



STELLA MARY'S COLLEGE OF ENGINEERING

(Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai)
Aruthenganvilai, Kallukatti Junction Azhikal Post, Kanyakumari District-629202,
Tamil Nadu, South India.

M.E. Industrial Safety Engineering **Department of Mechanical Engineering**

Academic Year (2023-2024)

Electives

Semester I

IL4074	Human Factors in Engineering	Professional Elective – I
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Semester II

IS4005	Fireworks Safety	Professional Elective – II
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IS4006	Safety in Construction	Professional Elective- III
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Semester III

IS4011	Safety in Engineering Industry	Professional Elective IV
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IS4012	Quality Engineering & Production Systems	Professional Elective V
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OCE434	Environmental Impact Assessment	Open Elective
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OBJECTIVES:

- ✓ Studying the work procedure and understanding the relationships between the workers and working environments.
- ✓ To study the applications of ergonomic principles and physiology of workers.
- ✓ To know the concepts of personal protective equipment and its usages.
- ✓ To create the knowledge in process and equipment design in safety aspects.

UNIT I ERGONOMICS AND ANATOMY**9**

Introduction to ergonomics: The focus of ergonomics, ergonomics and its areas of application in the work system, a brief history of ergonomics, attempts to humanize work, modern ergonomics, future directions for ergonomics

Anatomy, Posture and Body Mechanics: Some basic body mechanics, anatomy of the spine and pelvis related to posture, posture stability and posture adaptation, low back pain, risk factors for musculoskeletal disorders in the workplace, behavioural aspects of posture, effectiveness and cost effectiveness, research directions

UNIT II HUMAN BEHAVIOR**9**

Individual differences, Factors contributing to personality, Fitting the man to the job, Influence of difference on safety, Method of measuring characteristics, Accident Proneness. Motivation, Complexity of Motivation, Job satisfaction. Management theories of motivation, Job enrichment theory. Frustration and Conflicts, Reaction to frustration, Emotion and Frustration. Attitudes- Determination of attitudes, Changing attitudes Learning, Principles of Learning, Forgetting, Motivational requirements.

UNIT III ANTHROPOMETRY AND WORK DESIGN FOR STANDING AND SEATED WORKS**9**

Designing for a population of users, percentile, sources of human variability, anthropometry and its uses in ergonomics, principals of applied anthropometry in ergonomics, application of anthropometry in design, design for everyone, anthropometry and personal space, effectiveness and cost effectiveness

Fundamental aspects of standing and sitting, an ergonomics approach to work station design, design for standing workers, design for seated workers, work surface design, visual display units, guidelines for design of static work, effectiveness and cost effectiveness, research directions

UNIT IV MAN - MACHINE SYSTEM AND REPETITIVE WORKS AND MANUAL HANDLING TASK**9**

Applications of human factors engineering, man as a sensor, man as information processor, man as controller – Man vs Machine.

Ergonomics interventions in Repetitive works, handle design, key board design- measures for preventing in work related musculoskeletal disorders (WMSDs), reduction and controlling, training Anatomy and biomechanics of manual handling, prevention of manual handling injuries in the work place, design of manual handling tasks, carrying, postural stability

UNIT V HUMAN SKILL AND PERFORMANCE AND DISPLAY, CONTROLS AND VIRTUAL ENVIRONMENTS**9**

A general information-processing model of the users, cognitive system, problem solving, effectiveness.

Principles for the design of visual displays- auditory displays- design of controls- combining displays and controls- virtual (synthetic) environments, research issues.

TOTAL: 45 PERIODS**OUTCOMES:**

- ✓ Students can have the knowledge in work procedure and applications in hazardous workplaces.
- ✓ Students can design their own safety devices and equipment to reduce the accidents possibilities.
- ✓ Students will be able to incorporate human factors in design of Personal protective equipment.
- ✓ They know the risk factors, guide lines for safe design of man machine systems considering human factors.

L T P C
3 0 0 3

REFERENCES

1. Ergonomic design for organizational effectiveness, Michael O'Neill 1st Edition 1998.
2. Human factors in engineering and design, MARK S.SANDERS 1992.
3. Introduction to Ergonomics, R.S. Bridger, Taylor and Francis 3rd Edition 2008.
4. The Ergonomics manual, Dan McLeod, Philip Jacobs and Nancy Larson

CO-PO MAPPING

CO	PO					
	1	2	3	4	5	6
1	-	-	-	3	-	-
2	-	-	3	-	-	-
3	2	-	-	-	-	2
4	-	-	-	-	3	-
5	-	-	-	-	-	-
AVg.	2/1=2	-	3/1=3	3/1=3	3/1=3	2/1=2

1- low, 2-medium, 3-high, ‘-’- no correlation

IS4005

FIREWORKS SAFETY

OBJECTIVES:

- ✓ To study the properties of pyrotechnic chemicals
- ✓ To know about the hazards in the manufacture of various fireworks
- ✓ To understand the hazards in fireworks industries related processes
- ✓ To study the effects of static electricity
- ✓ To learn pyrotechnic material handling, transportation and user safety

PROGRESS THROUGH KNOWLEDGE

UNIT I	PROPERTIES OF FIREWORKS CHEMICALS	9
Fire properties – potassium nitrate (KNO ₃), potassium chlorate (KClO ₃), barium nitrate (BaNO ₃), calcium nitrate (CaNO ₃), Sulphur (S), Phosphorous (P), antimony (Sb), Pyro Aluminum (Al) powder- Reactions-metal powders, Borax, ammonia (NH ₃) – Strontium Nitrate, Sodium Nitrate, Potassium per chloride. Fire and explosion, impact and friction sensitivity.		
UNIT II	STATIC CHARGE AND DUST	9
Concept-prevention-earthing-copper plates-dress materials-static charge meter lightning, Causes-effects-hazards in fireworks factories-lightning arrestor :concept-installation-earth pit-maintenance-resistance-legal requirements-case studies.		
Dust: size-desirable, non-respirable-biological barriers-hazards-personal protective equipment-pollution prevention.		
UNIT III	PROCESS SAFETY	8
Safe-quantity, mixing-filling-fuse cutting – fuse fixing – finishing – drying at various stages-packing-storage-hand tools-materials, layout: building-distances- factories act – explosive act and rules – fire prevention and control – risk related fireworks industries.		
UNIT IV	MATERIAL HANDLING AND TRANSPORTATION:	10
Manual handling – wheel barrows-trucks-bullock carts-cycles-automobiles-fuse handling – paper caps handling-nitric acid handling in snake eggs manufacture-handling the mix in this factory-material movement-godown-waste pit.		
Packing-magazine-design of vehicles for explosive transports loading into automobiles-transport restrictions-case studies-overhead power lines-driver habits-intermediate parking-fire extinguishers-loose chemicals handling and transport.		
UNIT V	WASTE CONTROL AND USER SAFETY	9
Concepts of wastes – Wastes in fireworks-Disposal-Spillages-storage of residues. Consumer anxiety-hazards in display-methods in other countries-fires, burns and scalds-sales outlets-restrictions-role of fire service.		

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of the course the students will be able
- ✓ To gain knowledge of the chemical reactions of Fireworks chemicals
- ✓ To know safe manufacture of Fireworks items
- ✓ To improve process safety in fireworks industries
- ✓ To analyse safety measures applicable against static electricity
- ✓ To suggest safe practices for handling of fireworks in factories, transport and at user end

REFERENCES:

1. "Seminar on explosives", Dept. of explosives.
2. J.A.Purkiss, "Fireworks-Fire Safety Engineering"
3. Bill of once, "Fireworks Safety manual"
4. "Goeff, "Dust Explosion prevention, Part 1"
5. A.Chelladurai, "Fireworks related accidents"
6. A.Chelladurai, "Fireworks principles and practice"
7. A.Chelladurai, "History of the fireworks in India" Brock, "History of fireworks"
8. K.N.Ghosh, "Principles of fireworks", H.Khatsuria, Sivakasi, 1987.
9. "Proceedings of National seminar on Fireworks Safety-1999", MSEC-1999.

CO-PO MAPPING

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3	-	-	2	-	-	-
4	-	-	-	3	2	-
5	-	-	2	-	-	3
AVg.	-	3/1=3	(2+2)/2=2	(3+3)/2=3	2/1=2	(3+2)/2=2.5

1- low, 2-medium, 3-high, ‘-‘- no correlation

IS4006

SAFETY IN CONSTRUCTION

L T P C
3 0 0 3

OBJECTIVES:

- ✓ To know causes of accidents related to construction activities and human factors associated with these accident
- ✓ To understand the construction regulations and quality assurance in construction
- ✓ To have the knowledge in hazards of construction and their prevention methods
- ✓ To know the working principles of various construction machinery
- ✓ To gain knowledge in health hazards and safety in demolition work

UNIT I ACCIDENTS CAUSES AND MANAGEMENT SYSTEMS

9

Problems impeding safety in construction industry- causes of fatal accidents, types and causes of accidents related to various construction activities, human factors associated with these accident – construction regulations, contractual clauses – Pre contract activates, preconstruction meeting - design aids for safe construction – permits to work – quality assurance in construction - compensation – Recording of accidents and safety measures – Education and training

UNIT II HAZARDS OF CONSTRUCTION AND PREVENTION

9

Excavations, basement and wide excavation, trenches, shafts – scaffolding , types, causes of accidents, scaffold inspection checklist – false work – erection of structural frame work, dismantling – tunneling – blasting, pre blast and post blast inspection – confined spaces – working on contaminated sites – work over water - road works – power plant constructions – construction of high rise buildings.

UNIT III WORKING AT HEIGHTS

9

Fall protection in construction OSHA 3146 – OSHA requirement for working at heights, Safe access and egress – safe use of ladders- Scaffoldings , requirement for safe work platforms, stairways, gangways and ramps – fall prevention and fall protection , safety belts, safety nets, fall arrestors, controlled access zones, safety monitoring systems – working on fragile roofs, work permit systems, height pass – accident case studies.

UNIT IV CONSTRUCTION MACHINERY

9

Selection, operation, inspection and testing of hoisting cranes, mobile cranes, tower cranes, crane inspection checklist - builder's hoist, winches, chain pulley blocks – use of conveyors - concrete mixers, concrete vibrators – safety in earth moving equipment, excavators, dozers, loaders, dumpers, motor grader, concrete pumps, welding machines, use of portable electrical tools, drills, grinding tools, manual handling scaffolding, hoisting cranes – use of conveyors and mobile cranes – manual handling.

UNIT V SAFETY IN DEMOLITION WORK**9**

Safety in demolition work, manual, mechanical, using explosive - keys to safe demolition, pre survey inspection, method statement, site supervision, safe clearance zone, health hazards from demolition - Indian standard - trusses, girders and beams – first aid – fire hazards and preventing methods – interesting experiences at the construction site against the fire accidents.

TOTAL: 45 PERIODS**OUTCOMES:**

Upon completion of the course the students will be able

- ✓ To identify the problems impeding safety in construction industries. To identify types and causes of accidents, and designing aids for safe construction.
- ✓ To understand the hazards during construction of power plant, road works and high rise buildings.
- ✓ To understand the safety procedure for working at heights during construction.
- ✓ To have knowledge in selection, operation, inspection and testing of various construction machinery.
- ✓ To list out construction regulations and Indian standards for construction and demolition work.

REFERENCES

1. Handbook of OSHA Construction safety and health Charles D. Reese and James V. Edison
2. Hudson, R., "Construction hazard and Safety Hand book, Butter Worth's, 1985.
3. Jnathea D.Sime, "Safety in the Build Environment", London, 1988.
4. V.J.Davies and K.Thomasin "Construction Safety Hand Book" Thomas Telford Ltd., London, 1990.

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4	-	-	-	2	2	-
5	-	-	2	-	-	-
AVg.	2/1=2	3/1=3	2/1=2	(3+2)/2=2.5	2/1=2	2/1=2

1- low, 2-medium, 3-high, '-'- no correlation

IS4011**SAFETY IN ENGINEERING INDUSTRY****L T P C**
3 0 0 3**OBJECTIVES:**

- ✓ To know the safety rules and regulations, standards and codes
- ✓ To study various mechanical machines and their safety importance
- ✓ To understand the principles of machine guarding and operation of protective devices.
- ✓ To know the working principle of mechanical engineering processes such as metal forming and joining process and their safety risks.
- ✓ Developing the knowledge related to health and welfare measures in engineering industry

UNIT I SAFETY IN METAL WORKING MACHINERY AND WOOD WORKING MACHINES 9

General safety rules, principles, maintenance, Inspections of turning machines, boring machines, milling machine, planning machine and grinding machines, CNC machines,

Wood working machinery, types, safety principles, electrical guards, work area, material handling, inspection, standards and codes- saws, types, hazards.

UNIT II PRINCIPLES OF MACHINE GUARDING

9

Guarding during maintenance, Zero Mechanical State (ZMS), Definition, Policy for ZMS – guarding of hazards - point of operation protective devices, machine guarding, types, fixed guard, interlock guard, automatic guard, trip guard, electron eye, positional control guard, fixed guard fencing- guard construction- guard opening.

Selection and suitability: lathe-drilling-boring-milling-grinding-shaping-sawing-shearing-presses-forge hammer-flywheels-shafts-couplings-gears-sprockets wheels and chains-pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

UNIT III SAFETY IN WELDING AND GAS CUTTING

9

Gas welding and oxygen cutting, resistances welding, arc welding and cutting, common hazards, personal protective equipment, training, safety precautions in brazing, soldering and metalizing – explosive welding, selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution and handling of industrial gases-colour coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.

UNIT IV SAFETY IN COLD FORMING AND HOT WORKING OF METALS

9

Cold working, power presses, point of operation safe guarding, auxiliary mechanisms, feeding and cutting mechanism, hand or foot-operated presses, power press electric controls, power press set up and die removal, inspection and maintenance-metal sheers-press brakes.

Hot working safety in forging, hot rolling mill operation, safe guards in hot rolling mills – hot bending of pipes, hazards and control measures.

Safety in gas furnace operation, cupola, crucibles, ovens, foundry health hazards, work environment, material handling in foundries, foundry production cleaning and finishing foundry processes.

UNIT V SAFETY IN FINISHING, INSPECTION AND TESTING

9

Heat treatment operations, electro plating, paint shops, sand and shot blasting, safety in inspection and testing, dynamic balancing, hydro testing, valves, boiler drums and headers, pressure vessels, air leak test, steam testing, safety in radiography, personal monitoring devices, radiation hazards, engineering and administrative controls, Indian Boilers Regulation.

Health and welfare measures in engineering industry-pollution control in engineering industry-industrial waste disposal.

TOTAL: 45 PERIODS

OUTCOMES:

- ✓ Students can have the knowledge in safety rules, standards and codes in various mechanical engineering processes
- ✓ They can design machine guarding systems for various machines such as lathe, drilling, boring, milling etc.,
- ✓ They can implement the safety concepts in welding, gas cutting, storage and handling of gas cylinders, metal forming processes etc.,
- ✓ Students will have knowledge in testing and inspection as per rules in boilers, heat treatment operations etc.,
- ✓ They can take preventive measures in health and welfare of workers' aspects in engineering industry.

REFERENCES

1. "Accident Prevention Manual" – NSC, Chicago, 1982.
2. "Occupational safety Manual" BHEL, Trichy, 1988.
3. "Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 1989.
4. "Safety in Industry" N.V. Krishnan Jaico Publishery House, 1996.
5. Indian Boiler acts and Regulations, Government of India.
6. Safety in the use of wood working machines, HMSO, UK 1992.
7. Health and Safety in welding and Allied processes, welding Institute, UK, High Tech. Publishing Ltd., London, 1989.

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AVg.	-	$(3+3)/2=3$	-	$3/1=3$	$(3+2)/2=2.5$	$(3+3)/2=3$

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IS4012

QUALITY ENGINEERING IN PRODUCTION SYSTEMS

L T P C
3 0 0 3

OBJECTIVES:

- ✓ To know the quality engineering concepts in product design and development processes.
- ✓ To know the control and process parameters' characteristics with feedback system.
- ✓ To know the methods for production and diagnosis process improvements.
- ✓ To have knowledge on ISO quality systems and types of quality tools such as failure and effect analysis.
- ✓ To understand the six-sigma concepts and its implementation in engineering industries.

UNIT I INTRODUCTION TO QUALITY ENGINEERING AND LOSS FUNCTION

9

Quality value and engineering- overall quality system-quality engineering in product design - quality engineering in design of production processes - quality engineering in production - quality engineering in service. Loss function Derivation – use-loss function for products/system- justification of improvements-loss function and inspection- quality evaluations and tolerances-N type, S type, L type.

UNIT II ON-LINE QUALITY CONTROL

9

On-line feedback quality control variable characteristics-control with measurement interval- one unit, multiple units-control systems for lot and batch production. On-line process parameter control variable characteristics- process parameter tolerances- feedback control systems-measurement error and process control parameters

UNIT III ON-LINE QUALITY CONTROL ATTRIBUTES AND METHODS FOR PROCESS IMPROVEMENTS

9

Checking intervals- frequency of process diagnosis. Production process improvement method-

process diagnosis improvement method- process adjustment and recovery improvement methods.

UNIT IV QUALITY ENGINEERING AND TPM

9

Preventive maintenance schedules- PM schedules for functional characteristics- PM schedules for large scale systems. Quality tools–fault tree analysis, event tree analysis, failure mode and effect analysis. ISO quality systems.

UNIT V SIX SIGMA AND ITS IMPLEMENTATION

9

Introduction- definition-methodology- impact of implementation of six sigma-DMAIC method-roles and responsibilities –leaders, champion, black belt, green belts. Do's and don'ts - readiness of organization – planning-management role- six sigma tools – sustaining six sigma.

TOTAL: 45 PERIODS

OUTCOMES:

1. Students can understand the loss function derivation and quality engineering in product design and development processes.
2. Students can develop their knowledge in online quality control systems and process an control parameters.
3. The students will be able to improve the production and process diagnosis and production process.
4. The students will be able to gain knowledge in ISO quality management systems.
5. The students will be able to list the roles and responsibilities of leaders.

REFERENCES:

1. Brue G, "Six Sigma for Managers", Tata-McGraw Hill, New Delhi, Second reprint, 2002.
2. De Feo J A and Barnard W W, "Six Sigma: Breakthrough and Beyond", Tata McGraw-Hill, New Delhi, 2005.
3. Pyzdek T and Berger R W, "Quality Engineering Handbook", Tata-McGraw Hill, New Delhi, 1996
4. Taguchi G, Elsayed E A and Hsiang, T.C., "Quality Engineering in Production Systems", Mc-Graw-Hill Book company, Singapore, International Edition, 1989

CO-PO MAPPING

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AVg.	$(3+2)/2=2.5$	$(3+2)/2=2.5$	$(2+3)/2=2.5$	$3/1=3$	$3/1=3$	-

1- low, 2-medium, 3-high, '-'- no correlation

OCE434 ENVIRONMENTAL IMPACT ASSESSMENT

L T P C
3 0 0 3

OBJECTIVES:

- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION

9

Historical development of Environmental Impact Assessment (EIA). Environmental Clearance- EIA in project cycle. legal and regulatory aspects in India – types and limitations of EIA –EIA process- screening – scoping - terms of reference in EIA- setting – analysis – mitigation. Cross sectoral issues –public hearing in EIA- EIA consultant accreditation.

UNIT II IMPACT IDENTIFICATION AND PREDICTION

10

Matrices – networks – checklists – cost benefit analysis – analysis of alternatives – expert systems in EIA. prediction tools for EIA – mathematical modeling for impact prediction – assessment of impacts – air – water – soil – noise – biological — cumulative impact assessment

UNIT III SOCIO-ECONOMIC IMPACT ASSESSMENT

8

Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN

9

Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V CASE STUDIES

9

Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

TOTAL: 45 PERIODS

OUTCOMES:

- ✓ On completion of the course, the student is expected to be able to

CO1	Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles
CO2	Understand various impact identification methodologies, prediction techniques and model of impacts on various environments
CO3	Understand relationship between social impacts and change in community due to development activities and rehabilitation methods
CO4	Document the EIA findings and prepare environmental management and monitoring plan
CO5	Identify, predict and assess impacts of similar projects based on case studies

PROGRESS THROUGH KNOWLEDGE

REFERENCES:

1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
3. Canter, L.W., Environmental Impact Assessment, McGraw Hill, New York. 1996
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Interscience, New Jersey. 2003
5. Lee N. and George C. 2000. Environmental Assessment in Developing and Transitional Countries. Chichester: Willey
6. World Bank –Source book on EIA ,1999
7. Sam Mannan, Lees' Loss Prevention in the Process Industries, Hazard Identification Assessment and Control, 4th Edition, Butterworth Heineman, 2012.

CO – PO Mapping- ENVIRONMENTAL IMPACT ASSESSMENT

PO/PSO		Course Outcome					Overall Correlation of COs to Pos
		CO1	CO2	CO3	CO4	CO5	
PO1	Knowledge of Engineering Sciences		3			3	3
PO2	Problem analysis		2	2			2
PO3	Design / development of solutions		3	3	3		3
PO4	Investigation		2	2		2	2
PO5	Modern Tool Usage		2	2	3		2
PO6	Individual and Team work		2	2	2		2
PO7	Communication				1		1
PO8	Engineer and Society	2			2		2
PO9	Ethics	3	3	3	2	2	3
PO10	Environment and Sustainability	3			2		2
PO11	Project Management and Finance				1		L
PO12	Life Long Learning		1	1			L
PSO1	Knowledge of Environmental Engineering discipline	2					2
PSO2	Environmental Performance Evaluation and coordination		2	2	2		2
PSO3	Conceptualization of Environmental Engineering Systems		2		2		2

PROGRESS THROUGH KNOWLEDGE