

ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS – 2015
CHOICE BASED CREDIT SYSTEM

M. TECH. FOOTWEAR SCIENCE AND ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

- I. To prepare students to excel in research or to succeed in Footwear manufacture profession through globally renowned rigorous post graduate education.
- II. To provide students with a solid foundation in Footwear Science and Engineering required to excel in their profession for an inclusive growth in footwear manufacture
- III. To train students with good scientific and engineering knowledge so as to comprehend, analyze, design, and create novel products and solutions for the real life problems.
- IV. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate leather manufacture to broader social context.
- V. To provide students with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will demonstrate knowledge of mathematics, science and engineering.
2. Graduates will demonstrate an ability to identify, formulate and solve technological problems.
3. Graduate will demonstrate an ability to design and conduct experiments, analyze and interpret data.
4. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
5. Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks.
6. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
7. Graduates will demonstrate knowledge of professional and ethical responsibilities.
8. Graduate will be able to communicate effectively in both verbal and written form.
9. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
10. Graduate will develop confidence for self education and ability for life-long learning.

Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
I	✓	✓		✓						
II	✓		✓		✓	✓	✓		✓	
III				✓	✓	✓	✓		✓	
IV							✓	✓	✓	✓
V		✓	✓						✓	✓

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	
YEAR 1	SEM 1	Anatomy and Solid Modelling of Foot	✓		✓		✓						
		Materials Science				✓	✓						
		Technology of Footwear Manufacture	✓										
		Operation Research	✓	✓									
		Elective I											
		Footwear Fabrication - I					✓	✓					
	SEM 2	Footwear Chemicals and Polymers	✓									✓	
		Footwear Components and Accessories		✓	✓	✓		✓				✓	
		Modern footwear styling	✓			✓		✓					
		Technology of Speciality and Non – Leather Footwear				✓							
		Elective II											
		Footwear Fabrication - II					✓	✓					
		Testing of Footwear Materials and products		✓		✓	✓	✓					
YEAR 2	SEM 1	Computer Aided Design and Manufacturing for footwear	✓	✓		✓		✓					
		Elective III											
		Elective IV											
		Elective V											
		Project Work Phase I		✓		✓				✓			✓
		Seminar				✓				✓	✓		✓
	SEM 2	Project Work Phase II		✓		✓			✓			✓	

UNIVERSITY DEPARTMENTS
ANNA UNIVERSITY:CHENNAI – 600 025.
REGULATIONS – 2015
CHOICE BASED CREDIT SYSTEM
I – IV SEMESTER CURRICULUM AND SYLLABUS
M. TECH. FOOTWEAR SCIENCE AND ENGINEERING

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
SEMESTER - I								
Theory								
1.	FW7101	Anatomy and Solid Modelling of Foot	FC	3	3	0	0	3
2.	FW7102	Materials Science	PC	3	3	0	0	3
4.	FW7104	Technology Of Footwear Manufacture	PC	3	3	0	0	3
5.	PP7001	Operation Research	PC	3	3	0	0	3
6.		Elective I	PE	3	3	0	0	3
Practicals								
6.	FW7111	Footwear Fabrication - I	PC	6	0	0	6	3
TOTAL				21	15	0	6	18

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
SEMESTER – II								
Theory								
1.	FW7201	Footwear Chemicals and Polymers	PC	3	3	0	0	3
2.	FW7202	Footwear Components and Accessories	PC	3	3	0	0	3
3.	FW7203	Modern footwear styling	PC	3	3	0	0	3
4.	FW7204	Technology of Speciality and Non – Leather Footwear	PC	3	3	0	0	3
5.		Elective II	PE	3	3	0	0	3
Practicals								
6.	FW7211	Footwear Fabrication - II	PC	6	0	0	6	3
	FW7212	Testing of Footwear Materials and products	PC	6	0	0	6	3
TOTAL				27	15	0	12	21

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
SEMESTER - III								
1.	FW7301	Computer Aided Design and Manufacturing for footwear	PC	3	3	0	0	3
2.		Elective III	PE	3	3	0	0	3
3.		Elective IV	PE	3	3	0	0	3
		Elective V	PE	3	3	0	0	3
Practicals								
4.	FW7311	Industrial Training/Internship – I*	EEC	2	0	0	2	1
5.	FW7312	Project work Phase -I	EEC	12	0	0	12	6
TOTAL				26	12	0	14	19

Sl.No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
SEMESTER – IV								
1.	FW7411	Project work (Phase – II)	EEC	24	0	0	24	12
TOTAL				24	0	0	24	12

TOTAL CREDITS : 70

Foundation Courses (FC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Materials Science	FC	3	3	0	0	3
2.		Operation Research	FC	3	3	0	0	3

Professional Core (PC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Anatomy and Solid Modelling of Foot	PC	3	3	0	0	3
2.		Technology of Footwear Manufacture	PC	3	3	0	0	3
3.		Footwear Chemicals and Polymers	PC	3	3	0	0	3
4.		Footwear Fabrication – I(Lab)	PC	6	0	0	6	3
5.		Footwear Components and Accessories	PC	3	3	0	0	3

6.		Modern footwear styling	PC	3	3	0	0	3
7.		Technology of Speciality and Non – Leather Footwear	PC	3	3	0	0	3
8.		Footwear Fabrication – II(Lab)	PC	6	0	0	6	3
9.		Testing of Footwear Materials and products(Lab)	PC	6	0	0	6	3
10.		Computer Aided Design and Manufacturing for footwear	PC	3	3	0	0	3

Professional Electives (PE)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	FW7004	Mechanics of Machinery(For B. Tech. Leather Technology Students)	PE	3	3	0	0	3
2.	FW7008	Theory and Practice of Leather manufacture (For B.E Mechanical, Production, Industrial Engg. Students)	PE	3	3	0	0	3
3.	FW7001	Computational Methods and Computer graphics	PE	3	3	0	0	3
4.	FW7002	Gait Analysis	PE	3	3	0	0	3
5.	FW7003	Leather Product Design And Methodology	PE	3	3	0	0	3
6.	FW7005	Organization And Management Of Footwear Sector	PE	3	3	0	0	3
7.	FW7006	Pedorthic Footwear	PE	3	3	0	0	3
8.	FW7007	Quality Control Management In Footwear Industries	PE	3	3	0	0	3

Employability Enhancement Courses (EEC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Industrial Training/Internship – I	EEC	2	0	0	2	1
2.		Project work Phase -I	EEC	12	0	0	12	6
3.		Project work Phase -II	EEC	24	0	0	24	12

OBJECTIVE

The objective of this course is to provide the fundamental knowledge about foot and its modelling

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 etcfootcare 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**OUTCOME**

At the end of this course the students will be able to understand anatomy, biomechanics of foot and methods to model the foot.

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

FW7102

MATERIALS SCIENCE

L T P C

3 0 0 3

OBJECTIVE

This course is to highlight the students on the properties and behavior of various materials

UNIT I FUNDAMENTALS OF MATERIAL SCIENCE 15

Atomic structure and interatomic bonding; classification of materials; structures of metals, ceramics and polymers; types and application of materials; materials selection and design consideration; Environmental issues in materials science.

UNIT II ADVANCED MATERIALS 12

Smart materials, ferroelectric, piezoelectric, optoelectric, semiconducting behavior, lasers and optical fibers, photoconductivity and superconductivity, nano materials, super alloys, shape memory alloys.

UNIT III 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 IV THERMAL PROPERTIES 5

Heat capacity, thermal conductivity, thermal expansion 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

OUTCOME

At the end of this course, the students will be able to understand the properties of various materials and some of the methods to characterize them.

REFERENCES

- 1 Callister, W.D., Fundamentals 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

FW7104

TECHNOLOGY OF FOOTWEAR MANUFACTURING

L T P C

3 0 0 3

OBJECTIVE

The objective of this course is present the students on various unit operations in footwear manufacture.

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 scrimms, 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, uppercementing, 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, Dressshoe, casual footwear, women footwear, work shoe .Ethnic footwear. Jodhpur boot and variousboot. Safety footwear.

TOTAL:45 PERIODS

OUTCOME

At the end of this course, the students will be able to understand the various modules associated with footwear manufacture.

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”, 2ndEdn. 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, HuthigBuchVerlag, Heidelberg, 1988.

PP7001

OPERATIONS RESEARCH

**L T P C
3 0 0 3**

OBJECTIVE

The objective of this course is provide the basic concepts associated with operation research

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**OUTCOME**

At the end of this course the students will be able to understand various concepts on operation research

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.

FW7111**FOOTWEAR FABRICATION – I LAB****L T P C****0 0 6 3****OBJECTIVE**

To impart practical exposure in lasting and upper preparation operations

UNIT I LAST**30**

Central line drawing – Measurements – Design Insole pattern – Sole pattern – Forming – clotted, Fabric, Tape & Vaccum 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 UPPER PREPARATION**30**

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:60 PERIODS**OUTCOME**

At the end of the course, the students will be in a position to perform lasting and upper preparation for different styles of footwear

FW7201**FOOTWEAR CHEMICALS AND POLYMERS****L T P C
3 0 0 3****OBJECTIVE**

The objective of this course is provide theoretical knowledge on various chemicals and polymers associated with footwear

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 Cationic polymerisations.

Chemistry & Technology involved in manufacturing of following polymeric materials : Natural & synthetic rubber PVC - Polystyrene - 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, calendaring, 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.

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

OUTCOME

At the end of this course the students will be able to understand various chemicals and polymers materials used in footwear components

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

**FW7202 FOOTWEAR COMPONENTS AND ACCESSORIES L T P C
3 0 0 3**

OBJECTIVE

The objective of this course is provide the students with the knowledge on various components and accessories used for footwear manufacture

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.
 Grinders: Metallic grinders - 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 grinders: Reinforcement tape - tape preparation - Vulcanization of adhesive. Fibre fastening, Velcro, etc.

TOTAL :45 PERIODS

OUTCOME

At the end of this course the students will be able to understand about various footwear components and their characteristics

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.

FW7203

MODERN FOOTWEAR STYLING

L T P C

3 0 0 3

OBJECTIVE

The objective of this course is present the students on the footwear fashion trends and their consideration in product development.

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

OUTCOME

This course will help the students to understand the factors contributing to the fashion trends in footwear.

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.

FW7204

TECHNOLOGY FOR SPECIALTY AND NON LEATHER FOOTWEAR

**L T P C
3 0 0 3**

OBJECTIVE

The objective of this course is present the students on the technology to make non-leather and specialty footwear.

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 Welled 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, Sanfrancisco, 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 polyurethanemoulded 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

OUTCOME

At the end of this course the students will be able to understand the techniques in making non-leather and other specialty footwear.

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

FW7211

FOOTWEAR FABRICATION II LAB

**L T P C
0 0 6 3**

OBJECTIVE

To impart practical exposure in unit operations for full shoe manufacture

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

OUTCOME

At the end of the course, the students will gain skill set to handle full show manufacture

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.

OBJECTIVE

The objective of this course is provide practical exposure on the testing of footwear materials

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 grinders and accessories. Testing of safety shoe.

TOTAL :90 PERIODS

OUTCOME

At the end of this course the students will be have gained hands on experience of testing footwear materials and products

REFERENCES

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

FW7301 COMPUTER AIDED DESIGN AND MANUFACTURE FOR FOOTWEAR

**L T P C
3 0 0 3**

OBJECTIVE

The objective of this course is project the use of computer assisted designing techniques for making footwear

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

OUTCOME

At the end of this course the students will be able to appreciate the use of computer hardware and software in designing and manufacturing footwear

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. Zandi, “Computer Aided Design and drafting”, Published by Delmer, 1985.
4. Pratt, W., “Digital Image Processing”, 1978.
5. Desai and Abel, “Introduction to FEM”.
6. “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;SpringerVerlag, 2007

FW7311

INDUSTRIAL TRAINING / INTERNSHIP I

**L T P C
0 0 2 1**

Objective

The industrial internship is expected to enhance the technical employability skills of the students.

Students are expected to pursue one month industrial/laboratory training during the summervacation. Seminar presentations need to be made based on their comprehension of their exposure.

Outcome

At the end of this course the students will have confidence in handling practical aspects of footwear manufacture and also to improve the presentation skills of the students

FW7312

PROJECT WORK PHASE I

L T P C

0 0 12 6

OBJECTIVE

The objective of this course is to facilitate the students to identify innovative projects that promotes creativity.

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

OUTCOME

At the end of the project period phase I, students should be familiar with current thinking in their field, and able to apply the concepts to relevant research problems or practical applications.

FW7411

PROJECT WORK PHASE II

L T P C

0 0 24 12

OBJECTIVE

The objective of the project 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.

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.

OUTCOME

The project work is expected to shape the student to think originally, plan/execute work properly, analytical abilities and reporting/communication skills

FW7004

MECHANICS OF MACHINERY

L T P C

3 0 0 3

(BRIDGE ELECTIVE COURSE FOR B.TECH. LEATHER TECHNOLOGY)

OBJECTIVE

The objective of this course is to orient the leather technology students on the mechanical engineering aspects associated with the machinery.

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, magnetolectric, 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 motion/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 –types of gears 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

OUTCOME

At the end of this course the students will be able to understand the underpinning mechanical engineering concepts associated with the machineries.

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.

(BRIDGE ELECTIVE COURSE FOR B.E. MECHANICAL ENGG.)**OBJECTIVE**

This course objective is to orient the non-leather students on the fundamental science and technology of leather manufacture.

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**OUTCOME**

Through this course the student gains an appreciation of the underpinning science and technology involved in manufacturing of leathers.

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, Robert 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.

OBJECTIVE

The objective of this course is provide various theories on computation methods and graphics.

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 algorithm, 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.

TOTAL :45 PERIODS**OUTCOME**

At the end of this course the students will be able to understand different theories on computation methods and computer graphics.

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.
- Bor, Sergio Dulio ;SpringerVerlag, 2007

OBJECTIVE

The objective of this course is provide knowledge and demonstration on GAIT analysis

UNIT I LOWER LIMB ANATOMY**9**

Basic anatomical terms; Neuromuscular anatomy; Bones of pelvis and legs; Joints, Ligaments, Muscles, Tendons and Fascia.

UNIT II PRINCIPLES OF BIOMECHANICS**9**

Reference planes of motion; Kinematics; Limb Movements; Motion Of Joints; Kinetics; Force; Momentum; Inertia ; Pressure; Torque; Work, Power and Energy.

UNIT III GAIT**9**

Terminology used in Gait; Gait Parameters Definition and Description; Phases of Gait Cycle; Fundamentals in Gait Analysis; Balance and Posture; Ground Reaction Force; Energy Transfer; Mechanical Analysis; Mathematical Modelling

UNIT IV INFLUENCE OF FOOTWEAR ON GAIT**9**

Influence of footwear on hip, knee, ankle and foot movement; Abnormal walking base; Common pathologies affecting gait and corrective measures using footwear.

UNIT V GAIT ANALYSIS TECHNIQUE**9**

Visual/observational gait analysis; 2D video analysis; 3D video analysis; Inertial sensors; Electro goniometers; Force platforms; Wearable sensors; Pressure platforms; Electro myography; Energy consumption.

TOTAL :45 PERIODS**OUTCOME**

At the end of this course the students will be able to understand GAIT analysis and will be able to appreciate their use in footwear design

REFERENCES:

1. Gait Analysis – An Introduction; Editor(s): Levine & Richards & Whittle, Release Date: 10 Jul 2012, Churchill Livingstone Print Book, ISBN:9780702042652, eBook ISBN:9780702051999, Pages: 192, Dimensions: 246 X 189
2. Basic biomechanics. Susan. J.Hall. Sixth edition 2011, McGraw-Hill Humanities/Social Sciences/Languages; ISBN-10: 0073376442 ISBN-13: 978-0073376448
3. Fundamentals of Biomechanics, Duane knudson. Springer; Second edition (2007) ISBN-10: 0387493115 ISBN-13: 978-0387493114
4. Kinesiology – The mechanics and pathomechanics of human movement. Carol A. Oatis. Edition 2, Lippincott Williams & Wilkins, 2009 ISBN 0781774225, 9780781774222
5. Gait Analysis – Normal and pathological function. Jacquelinperpy& Judith M.Burnfield. SLACK Incorporated; 2nd Revised edition (15 March 2010) ISBN-10: 1556427662, ISBN-13: 978-1556427664,
6. Clinical Gait analysis – Theory and Practice. Chris Kirtley, Churchill Livingstone; 1 edition 2005; ISBN-10: 0443100098, ISBN-13: 978-0443100093.

OBJECTIVE

The objective of this course is present various concepts of design and specific reference would be given on the process of leather product design.

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, Trickle down 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 entomology 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**OUTCOME**

At the end of this course the students will be able to understand and appreciate the concepts and trends in leather products designing.

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.

OBJECTIVE

The objective of this course is present students on various aspects on the organization management in footwear manufacture

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 equipments 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 - Job 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**OUTCOME**

At the end of this course the students will be able to understand the organizational management associated with footwear sector

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.
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.

FW7006 **PEDORTHIC FOOTWEAR** **L T P C**
3 0 0 3

OBJECTIVE

The objective of this course is present the complications associated with foot and strategies to fabricate appropriate footwear

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 fasciitis, 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 forces friction,

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

OUTCOME

At the end of this course the students will be able to understand the foot deformities and the need/means for the development of specialty footwear

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-Heinemann Publication.
4. J.H. Thornton, Text book of Footwear Manufacture-National trade Press Ltd, London, 1970.

OBJECTIVE

The objective of this course is present students on the quality control and management aspects associated with footwear manufacture.

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. Deming'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**OUTCOME**

At the end of this course the students will be able to understand the requirement of different quality control and management tools and their application in footwear manufacture

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.