UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY, CHENNAI – 600 025.

REGULATIONS – 2013

I TO IV SEMESTERS CURRICULA AND SYLLABI

M. TECH. FOOTWEAR SCIENCE AND ENGINEERING (FULL TIME)

SEMESTER I

COURSE CODE	COURSE TITLE	L	T	P	C
FW8101	Anatomy and Solid Modelling of Foot	3	0	0	3
FW8102	Materials Science	3	0	0	3
FW8103	Technology of Footwear Manufacture	3	0	0	3
MA8162	Applied Mathematics	3	1	0	4
	Bridge course Elective	3	0	0	3
PRACTICAL					
FW8111	Footwear Fabrication - I	0	0	6	3
	TOTAL	**15**	**1**	**6**	**19**

SEMESTER II

COURSE CODE	COURSE TITLE	L	T	P	C
FW8201	Footwear Chemicals and Polymers	3	0	0	3
FW8202	Footwear Components and Accessories	3	0	0	3
FW8203	Footwear Machinery	3	0	0	3
FW8204	Technology of Speciality and non-Leather Footwear	3	0	0	3
	Elective I	3	0	0	3
PRACTICAL					
FW8211	Footwear Fabrication – II	0	0	6	3
FW8212	Testing of Footwear Materials and Products	0	0	4	2
	TOTAL	**15**	**0**	**10**	**20**

SEMESTER III

COURSE CODE	COURSE TITLE	L	T	P	C
	Elective II	3	0	0	3
	Elective III	3	0	0	3
	Elective IV	3	0	0	3
PRACTICALS					
FW8311	Project Work Phase – I	0	0	12	6
FW8312	Seminar	0	0	2	1
	TOTAL	**9**	**0**	**14**	**16**

SEMESTER IV

COURSE CODE	COURSE TITLE	L	T	P	C
FW8411	Project Work Phase – II	0	0	24	12
	TOTAL	**0**	**0**	**24**	**12**

Attested

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BRIDGE COURSE ELECTIVES

COURSE CODE	COURSE TITLE	L	T	P	C
FW8007	Mechanics of Machinery (For B.Tech Leather Technology students)	3	0	0	3
FW8013	Theory and Practice of Leather Manufacture (For B.E. Mechanical, Production, Industrial Engg. Students)	3	0	0	3

LIST OF ELECTIVES

COURSE CODE	COURSE TITLE	L	T	P	C
FW8001	Computational Methods and Computer Graphics	3	0	0	3
FW8002	Computer Aided Design and Manufacture for Footwear	3	0	0	3
FW8003	Financial Management	3	0	0	3
FW8004	Gait Analysis@	3	0	0	3
FW8005	Industrial Relations and Labour Laws	3	0	0	3
FW8006	Leather product design Methodology@	3	0	0	3
FW8008	Modern Footwear Styling	3	0	0	3
FW8009	Organisation and Management of Footwear Sector	3	0	0	3
FW8010	Pedorthic Footwear@	3	0	0	3
FW8011	Quality Control Management in Footwear Industries	3	0	0	3
FW8012	Safety in Footwear Industry	3	0	0	3
CL8120	Total Quality Management	3	0	0	3
MG8071	Operations Research	3	0	0	3

@ - Special Electives for M.S./Ph.D. programmes; Approved in 16th AC 02.12.2010
* - Students will be encouraged to choose appropriate elective courses offered by other departments from Faculty of Technology

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FW8101 ANATOMY AND SOLID MODELLING OF FOOT L T P C
3 0 0 3

UNIT I ANATOMY OF HUMAN FOOT 9

Lower limb - bones, muscles, nerves and fascia, their functions in structural stability (static & dynamic) muscles in helping in walking, muscle relate to limb functions like flexion, extension, etc. Science in Shoe Design.

UNIT II GROWTH AND DEFORMITIES 7

Growth of foot from infancy to maturity, arches of foot, relationship between foot shape and last. Different types of foot deformities like PesCavus, Valgus, Blisters, Gangrene, injuries in sports, methods of prevention etc footcare and protection.

UNIT III BIO MECHANICS 7

Free body diagram, analysis - biomechanics of walking, running and other sports. Types of forces - friction, moments.

Gait analysis and foot comfort - gait patterns, pressure distribution etc. in case of normal and abnormal feet.

UNIT IV ESSENTIALS OF THERAPEUTIC FOOTCARE 7

Footwear Criteria to address foot problems; comfort Elements; Principles of protective footwear; Common features of therapeutic footwear.

UNIT V SOLID MODELLING 15

Basic principles of solid modelling and surface modelling using contours and geometry.Use of solid modelling in designing and developing modern footwear.

Introduction to Foot Anthropometry; Design of anthropometric foot surveys; Data collection and Statistical Analysis of foot data; Establishment of Sizing systems.

Lasts: Different measurement of feet and lasts - methods, units, sizing systems such as English, French, American, German, Japan Mondo-point their conversion and comparison. Materials for last making, manufacturing technique. Model development.

Principles of grading - Manual, machine and computer grading.

TOTAL : 45 PERIODS

REFERENCES

1. Hollinshead, H., “Text book of Anatomy”, Oxford IBH London 1967.
2. Morton, D.J., “The Human Foot”, Hafner Publishing Co., New York, London, 1964.
3. Thornton, J.H., “Text book of Footwear Manufacture”, National Trade Press Ltd., London, 1970
4. Edwards, C.A., “Orthopaedic shoe technology”, Precision Printing Co., Indiana, 1964.
5. Whittle, M., “Gait Analysis: An introduction,” butterworth – Heinemann Publication, 2002.
6. Vincent G Duffy, “Digital Human Modelling”, Springer, July 2011.

FW8102 MATERIALS SCIENCE L T P C
3 0 0 3

UNIT I ADVANCED MATERIALS 12

Smart materials, ferroelectric, piezoelectric, optoelectric, semiconducting behavior, lasers and optical fibers, photoconductivity and superconductivity, nanomaterials, superalloys, hapememory alloys.

UNIT II MECHANICAL PROPERTIES 12

Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, tensile strength, toughness, elongation, plastic deformation, viscoelasticity, hardness, impact strength, creep, fatigue, ductile and brittle fracture.

UNIT III HERMAL PROPERTIES 5

Heat capacity, thermal conductivity, thermal expansion of different materials.

UNIT IV OPTICAL PROPERTIES 5

Reflection, refraction, absorption and transmission of electromagnetic radiation of different materials.

UNIT V CHARACTERISATION OF MATERIALS 11

Outline of spectroscopy methods, x-ray diffraction, electron microscopy, optical microscopy and applications to material characterization and Identification of polymeric materials, glass transition in polymers, methods of measuring it.

TOTAL : 45 PERIODS

REFERENCES

1. Callister, W.D.,Fundamentls of Materials Science and Engineering, Wiley, 2007.
2. Ahuja, S. and Jespersen, N., "Modern Instrumental Analysis", Elsevier, 2006.
3. Kaufmann, E.N. Characterization of Materials, 2 Volume, Wiley 2003

FW8103 TECHNOLOGY OF FOOTWEAR MANUFACTURING L T P C
3 0 0 3

UNIT I DESIGN AND PATTERN DEVELOPMENT 7

History of shoe – purposes and styles – fashions & designs – selection criteria for last, Forming, conceptual design (Manual & Computer) - Grading Preparation of bottom and insole patterns – Preparation of standards and section for Men, Ladies & Children classic and other types of shoes and boots.

UNIT II CUTTING 6

Selection of materials – Layout preparation – Materials Economy - Principles of cutting – Hand, machine, Scope for automation, Standard time – Quality Control – Clicking room design and management. Fabric, rolls and sheet materials cutting technique.

UNIT III PRE-CLOSING & CLOSING 11

Checking incoming work, stitch making, skiving, punching and gimping, heat embossing, flow moulding, toe puff attachment, attaching linings and scrims, trimming linings, finishing off closed seams. Top line and other edge treatments, local reinforcements, attaching fasteners and trims Threads, needles, Seam and stitch types, preparing for stitching, Dealing with thread breakages, automatic stitching, working environment faults and remedies, Types of stitching machines

UNIT IV LASTING 9

Principles and methods of pre lasting and lasting operation – Manual and mechanical method.Effect of temperature, humidity and materials in lasting and making operations.Types of machinery and the principles involved in mechanical operations. Bottom stock preparation

UNIT V POST LASTING & FINISHING 11

Principles and methods of various post lasting and finishing operation ; Sole attaching – preparation of lasted margin, upper preparation, sole preparation, sole cementing, upper cementing, halogenations; bottom fillers and shanks adhesive drying, heat activation, spotting, pressing, last slipping, health and safety, quality control and fault finding problems- solving, recommended bonding systems. Shoe room technique ,packing and storing technique, Dress shoe, casual footwear, women footwear, work shoe .Ethnic footwear. Jodhpur boot and various boot. Safety footwear.

TOTAL : 45 PERIODS

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REFERENCES

1. Patrick, H.J., "Modern pattern cutting and design", Mobbs and Lewis Ltd., Kettering, England, 1983.
2. Lyon, D., "Modern approach to Footwear pattern cutting", 2nd Edn. 1979.
3. Thornton, J.H., "Text book of Footwear Manufacture", National Trade Press Ltd., London, 1970.
4. "Manual of Shoe Making" – Clarks Ltd. (London) 1978.
5. Wilhelm, A., "Tips for shoe production" Vol. I, II & III, Huthig Buch Verlag, Heidelberg, 1988.

MA8162 APPLIED MATHEMATICS L T P C
3 1 0 4

UNIT I TENSOR ANALYSIS 12

Tensor Algebra, Metric Tensor, Christoffel Symbols and covariant differentiation, Riemann-Christoffel Curvature Tensor, Cartesian Tensors

UNIT II FOURIER TRANSFORMS 12

Fourier Transforms, Complex, Sine and Cosine Transforms, Finite Fourier Transforms, Applications to heat conduction problems

UNIT III CALCULUS OF VARIATIONS 12

Simple variational problems with fixed boundaries, Euler`s equations, conditional extrema, Isoperimetric problems, Approximate solutions, Direct methods, Euler`s finite difference method, Ritz method

UNIT IV METHOD OF WEIGHTED RESIDUALS 12

Basics of variational principle, Applications to ordinary and partial differential equations, sub-domain method, Collocation method, least square method, Galerkin method

UNIT V QUALITATIVE ANALYSIS OF ORDINARY DIFFERENTIAL EQUATION 12

Stability of nonlinear systems, Elements of control Theory

TOTAL : 60 PERIODS

REFERENCES

1. Ramanaiah, G. T., "Tensor Analysis", S. Viswanatthan Pvt. Ltd., 1990.
2. Narayanan S, Manicavachagom Pillai T K and Ramanaiah G, "Advanced Mathematics for Engineering Students," Vol.III, S.Viswana, B. than Pvt. Ltd., 1990.
3. Finalyson A., "The Method of Weighted Residuals and Variational Principles", Academic Press, 1972.
4. Geo, S. G. and Raghavendra V, "Ordinary Differential Equations and Stability Theory", Tata McGraw Hill, 1980.
5. Pushpavanam S., "Mathematical Methods in Chemical Engineering", Prentice Hall of India.

FW8111 FOOTWEAR FABRICATION – I L T P C
0 0 6 3

UNIT I LAST 45

Central line drawing – Measurements – Design Insole pattern – Sole pattern – Forming – clotted, Fabric, Tape &Vaccum Method. Men's shoe standard and sction preparation (Derby, Oxford, Mocassins, Ankle boots, long boots etc.) Ladies & Children's standard and section preparation. Design of Toe-Puff, Stiffeners, Sock.

UNIT II UPPER PREPARATION 45

Leather Assortment – Grading – cuttability etc. Layout preparation on paper & leather.Leather consumption calculation; parallelogram and other methods.Hand and Machine cutting Fabric and other sheet materials; Layout; Preparation and cutting Pre Assemble operation Closing Operation.

TOTAL : 90 PERIODS

FW8201 FOOTWEAR CHEMICALS AND POLYMERS L T P C
3 0 0 3

UNIT I POLYMERIC MATERIALS FOR FOOTWEAR INDUSTRY 15

Definition and classification of polymers - Chemistry and mechanism involved in different polymerisation processes such as Stepwise, Addition, Ring opening, Free Radical polymerisations (Bulk, solution, suspension and emulsion polymerisations) – Copolymerisation - Anionic and Cationicpolymerisations.

ii. Chemistry & Technology involved in manufacturing of following polymeric materials : Natural & synthetic rubber PVC - Polystrene - PU, LDPE & HDPE Polypropylene - Nylon – EPDM-Polyesters - Polyamines - EVA-ABS - Acrylics - Fibre Reinforced Plastics - Poromerics / PVC or PU coated fabrics.

UNIT II MODIFICATIONS OF POLYMERIC MATERIALS FOR DIFFERENT FOOTWEAR COMPONENTS 10

i. Polymer Blending : High polymer blends - Plasticization – Other additives, fillers, Antioxidants, flame retardants, stabilizers, colorants and pigments - Post reactions of polymers

ii. Moulding techniques and equipment used in fabrication of polymer products such as : Injection moulding, calendering, Reaction Injection moulding (RIM), Blow moulding etc.

UNIT III PROPERTIES, SPECIFIC USES AND TESTING OF DIFFERENT POLYMER MATERIALS 8

Properties and test procedures for polymer materials such as rheological, mechanical, electrical, thermal, chemical and comfort -suitability of polymer materials for different components of footwear such as upper, lining, shank, insole, outer sole, heel, thread etc.

UNIT IV ADHESIVES 6

Adhesive formulations involving starch, glue, latex, rubber solutions, chloroprene, PU etc. - Properties of adhesives & their choice for different purposes and in construction as in DIP, DVP, cemented etc. Mechanism of adhesion.

UNIT V FOOTWEAR DRESSING CHEMICALS 6

Formulation of polymeric materials such as shoe polishes, upper dressings, glazing materials, lacquers, binders, resins - Properties and their application in footwear industry. Manufacture of shoe finishes.

TOTAL : 45 PERIODS

REFERENCES

1. Miles, D.C. and Briston, J.H., “Polymer Technology”,Temple Press, London, 1965.
2. Flory, P.R., “Principles of Polymer Chemistry”, Cornell University Press, Ithaca, New York, 1953.
3. Kaufman, H.S. and Falcetta, J.J., “Introduction to Polymer Science and Technology”, John Wiley & Sons, New York, 1977.
4. Harvey, A.J., “Footwear Materials and Process Technology”, LASRA Publications, New Zealand, 1982.

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FW8202 FOOTWEAR COMPONENTS AND ACCESSORIES L T P C
3 0 0 3

UNIT I COMPONENTS 9

Insole: Raw material - Kind of insoles: Leather Board of stock preparation - Board making. Heel: Injection moulded heels: mould design, raw materials selection - injection moulding and finishing.

UNIT II GRINDERIES AND CHEMICALS 13

Last: Raw material - Manufacture of wooden last, Plastic last and metal last.
Constitutents and Manufacture of fibreboards.Plastic back part insole and stiffener board. Shank, Raw Material - Wood, Fibre board Steel, combined wooden board or steel and board, manufacture technique.
Adhesive: Types of adhesives used in shoe making, raw materials - formulation and manufacture.
Grinderies: Metallic grinderies - tack, rivet and nails, wires - raw materials - sorting and polishing.

UNIT III FASTENERS 9

Fasteners: Threads, Lace Fabrics: Raw Material – Manufacture Technique and Finishing. Eyelets: Raw materials - designing and manufacturing processes.
Slide fasteners: Types of materials used in slide fasteners - manufacturing processes.

UNIT IV ACCESSORIES 5

Ornaments, embellishments, studs, methods of manufacture, moulding, electroplating and polishing.

UNIT V REINFORCEMENTS 9

Toe-puff and Stiffeners: Types of Toe-puff and stiffeners, manufacture techniques - Paint on liquids, impregnated fabrics, print on hot-melt resin, filmic. Recommended use. Non-metallic grinderies: Reinforcement tape - tape preparation - Vulcanization of adhesive. Fibre fastening, Velcro, etc.

TOTAL : 45 PERIODS

REFERENCES

1. Thornton, J.H., “Text book of Footwear Materials”, The National Trade Press Ltd., London, 1970.
2. Harvey, A.J., “Footwear Materials and Process Technology”, N.Z. Leather & Shoe Research Association, New Zealand,1982.

FW8203 FOOTWEAR MACHINERY L T P C
3 0 0 3

UNIT I HAND TOOLS,UPPER MAKING AND UNITSOLE MAKING MACHINES 8

Hand tools and machinery used in upper making and other auxiliaries operations – General constructions - Principles involved in their working - Power transmissions systems. The machinery: Pattern grading, clicking Press, splitting, skiving, edge-folding, stamp Marking, sewing, punching, crimping, eyeleting, Seam-rubbing and taping, thermo-cementing, Pre-forming, etc.

UNIT II MACHINES FOR SHOE –CONSTRUCTION 8

Machines used in cemented, stitch down, welted, string lasted, DVP & DIP and other types of construction. Principles involved in their working - trouble shooting and & preventive maintenance. Spare parts planning and inventing control.

UNIT III TRANSPORT SYSTEM

Different types of material handling system in footwear industry. Manual, semi-automatic and automatic conveyors.

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UNIT IV AUTOMATION IN FOOTWEAR MACHINES 11

Application of computer/microprocessor base footwear machine, principle and operation technique, safety measurements computerized controls, micro-processor links, and Robotics: concept and application, off line grading and nesting system, Die Less Cutting Systems. CAM for automatic stitching and other advance footwear machinery.

UNIT V MODULAR MANUFACTURING AND LAYOUT 14

Productivity improvements: scheduling, Simulation, Toyota and rink system and Lean manufacturing system.

Factors affecting plant location and construction of factory building for balancing the production line in footwear Industry. Application of Neural-network software in layout preparation.

TOTAL : 45 PERIODS

REFERENCES

1. Thornton, J.H, "Text Book of Footwear Manufacture", National Trade Press Ltd., London, 1970.
2. Blakeman, J., "An Introduction to applied Science for Boot and Shoe Manufacture", The Anglo American Technical Co.Ltd., London,1924.

FW8204 TECHNOLOGY OF SPECIALTY AND NON-LEATHER FOOTWEAR L T P C
3 0 0 3

UNIT I LASTING 5

Principles and methods of lasting for different types of construction – Manual and mechanical method.Effect of temperature, humidity and materials in lasting and making operations.Types of machinery and the principles involved in mechanical operations.Management of the lasting and making department.

UNIT II GOOD YEAR WELTED CONSTRUCTION 9

Principle of Good Year Welted construction; preparation of uppers; Insoles – Rib attaching – Sewing in welt sole attaching – Variation in the welted method. Finishing and machinery.

UNIT III STITCHDOWN AND OTHER CONSTRUCTION 11

Principle and methodology of Stitchdown Construction. Upper preparation- The machine & sewn method; Veldtschoen construction: Veldtschoen – Turnshoes& Little way method. California ,Sanfranscino, DVP and DMS.

UNIT IV SPORTS & MOULDED FOOTWEAR 11

Footwear's for sports .Relation between surface, activity and footwear. Materials and method of construction Preparation of uppers, sequence of operations, sponge rubber, moulded on slippers, soled rubber moulded on footwear, thermoplastic injection moulded on footwear, cellular polyurethane moulded on footwear, Health and Safety

UNIT V ORTHOPEDIC & THERAPEUTIC FOOTWEAR 9

Need of Pedorthic and anatomically-correction, friction reduction and comfort qualities, off loading technique, materials and construction, evaluation technique

TOTAL : 45 PERIODS

REFERENCES

1. Thornton, J.H., "Text book of footwear Manufacture", National Trade Press Book Ltd., London, 1970.
2. Skoggard, I.A., "Modern Shoe Making– Lasting", SATRA Publication, Sharpe,1996
3. Miller, R.G., "Manual of Shoe Making", Clarks Ltd., London, 1978

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FW8211 FOOTWEAR FABRICATION II L T P C
0 0 6 3

UNIT I LAST 15

Central line drawing – Measurements - Design Insole pattern - Sole pattern - Forming - slotted, Fabric, Tape & Vacuum Method. Men's shoe standard and section preparation (Derby, Oxford, Mocassins, Ankle boots, long boots etc.) Ladies & Children's standard and section preparation. Design of Toe-Puff, Stiffeners, Sock.

UNIT II 10

Practice in CAD/CAM and pattern grading using machine.

UNIT III UPPER PREPARATION 25

Leather Assortment - Grading - cuttability etc. Layout preparation on paper & leather. Leather consumption calculation: parallelogram and other methods. Hand and Machine cutting Fabric and other sheet Materials: Layout; Preparation and cutting Pre Assembly operation Closing Operation.

UNIT IV BOTTOM STOCK PREPARATION 20

Insole cutting - Sole cutting and cutting other sections/components. Leather/Rubber Sole preparation - Heel attaching - Heel treatment - Edge Treatment - Finishing.

UNIT V LASTING AND FINISHING 10

Hand Lasting; M/c lasting for cemented construction.

UNIT VI 10

Practice in classic shoe making; moccasin construction; practice in shoe finishing.

TOTAL : 90 PERIODS

REFERENCES

1. Bordoli, B., "The Boot and Shoe Maker", (4 volumes) The Gresham Publishing Co.Ltd., London, 4th edition, 1966.
2. Katz, R.J., "Footwear: Shoes and Socks You can make Yourself" Reinhold, New York, 1979.
3. "Manual of shoe designing ", CLRI Publications, 1999.

FW8212 TESTING OF FOOTWEAR MATERIALS AND PRODUCTS L T P C
0 0 4 2

Methods of sampling and conditioning of footwear materials and end products.

Physical and chemical analysis of leather upper, lining, toe-puff / stiffener, insole and sole.

Physico-mechanical properties of non-leather upper and lining materials and coated fabrics-pH and chloride content

Physico - mechanical properties of rigid Cellulose - Woven and Non-Woven insole

Testing of shoe - visual and physico-mechanical tests like seam strength, strap strength, Toe load, Heel pull-off (ladies), top-line strength, water resistance etc.

Testing of footwear grinderies and accessories.

Testing of safety shoe.

TOTAL : 60 PERIODS

REFERENCES

1. BIS Standards.
2. "Quality manuals of footwear materials", CLRI publications, 2000

FW8311	PROJECT WORK PHASE I	L T P C 0 0 12 6

Under Project Work Phase I the students are expected to pursue preliminary work on a project undertaken by and assigned to him/her by the Department. A report should be submitted based on the information available in the literature or data determined in the laboratory/industry. The objective of the project work is to make use of the knowledge gained by the student at various stages of the degree programme. Project Work Phase I is intended to facilitate the better completion of project extended through Project Work Phase II in Semester IV.

VIVA VOCE

The object of the viva-voce examination is to determine whether the objectives of the Project work have been met by the student as well as to assess the originality and initiative of the student as demonstrated in the Project Work.

FW8312	SEMINAR	L T P C 0 0 2 1

Students are expected to pursue one month industrial training during the summer vacation. Seminar presentations need to be made based on their comprehension on their industrial exposure.

FW8411	PROJECT WORK PHASE II	L T P C 0 0 24 12

The students should continue their work proposed in Project Work Phase I and are expected to complete the proposed work. A report should be submitted based on the data determined in the laboratory/industry. The objective of the project work is to make use of the knowledge gained by the student at various stages of the degree programme. This helps to judge the level of proficiency, originality and capacity for application of the knowledge attained by the student at the end of the programme.

VIVA VOCE

The object of the viva-voce examination is to determine whether the objectives of the Project work have been met by the student as well as to assess the originality and initiative of the student as demonstrated in the Project Work.

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FW8007 **MECHANICS OF MACHINERY** **L T P C**
3 0 0 3

(BRIDGE ELECTIVE COURSE FOR B.E. MECHANICAL ENGG. STUDENTS)

UNIT I POWER TRANSMISSION **10**

Principles of Hydraulic, Pneumatic and mechanical systems of power transmission, Use of these systems either alone or in combination in the working parts of the machine. Electronic, magno-electric, photo-cell and control safety systems.

UNIT II MECHANICAL PROPERTIES AND TRANSMISSION **10**

Mechanical properties - Tensile strength, Yield strength, Creep strength, Impact strength, Effect of temperature, Wear resistance- Laws of friction and application - Transmission of power/belt, rope and chain drives, Length Types, Creep, Tensions, Pulleys, conditions for maximum power Transmission.

UNIT III MOTION AND INERTIA **10**

Kinematics - Velocity and Acceleration, Analysis of motion of simple mechanisms with special reference to footwear machines, Kinetics- Application of forces in machines - Inertia forces and torque - Fluctuation of energy and speed - Flywheel effect and punching press.

UNIT IV CAMS AND GEAR TRAINS **9**

Cams - Types and classification of cams and followers–Construction of cam profiles for different type of followers with simple harmonic, uniform acceleration and retardation motion - Application of simple, compound, reverted and epicycle gear trains.

UNIT V TRANSPORT SYSTEM **6**

Different types of material handling system in footwear industry. Manual, semi-automatic and automatic conveyors.

TOTAL : 45 PERIODS

REFERENCES

1. Shigley, J.E. and Vicker, J.J., “Theory of Machines and mechanisms”, McGraw Hill,1995.
2. Paul, B., “Kinematics and Dynamics of Planar Machinery”, Prentice Hall, 1979.

FW8013 **THEORY AND PRACTICE OF LEATHER MANUFACTURE** **L T P C**
3 0 0 3

(BRIDGE ELECTIVE COURSE FOR B.E. MECHANICAL ENGG. STUDENTS)

UNIT I HIDES & SKINS & PRESERVATION **9**

Hides and skins – origin, availability, flaying technique, histological characteristics, leather making materials, ante-mortem and postmortem defects and its effects in shoe making. Comparisons between different hides and skins from shoe maker point of view.

UNIT II LEATHER PROCESS TECHNOLOGY **10**

Principles and techniques involved in different unit processes and operations in leather processing (pre and post tanning). Bio processing of leather, Eco processing. Process device and importance machines in leather processing and costing of leathers.

UNIT III FINISHING **7**

Chemicals and auxiliaries used in leather finishing, its compatibility with shoe finishes. Application techniques. Texture and special finishes. Assortment.

UNIT IV FOOTWEAR LEATHER MANUFACTURING 12

Process parameters and control for unit operations for Upper leather manufacturing from different kinds of raw materials. Special process techniques for Kid leather, soft upper and upper from sheep.Processes for the manufacture of sole and lining leathers.

UNIT V TANNERY EFFLUENTS 7

Source of generation of liquid and solid wastes in tanneries. Characterization of liquid, wastes and assessment of critical parameters of pollution (solids, BOD, COD, nutrients, metals and phenolics)

TOTAL : 45 PERIODS

REFERENCES

1. Sarkar, K.T., "Introduction to the Principles of Leather Manufacture", Ajoy Sorcor, Madras, 1981.
2. Dutta, S.S.," Introduction to the Principles of Leather Manufacture", Indian Leather Technologists Association, Calcutta, 1980.
3. Thorstenson, T.C.," Practical Leather Technology", Robert E. Krieger Publishing Co., Malabar, Florida, 1985.
4. Fred O Flaherty, Roddy, T.W. and Lollar, R.M., "The Chemistry and Technology of Leather", Vol.I & II, Type of tannages, Rober E. Krieger Publishing Co., New York, 1977.
5. Tchobanoglous, G., Burton, F.L. and Stensel, H.D. (Eds), "Waste water Engineering, treatment, disposal and reuse: Metcalf and Eddy", 3rd edn. Tata-McGraw Hill Publishing, New Delhi, 1991.

FW8001 COMPUTATIONAL METHODS AND COMPUTER GRAPHICS L T P C
3 0 0 3

UNIT I SOLUTION OF LINEAR EQUATION AND INTERPOLATION 9

Solution of a linear system by Gaussian, Gauss-Hordon, Jacobi and Gauss- seidal methods. Interpolation with Newton divided differences – Lagrange's polynomial – numerical differentiation with interpolation polynomials0. Numerical integration by trapezoidal, Simpsons rule and two point Gaussian quadrature.

UNIT II INITIAL AND B.VP FOR ODE 9

Taylor series, Euler, Modified Euler, RungeKutta method of Fourth order for First and Second order differential equations – Finite difference solution for the second order ordinary differential equation.

UNIT III FINITE ELEMENT METHOD 9

Integral Formulation and variational methods – Mathematical concepts, weak formulation of BVP, variational methods of approximation, Two dimensional BVP – Model equation, Finite element discretization, Interpolation – function, Assembly of element equation, Axisymmetric problems-Mesh generation and interposition of Boundary condition.

UNIT IV TWO DIMENSIONAL GRAPHICS 9

Line, circle, ellipse drawing algorithim, line attributes, curve attributes, character generation, line clipping algorithm, two dimensional geometric transformations.

UNIT V THREE DIMENSIONAL GRAPHICS 9

Bezier curves, Bezier surfaces, generation of quadric surfaces, Three dimensional geometric transformations, viewing transformations– projections.

Attested

TOTAL : 45 PERIODS

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REFERENCES

1. Grewal, B.S. and Grewal J.S." numerical methods in Engineering & Sciences", Khann Publications, New Delhi 1999.
2. Reddy, J.N." An Introduction to Finite Element Methods", Second Edition, McGraw Hill Inc.New York, 1993.
3. Hearn .and Bakes, "Computer Graphics"(2nd Edition), Printice Hall of India, 1998.

FW8002 COMPUTER AIDED DESIGN AND MANUFACTURE FOR FOOTWEAR L T P C
3 0 0 3

UNIT I COMPUTER APPLICATIONS IN FOOTWEAR SECTOR 3

Definition, historical development, scope of applications and advantage.

UNIT II HARDWARE IN CAD 12

Introduction, Principles, Capabilities and operation of graphical workstations, central processing units, graphic terminals, input/output devices, interface and storage devices, net-working concepts of LAN and WAN.

Digitization : 2D & 3D Coordinate extracting, principles of digital and analog conversion, digital input/output processing systems.

CNC devices for computer aided cutting including laser and water jet, computer aided manufacturing.

UNIT III PATTERN ENGINEERING 8

Computerized techniques for pattern generation, grading and assessment of footwear patterns, consumption calculations, pattern nesting and costing, stitching etc. through computerized techniques.

UNIT IV LAST MODELLING 10

Digitization with 3D Scanner; manipulation and optimization of digitized last; use of macros; last comparison; grading wizard; flattening; 3D visualization of last and styles; concept of e-last; introduction to sole and sole mould design.

UNIT V ADVANCED COMPUTATIONAL TECHNIQUES IN CAD, RAPID PROTOTYPING 12

Principles and practice of foot scanner; conversion of foot dimensions to last model; creation of stl files for last manufacture; simulation – concepts and applications; robotics: concepts and applications in footwear manufacture

TOTAL : 45 PERIODS

REFERENCES

1. Groover, M.P. and Zinimers, M.P., "CAD/CAM, Computer Aided Design and Manufacturing", Prentice Hall of India, 1984.
2. Newman and Sul, S.P., "Introduction to Computer Graphics", Published by Morgan Kaufmann,1995
3. Harrington, S., "Computer Graphics : A programming approach", 2nd Edn., Published by Elsevier, 1997.
4. Zandi, "Computer Aided Design and drafting", Published by Delmer,1985.
5. Pratt, W., "Digital Image Processing", 1978.
6. Desai and Abel, "Introduction to FEM"."Step by Step guide to CAD for footwear": CAD Centre, SDDC, CLRI.
7. Rapidprototyping; AU – FRG publications, 1984.
8. Buchner, J., "Simulation: QUEST manual" : EDS Technologies, Published by Springer, 2003.
9. Mass Customization And Footwear: Myth, Salvation Or Reality?: A Comprehensive Analysis Of The Adoption Of The Mass Customization Paradigm In Footwear by Claudio R. Bor, Sergio Dulio ;Springer Verlag, 2007

FW8003 **FINANCIAL MANAGEMENT** **L T P C**
3 0 0 3

UNIT I **9**
Goals and functions of finance; costing – concepts, classification; preparation of cost sheet; costing of yarn, fabric and garment

UNIT II **9**
Investment appraisal; Payback period method, Accounting Rate of Return; introduction to discounting and cash flows estimation, DCF methods - IRR, NPV, PI; Discounted payback methods; depreciation - concept, methods

UNIT III **9**
Financing and dividend policies; cost of capital, source of capital

UNIT IV **9**
Working capital management; estimation of working capital, requirements for spinning mill, composite mill and garment unit

UNIT V **9**
Tools of financial analysis and control – trading, profit and loss account, balance sheet; financial ratio analysis; funds flow analysis and financial forecasting; analysis of operating and financial leverage; illustrations for spinning mill, composite mill and garment industry

TOTAL : 45 PERIODS

REFERENCES

1. Pandey I. M., "Financial management", Vikas Publishing House Pvt. Ltd., New Delhi, 8th Edition, 1999.
2. Bhave P.V. and Srinivasan V., "Costing accounting to textile mills", ATIRA, Ahmadabad, 1976.
3. Thukaram Rao M.E., "Cost and management accounting", New Age International, Bangalore, Karnataka., 2004.
4. Thukaram Rao M.E., "Cost accounting and financial management", New Age International, Bangalore, Karnataka., 2004.
5. Prasanna Chandra, "Financial management, theory and practice", Tata McGraw -Hill Publishing Co Ltd., 5th edition, New Delhi, 2001.
6. James C. Vanhorne, "Financial management and policy", Pearson Education Asia (Low priced edition) 12th edition, 2002.
7. Narang, G. B. S. and Kumar V., "Production and costing", Khanna Publishers, New Delhi, 1988.
8. Aswat Damodaran, "Corporate finance theory and practice", John Wiley and Sons, Asia., 2000.
9. Hrishikes Bhattacharya, "Working capital management", strategies and techniques", Prentice – Hall of India Pvt.Ltd., New Delhi, 2001.
10. Khan and Jain, "Basic financial management and practice", Tata McGraw Hill, New Delhi, 5th edition, 2001.

FW8004 **GAIT ANALYSIS** **L T P C**
3 0 0 3

UNIT I ANATOMY OF HUMAN FOOT **6**
Basic anatomical terms; Reference planes of limb motion; limb movements; motion of joints; bones of pelvis and legs; joints and ligaments; muscles and tendos.

UNIT II BIOMECHXNICS **4**
Force; Moments of Force; Kinetics and Kinematics; Work, Energy and Power.

UNIT III NORMAL GAIT 12

Force Platforms; Mechanical Analysis; Mathematical Modelling; Terminology used in Gait Analysis; Gait cycle timing; Foot Placement; Cadence, Cycle time and Speed; Outline of Gait cycle; Gait cycle in detail; Ground Reaction Forces; Energy Transfers;
Determinants of Gait.

UNIT IV ABNORMALITY OF GAIT 11

Specific Gait abnormalities; Functional leg length discrepancy; Abnormal Hip rotation; Excessive Knee Flexion; Excessive Knee Extension; Abnormal Foot Contact; Abnormal foot Rotation; Abnormal Walking Base; Common Pathologies affecting Gait.

UNIT V METHODS OF GAIT ANALYSIS 12

Visual Gait Analysis; General gait Parameters; Motion Measurement systems; Electrogoniometers; Pressure beneath the foot; Mapping Systems; Electromyography; Energy Consumption; Force Platforms.

TOTAL : 45 PERIODS

REFERENCES

1. Journals of: (a) Biomechanics; (b) Biomedical Engineering; (c) Gait and Posture;(d) Clinical Biomechanics.
2. Gait Analysis – an Introduction; Michael W Whittle, Butterworth Heinemann Publications.

FW8005 INDUSTRIAL RELATIONS AND LABOUR LAWS L T P C
3 0 0 3

UNIT I DEFINITION AND SCOPE 9

Aim and scope of industrial psychology; Indian labour laws ands their administration – their impact on business and economy.

UNIT II WORKERS EDUCATION 9

Workers education; social responsibility; Industrial harmony and native welfare; labour unrest; collective bargaining.

UNIT III INDUSTRIAL DISPUTES 9

Methods of settlement of industrial disputes, reconciliation, arbitration, adjudication: role of labour welfare officer.

UNIT IV HUMAN RELATIONS 9

Workers participation in industry; human relations in industry.

UNIT V INDUSTRIAL SICKNESS 9

B.I.F.R.; Factories Act.

TOTAL : 45 PERIODS

REFERENCES

1. Yoder D. and Paul Standohar D., “Personal Management and Industrial Relations ”, Prentice Hall of India (P) Limited, New Delhi, 1984.
2. Tripathi P.C., “Personal Management and Industrial Relations”, Sultan Chand and Sons, New Delhi, 1988.

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FW8006 LEATHER PRODUCT DESIGN METHODOLOGY L T P C
3 0 0 3

UNIT I HISTORY OF DESIGN 5

History of art and architecture and its influences in product design, History of garments, textiles and costumes , History of personal accessories, History of footwear and leather goods, Relevance of personal accessories in respect of sociological status, Visual appeal and Vablen's conspicuous consumption, Trickledown theory and its relevance in product history.

UNIT II ELEMENTS OF DESIGN 10

Elements and theories of design, Application of the basic elements of design,Ergonomics and interactive scenario of the design elements, Applications of the elements in the relevance of space and demography, Elements of design and its application in socio psychology.

UNIT III DESIGN METHODOLOGY 10

The golden rule in nature and importance of it in design, Gastolt's law and its importance in design, Semiotics in design, Brain storming method of idea generation, Understanding the consumer need and demand, Concept of space and patterns in nature, Product usage and its categories, Product mix and innovation, Design process for accessories, Types, categories and usage of footwear and leather goods.

UNIT IV FASHION TREND AND FORECAST ANALYSIS 10

Definition and en tomology of fashion, trend, style and elements of trend direction, Types of trend direction review process, Application micro and macro trend directions,Importance of soil, Economical, Political and Psychological influences in trend direction, Development of forecast and understanding of styling, Discussions on various trend agencies and periodicals, Understanding the trends in accessories.

UNIT V LEATHER PRODUCT DESIGN PROCESS 10

Market and category research, Trend analysis, Concept development, Client analysis, Material selection, Color selection and functionality of the product, Brainstorming and idea generation, Design development and basic illustrations, Fine tuning the basic
designs to create the collection, development of the prototype.

TOTAL : 45 PERIODS

REFERENCES

1. Mike Baxter, Product Design, CRC Press, Florida, USA, 1988.
2. John Kris Jones, Design methods, John Wiley and sons, New York, 1992.
3. Evelyn L. Brannon, Fashion Forecasting (2nd Edition), Paperback from Fairchild Pubns, 2010.
4. Philip Kotler, Gary Armstrong, and Peggy H. Cunningham, Principles of Marketing, Seventh Canadian Edition, 2010.

FW8008 MODERN FOOTWEAR STYLING L T P C
3 0 0 3

UNIT I HISTORICAL EVALUATION & INTERNATIONAL TRENDS 10

Historical evaluation of footwear styling. Seasonal influences on fashion, cultural and geographical instances on footwear fashion. Market research and track record.

UNIT II FASHION CONSIDERATIONS 9

Design Criteria through effect of shape, colour, pattern, texture and decorative materials. Life cycle of fashion

UNIT III PRODUCT DEVELOPMENT 9

Market Strategy - Prototype Development - Field test and evaluation - Standard preparation - Second prototype - Final run. Costing

UNIT IV PRESENTATION TECHNIQUES 9

Organisation of shows and preparation of art portfolios; advertising; effect of foreign languages in the presentation and promotional activities.

UNIT V FASHION FORECAST 8

Direction of fashion trends in footwear production and marketing.

TOTAL : 45 PERIODS

REFERENCES

1. Cott, N.F., "American Shoe Making", Shoe Trades Publishing Co., Cambridge. 1993.
2. "Apparel International" Published by P.F collier and sons, U.K, 1961.
3. "Shoes and Leather News",Published by bureau of foreign and domestic commerce, Dept of commerce, US, 1940.

FW8009 ORGANISATION AND MANAGEMENT OF FOOTWEAR SECTOR L T P C
3 0 0 3

UNIT I PRODUCTION MANAGEMENT 12

Overview of production management and organization in a factory.The functions of a production manager in production planning and control. Production cost, Introduction to work study. Method study and work measurement, materials handling, Manpower planning lay outing equipment selection.

UNIT II MARKETING STRATEGY 10

i. Consumer psychology - factors affecting supply and demand - Market channels in the domestic market - Export Import policy.

ii. Product Development : Style creation - Prototype preparation - Market feed back - pilot production - specification - Final prototype.

UNIT III PERSONNEL MANAGEMENT 10

Principles - Motivation, Employee training and development - Jop analysis, Recruitments. Performance Evaluation Technique, wages and salary, labour laws and factory acts in footwear industry.

UNIT IV ERGONOMICS AND COMMUNICATION 7

i. Basic man/machine relationship - Machine organisation in industrial environment.

ii. Recording, Storage& retrieval of information - instruction - reporting information feed back process - telephone and other communication means - memoranda.

UNIT V FOOTWEAR TRADE AND INDUSTRY IN INDIA 6

Structure and concentration of the industry, production, employment, sub-contracting systems and trade practices in different sectors of industry. Origin of industry and its growth trends.Industrial/trade policies and role of various developmental organisations. International trade in footwear in relation to leather manufactures, export procedures, incentives, duties and major importing countries and competitors.

TOTAL : 45 PERIODS

REFERENCES

1. Boon, G.K., "Technology and employment Footwear Manufacturing", Sijthoff and Noordhoff,Published by BRILL,1980.
2. Mehta, P., "Managerial Economics", Sultan Chand Co., 1985.
3. Shukla, M.C., "Business Organization & Management", Sultan Chand & Co, Published by Progoti publishers,1969.
4. Rugman, A.M. "International Business Firm Environment", Mcgraw-Hill., New York,Published by Taylor and Francis, 2002.

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5. “Employment and working conditions and Competitiveness in the Leather and Footwear Industry”, ILO, Report II, Published by international labour organization, Geneva, 1995.
6. Kanawaty, G., “Introduction to work study”, Published by International Labour Organisation, 1992.

FW8010 PEDORTHIC FOOTWEAR L T P C
3 0 0 3

UNIT I INTRODUCTION 5

Pedorthics – Role of Pedorthist – Pedorthic evaluation – Patient management -implementation and Practice management.

UNIT II FOOT DEFORMITIES AND LOCOMOTION 10

Descriptive knowledge on High arches, Flat feet, Forefoot varus, Calluses, Plantar fascitis, Metatarsalgia, Mortons neuroma, Hallux valgus, Hallux Rigidus, Hammer or Claw toes, Heel spur, Talgia, Frequent ankle sprains. Gait analysis-gait cycle, Gait patterns. Types of forcesfriction, moments, ground reaction force and muscle activity.

UNIT III FOOT ORTHOSES 10

Orthoses; Raw material- Kind of foot orthoses - Fabrication techniques and Finishing. Clinical management.

UNIT IV FOOT COMPLICATIONS AND LIFESTYLE DISEASES 7

Enumeration of Lifestyle diseases such as Diabetes, Obesity etc; Foot related complications; Risk levels of foot ; Foot characteristics – low risk to high risk; Principles of therapeutic footwear and Bio-mechanical principles in design and development of
footwear.

UNIT V CORRECTIVE FOOTWEAR FABRICATION TECHNOLOGY 13

Overview-Footwear modifications - Heel modifications - Heel and Sole wedges - Customization of fit parameters – Stretching – Widening – Lengthening - Internal volume changes - Rocker bottom - Facilitation of entry and closure - Alterations including rebuilding, relasting, Shoe repair and shoe refurbishing.

TOTAL : 45 PERIODS

REFERENCES

1. D.J.Morton, The Human Foot, Hafner Publishing Co, New York, London, 1964.
2. C A Edwards, Orthopaedic shoe Technology, Precision Printing Co., Indiana,1981
3. Micheal W Whittle, “Gait Analysis: An introduction,” Butterwolrth-HeinemannPublication.
4. J.H. Thornton, Text book of Footwear Manufacture-National trade Press Ltd, London,1970.

FW8011 QUALITY CONTROL MANAGEMENT IN FOOTWEAR INDUSTRIES L T P C
3 0 0 3

UNIT I CONCEPTS OF QUALITY 9

Definition of quality, quality control theory, fundamentals of statistics and probability, confidence intervals, testing significance, statistical process control techniques, analysis, defect diagnosis and prevention.

UNIT II QUALITY IMPROVEMENT 9

Concepts of TQM, TQC, KANBAN, Zero defects, JIT – continuous improvement – HRD in quality management – quality grades, Dr. Derming’s 14 points management concept, TQA.

UNIT III STANDARDIZATION 9

Historical development of standards, aims techniques, management, formulations, implementation of international and national standards – economic benefits.

UNIT IV QUALITY ASSURANCE SYSTEM 9

Introduction to ISO – 9000 and 14000 and related international /national standards, case study.

UNIT V ACCREDITATION AND CERTIFICATION BODIES 9

Relevant standards, internal and external audit, corrective action, remedies.

TOTAL : 45 PERIODS

REFERENCES

1. A.J. Duncan, "Quality Control and Industrial Statistics", Homewood, Illinois, Published by Irwin, 1986.
2. "International Organization for Standardization" case postale 56, CH-1211-Geneva – 20, Switzerland.
3. "Bureau of Indian Standards", New Delhi.

FW8012 SAFETY IN FOOTWEAR INDUSTRY L T P C
3 0 0 3

UNIT I SAFETY PROGRAMMES 10

Safety in Industries; Need for development; Importance of safety consciousness in Indian Footwear Industry. Elements of safety programme; Effective realisation of economic and social benefits; Effective communication; Training at various levels of production and operation; Psychological attitude towards safety programmes.

UNIT II INDUSTRIAL SAFETY 9

Footwear industry and allied fields; Potential hazards; Job safety analysis; Toxic, explosive and inflammable chemicals; Safe handling and operation of materials and machineries. Promotion of Industrial Safety :Safety Standards; Role of Government; Safety Organisation; Management and Trade Unions in promoting industrial safety.

UNIT III ACCIDENTS & SAFETY PERFORMANCE 10

Industrial accidents; Identification of accident spots; Accident prevention; Accident proneness; Fire prevention and fire protection; Identification of vulnerable areas of accidents.

Safety Performance: Appraisal; Effective steps to implement safety procedures; Periodic inspection and study of plant layout and maintenance; Proper selection and replacement of handling equipments; Personal protective equipments.

UNIT IV POLLUTION 8

Atmospheric pollution; Waste and dust; Toxic Materials and gases; Environmental pollution by footwear industry.

UNIT V HEALTH HAZARDS AND LEGAL ASPECTS 8

Health and occupational hazards; Health standards and rules; Safe working environment; Legislations, Factories, Labour Welfare, ESI and Workmen Compensation Acts.

TOTAL : 45 PERIODS

REFERENCES

1. Handley, W., "Industrial Safety Hand Book", 2nd Edn., McGraw Hill Book Company, 1977.
2. Heinrich, H.W., Petenen, D. and Roos, N., "Industrial accident prevention", McGraw-Hill, New York, 1980.
3. Blake, R.P., "Industrial Safety", 2nd Edn., Prentice Hall Inc., New Jersey, 1963.
4. Stellman, J.M. "EN-344 standards" Published by International labour Organisation, 1998.

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CL8120 **TOTAL QUALITY MANAGEMENT** **L T P C**
(Elective offered by Dept of Chemical Engineering) **3 0 0 3**

UNIT I CONCEPTS OF TQM **5**
Philosophy of TQM, Customer focus, organization, top management commitment, team work, quality philosophies of Deming, Crosby and Muller.

UNIT II TQM PROCESS **12**
QC Tools, Problem solving methodologies, new management tools, work habits, quality circles, bench marking, strategic quality planning.

UNIT III TQM SYSTEMS **8**
Quality policy deployment, quality function deployment, Standardization, designing for quality, manufacturing for quality.

UNIT IV QUALITY SYSTEM **10**
Need for ISO 9000 system, Advantages, clauses of ISO 9000, Implementation of ISO 9000, quality costs, quality, auditing, case studies.

UNIT V IMPLEMENTATION OF TQM **10**
Steps, KAIZEN, 5s, JIT, POKAYOKE, Taguchi methods, case studies.

TOTAL : 45 PERIODS

REFERENCES

1. Rose J. E., "Total quality Management", Kogan Page Ltd, 1999.
2. Bank, J., "The essence of Total Quality Management", Prentice Hall of India, 1993.
3. Bonds, G., "Beyond Total Quality Management", McGraw Hill, 1994.
4. Osada, T., "The 5S's, The Asian Productivity Organisation", 1991.

MG8071 **OPERATIONS RESEARCH** **L T P C**
(Elective offered by Dept of Chemical Engineering) **3 0 0 3**

UNIT I MATHEMATICAL PROGRAMMING **12**
Introduction, Linear Programming, Solution by simplex method, Duality, Sensitivity analysis, Dual simplex method, Integer Programming, Branch and bound method, Geometric programming and its application.

UNIT II DYNAMIC PROGRAMMING **10**
Elements of DP models, Bellman's optimality criteria, Recursion formula, Solution of multistage decision problem by DP method. Application is Heat Exchange Extraction systems.

UNIT III PERT, CPM and GERT **9**
Network representation of projects, Critical path calculation, construction of the time-chart and resource leveling, Probability and cost consideration in project scheduling, Project control. Graphical Evaluation and Review Techniques.

UNIT IV ELEMENTS OF QUEUING THEORY **7**
Basic elements of the Queuing model, M/M/1 and M/M/C Queues.

UNIT V ELEMENTS OF RELIABILITY THEORY **7**
General failure distribution, for components, Exponential failure distributions, General model, Maintained and Non-maintained systems, Safety Analysis.

TOTAL : 45 PERIODS

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Anna University, Chennai-600 025.

REFERENCES

1. Carter, M. W. and Price, C. C., Operations Research: A Practical Introduction Contributor, CRC Press, 2001.
2. Edgar, T. F., Himmelblau, D. M. and Ladson, L. S., "Optimization of Chemical Processes", 2nd Ed., McGraw Hill, New York, 2003.
3. Hillier, F. S., and Lieberman, G. J., Introduction to Operations Research, McGraw-Hill, 2005
4. Taha, H. A., "Operations Research, An introduction", 6th Ed., Prentice Hall of India, New Delhi, 2006.