production Schedule, Maintenance of MPS – Scheduling in Manufacturing Systems – Conventional & Flexible Systems.

6. **SUPPORTING PPC ACTIVITIES**: Enterprise Resource planning (ERP) – Objective and Advantages of ERP, Supply Chain Management (SCM) – Definitions, Need, SCM Models, Concept of Lean Manufacturing (LM) and Just in time (JIT) in Production Systems.

RECOMMENDED BOOKS
1. Production Planning b& Inventory Control   Seetharama L et. al
2. Production & Operation Management   N. Gaither Dryden
3. Material Management System   R.J.Brown
4. Decision Support for Inventory Management & Production Planning   Peterson & Surer

****