Vel Tech

Rangarajan Dr. Sagunthala

R&D Institute of Science and Technology

(Deemed to be University Estd. u/s 3 of UGC Act, 1956)

CURRICULUM & SYLLABUS

for

PG PROGRAMS

(Regulations: MTECH-R16)

M. Tech. – INDUSTRIAL SAFETY ENGINEERING

M. Tech. – METALLURGICAL AND MATERIALS SCIENCE

DEPARTMENT OF MECHANICAL ENGINEERING

SCHOOL OF MECHANICAL AND CONSTRUCTION

Vel Tech

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CURRICULUM AND SYLLABUS

for

M. Tech. – Industrial Safety Engineering

FOUNDATION COURSE					
Code	**Course**	**L**	**T**	**P**	**C**
		3	2	0	4

PROGRAMME CORE						
Sl. No.	**Code**	**Course**	**L**	**T**	**P**	**C**
Theory Courses						
1	2161ME132	Principles of Safety Management	3	0	0	3
2	2161ME133	Occupational Health & Industrial Hygiene	3	0	0	3
3	2161ME134	Industrial Safety, Health and Environment (SHE)	3	0	0	3
4	2161ME135	Environmental Safety	3	0	0	3
5	2161ME136	Fire Engineering and Explosion Control	3	0	0	3
6	2161ME137	Computer Aided Hazard Analysis	4	0	0	4
7	2161ME138	Safety in Engineering Industry	3	0	0	3
8	**2161ME167**	Electrical safety	3	0	0	3
9	**2161ME168**	Safety in Process Industries	3	0	0	3
					Total Credits	**28**
Laboratory Courses						
1	2161ME309	Design and Fabrication of Safety Device	0	0	2	1
2	2161ME310	Industrial Safety and Environmental Laboratory	0	0	2	1
					Total credits	**2**

PROGRAMME ELECTIVES (ANY FOUR)						
1	2162ME150	Principles of Disaster Management	3	0	0	3
2	2162ME116	Advanced Plant Layout and Materials Handling	3	0	0	3
3	2162ME151	Fireworks Safety	3	0	0	3
4	2162ME152	Safety in Chemical Industry	3	0	0	3
5	2162ME113	Quality and Reliability Engineering	3	0	0	3
6	2162ME153	Safety in On and Off Shore Drilling	3	0	0	3
7	2162ME154	Industrial Noise and Vibration Control	3	0	0	3
8	2162ME155	Occupational Health and Environmental Management System standards	3	0	0	3
9	2162ME156	Design of Industrial Ventilation System	3	0	0	3
10	2162ME180	Safety in Construction Industries	3	0	0	3
					Total credits	**8**

INDEPENDENT LEARNING COURSES					
COURSE CODE	**COURSE TITLE**	**L**	**T**	**P**	**C**
	Massive Open Online Course	-	-	-	2
2163ME501 2163ME801 2163ME802	Research Seminar [**OR**] Field Study [**OR**] Internship	- - -	- - -	- - -	2
2163GE401 2163GE402	Business Communication [**OR**] Technical Writing Tools	- -	- -	- -	2
2163MG401	Research Methodology	-	-	-	2
				Total Credits	**8**

PROJECT WORK					
COURSE CODE	**COURSE TITLE**	**L**	**T**	**P**	**C**
2164ME601	Project Phase I	0	0	20	10
2164ME701	Project Phase II	0	0	32	16
				Total Credits	**26**

PROGRAMME STRUCTURE AND MINIMUM CREDITS REQUIRED

IN COURSE CATEGORIES

SECTION NUMBER	COURSE CATEGORY	MINIMUM CREDITS
		REQUIRED
7.2.1	**FOUNDATION COURSE**	**04**
7.2.2	**PROGRAM CORE COURSES**	**30**
7.2.3	**PROGRAM ELECTIVE COURSES**	**12**
7.2.4	**INDEPENDENT LEARNING COURSES**	**8**
7.2.5	**PROJECT WORK**	**26**
	TOTAL CREDITS	**80**

2161ME132	PRINCIPLES OF SAFETY MANAGEMENT	L	T	P	C
		3	0	0	3

UNIT I CONCEPTS AND TECHNIQUES **9**

History of Safety movement –Evolution of modern safety concept- general concepts of management – planning for safety for optimization of productivity -productivity, quality and safety-line and staff functions for safety-budgeting for safety- safety policy. Incident Recall Technique (IRT), disaster control, job safety analysis, safety survey, safety inspection, safety sampling, evaluation of performance of supervisors on safety.

UNIT II SAFETY AUDIT – INTRODUCTION **9**

Components of safety audit, types of audit, audit methodology, non-conformity reporting (NCR), audit checklist and report – review of inspection, remarks by government agencies, consultants, experts – perusal of accident and safety records, formats – implementation of audit indication - liaison with departments to ensure co-ordination – check list – identification of unsafe acts of workers and unsafe conditions in the shop floor.

UNIT III ACCIDENT INVESTIGATION AND REPORTING **9**

Concept of an accident, reportable and non-reportable accidents, reporting to statutory authorities – principles of accident prevention – accident investigation and analysis – records for accidents, 4 departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – role of safety committee –cost of accident.

UNIT IV SAFETY PERFORMANCE MONITORING **9**

ANSI (Z16.1) Recommended practices for compiling and measuring work injury experience – permanent total disabilities, permanent partial disabilities, temporary total disabilities -

Calculation of accident indices, frequency rate, severity rate, frequency severity incidence, incident rate, accident rate, safety "t" score, safety activity rate – problems.

UNIT V SAFETY EDUCATION AND TRAINING **9**

Importance of training-identification of training needs-training methods – programmes, seminars, conferences, competitions – method of promoting safe practice - motivation – communication - role of government agencies and private consulting agencies in safety training – creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign – Domestic Safety and Training.

TOTAL: 45 PERIODS

REFERENCES:

1. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay,1997.
2. Lees, F.P., "Loss Prevention in Process Industries" Butterworth publications, London, 2nd edition, 1990.
3. John Ridley, "Safety at Work", Butterworth and Co., London, Sixth edition 2003.
4. Industrial Safety Management, L M Deshmukh, Tata McGraw-Hill Education,2005

2161ME133	OCCUPATIONAL HEALTH AND INDUSTRIAL HYGIENE	L	T	P	C
		3	0	0	3

UNIT I PHYSICAL HAZARDS **9**

Noise, compensation aspects, noise exposure regulation, properties of sound, occupational damage, risk factors, sound measuring instruments, octave band analyzer, noise networks, noise surveys, noise control program, industrial audiometry, hearing conservation programs- vibration, types, effects, instruments, surveying procedure, permissible exposure limit. Ionizing radiation, types, effects, monitoring instruments, control programs, OSHA standard- nonionizing radiations, effects, types, radar hazards, microwaves and radio-waves, lasers, TLV- cold environments, hypothermia, wind chill index, control measures- hot environments, thermal comfort, heat stress indices, acclimatization, estimation and control

UNIT II CHEMICAL HAZARDS **9**

Recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. dose, TLV - Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Industrial Hygiene calculations, Comparison with OSHAS Standard. Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures, Gas and Vapour monitors, dust sample collection devices, personal sampling Methods of Control - Engineering Control, Design maintenance considerations, design specifications - General Control Methods - training and education

UNIT III BIOLOGICAL AND ERGONOMICAL HAZARDS **9**

Classification of Biohazardous agents – examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases - Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets - building design. Work Related Musculo skeletal Disorders –carpal tunnel syndrome CTS-Tendon pain-disorders of the neck- back injuries.

UNIT IV OCCUPATIONAL HEALTH AND TOXICOLOGY **9**

Concept and spectrum of health - functional units and activities of occupational health services, pre- employment and post-employment medical examinations - occupational related diseases,

levels of prevention of diseases, notifiable occupational diseases such as silicosis, asbestosis, pneumoconiosis, siderosis, anthracosis, aluminosis and anthrax, lead-nickel, chromium and manganese toxicity, gas poisoning (such as CO, ammonia, coal and dust etc) their effects and prevention - Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems

UNIT V OCCUPATIONAL PHYSIOLOGY **9**

Man as a system component – allocation of functions – efficiency – occupational work capacity – aerobic and anaerobic work – evaluation of physiological requirements of jobs – parameters of measurements – categorization of job heaviness – work organization – stress – strain – fatigue – rest pauses – shift work – personal hygiene.

TOTAL: 45 PERIODS

REFERENCES:

1. Fundamental Principles of Occupational Health and Safety- Benjamin O. Alli International Labour Office –Geneva - Published 2008
2. Occupational Health and Safety Management: A Practical Approach, by Reese, Third Edition 2017-, CRC PRESS

2161ME134	INDUSTRIAL SAFETY, HEALTH AND ENVIRONMENT ACTS	L	T	P	C
		3	0	0	3

UNIT I FACTORIES ACT – 1948 **9**

Stuatutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare, working hours, employment of young persons – special provisions – penalties and procedures- Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948

UNIT II ENVIRONMENT ACT – 1986 **9**

General Powers of the central government, prevention, control and abatement of environmental pollution-Biomedical waste (Management and handling Rules, 1989-The noise pollution (Regulation and control) Rules, 2000-The Batteries (Management and Handling Rules) 2001- No Objection certificate from statutory authorities like pollution control board. Air Act 1981 and Water Act 1974: Central and state boards for the prevention and control of air pollution-powers and functions of boards – prevention and control of air pollution and water pollution – fund – accounts and audit, penalties and procedures.

UNIT III MANUFACTURE, STORAGE AND IMPORT OF HAZARDOUS CHEMICAL RULES 1989 **9**

Definitions – duties of authorities – responsibilities of occupier – notification of major accidents – information to be furnished – preparation of offsite and onsite plans – list of hazardous and toxic chemicals – safety reports – safety data sheets.

UNIT IV OTHER ACTS AND RULES **9**

Indian Boiler Act 1923, static and mobile pressure vessel rules (SMPV), motor vehicle rules, mines act 1952, workman compensation act, rules – electricity act and rules – hazardous wastes (management 7 and handling) rules, 1989, with amendments in 2000- the building and other construction workers act 1996., Petroleum rules, Gas cylinder rules-Explosives Act 1983-Pesticides Act

UNIT V INTERNATIONAL ACTS AND STANDARDS **9**

Occupational Safety and Health act of USA (The Williames-Steiger Act of 1970) – Health and safety work act (HASAWA 1974, UK) – OSHAS 18000 – ISO 14000 – American National Standards Institute (ANSI).

TOTAL: 45 PERIODS

REFERENCES:

1. The Factories Act 1948, Madras Book Agency, Chennai, 2000
2. The Environment Act (Protection) 1986, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
3. Water (Prevention and control of pollution) act 1974, Commercial Law publishers (India) Pvt.Ltd., New Delhi.
4. Air (Prevention and control of pollution) act 1981, Commercial Law Publishers (India) Pvt.Ltd., New Delhi.
5. The Indian boilers act 1923, Commercial Law Publishers (India) Pvt. Ltd., Allahabad.
6. Industrial Safety, Health Environment and Security, Basudev Panda Laxmi Publications, 2012

2161ME135	ENVIRONMENTAL SAFETY	L	T	P	C
		3	0	0	3

UNIT I AIR POLLUTION **9**

Classification and properties of air pollutants – Pollution sources – Effects of air pollutants on human beings, Animals, Plants and Materials - automobile pollution-hazards of air pollution-concept of clean coal combustion technology - ultra violet radiation, infrared radiation, radiation from sun-hazards due to depletion of ozone - deforestation-ozone holes-automobile exhausts-chemical factory stack emissions-CFC.

UNIT II WATER POLLUTION **9**

Classification of water pollutants-health hazards-sampling and analysis of water-water treatment - different industrial effluents and their treatment and disposal -advanced wastewater treatment - effluent quality standards and laws- chemical industries, tannery, textile effluents-common treatment.

UNIT III HAZARDOUS WASTE MANAGEMENT **9**

Hazardous waste management in India-waste identification, characterization and classification technological options for collection, treatment and disposal of hazardous waste-selection charts for the treatment of different hazardous wastes-methods of collection and disposal of solid wastes-health 5 hazards-toxic and radioactive wastes-incineration and vitrification - hazards due to bio-process- dilution-standards and restrictions – recycling and reuse.

UNIT IV ENVIRONMENTAL MEASUREMENT AND CONTROL **9**

Sampling and analysis – dust monitor – gas analyzer, particle size analyzer – lux meter-pH meter – gas chromatograph – atomic absorption spectrometer. Gravitational settling chambers-cyclone separators-scrubbers-electrostatic precipitator - bag filter – maintenance - control of gaseous emission by adsorption, absorption and combustion methods- Pollution Control Board-laws.

UNIT V POLLUTION CONTROL IN PROCESS INDUSTRIES 9

Pollution control in process industries like cement, paper, petroleum-petroleum products-textile tanneries-thermal power plants – dying and pigment industries - eco-friendly energy.

TOTAL: 45 PERIODS

REFERENCES:

1. Rao, CS, "Environmental pollution engineering:, Wiley Eastern Limited, New Delhi, 1992.
2. S.P.Mahajan, "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 1993.
3. Varma and Braner, "Air pollution equipment", Springer Publishers, Second Edition.

2161ME136	FIRE ENGINEERING AND EXPLOSION CONTROL	L	T	P	C
		3	0	0	3

UNIT I PHYSICS AND CHEMISTRY OF FIRE 9

Fire properties of solid, liquid and gases - fire spread - toxicity of products of combustion - theory of combustion and explosion – vapour clouds – flash fire – jet fires – pool fires – unconfined vapour cloud explosion, shock waves - auto-ignition – boiling liquid expanding vapour explosion – **case studies –** Peterborough and Bombay Victoria dock ship explosions.

UNIT II FIRE PREVENTION AND PROTECTION 9

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E – types of fire extinguishers – fire stoppers – hydrant pipes – hoses – monitors – fire watchers – lay out of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills – notice-first aid for burns.

UNIT III INDUSTRIAL FIRE PROTECTION SYSTEMS 9

Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO2 system, foam system, dry chemical powder (DCP) system and halon system – need for halon replacement – smoke venting. Portable extinguishers – flammable liquids – tank farms – indices of in flammability- Firefighting systems.

UNIT IV BUILDING FIRE SAFETY 9

Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity – concept of egress design - exists – width calculations - fire certificates – fire safety requirements for high rise buildings – snookers.

UNIT V EXPLOSION PROTECTING SYSTEMS 9

Principles of explosion-detonation and blast waves-explosion parameters – Explosion Protection, Containment, Flame Arrestors, isolation, suppression, venting, explosion relief of large enclosure-explosion venting-inert gases, plant for generation of inert gas-rupture disc in process vessels and lines explosion, suppression system based on carbon dioxide (CO2) and halons-hazards in LPG, ammonia (NH3), sulphur dioxide (SO3), chlorine (CL2) etc.

TOTAL: 45 PERIODS

REFERENCES:

1. Gupta, R.S., "Hand Book of Fire Technology" Orient Longman, Bombay 1977.
2. "Accident Prevention Manual for Industrial Operations" N.S.C., Chicago, 1982.
3. DinkoTuhtar, "Fire and Explosion Protection" 1989.
4. Derek, James, "Fire Prevention Hand Book", Butter Worths and Company, London, 1986.

2161ME137	COMPUTER AIDED HAZARD ANALYSIS	L	T	P	C
		4	0	0	4

UNIT I HAZARD, RISK ISSUES AND HAZARD ASSESSMENT 12

Introduction, hazard, hazard monitoring-risk issue, group or societal risk, individual risk, voluntary and involuntary risk, social benefits Vs technological risk, approaches for establishing risk acceptance levels, Risk estimation. Hazard assessment, procedure, methodology; safety audit, checklist analysis, what-if analysis, safety review, preliminary hazard analysis (PHA), human error analysis, hazard operability studies(HAZOP),safety warning systems.

UNIT II COMPUTER AIDED INSTRUMENTS 12

Applications of Advanced Equipments and Instruments, Thermo Calorimetry, Differential Scanning Calorimeter(DSC), Thermo Gravimetric Analyser(TGA), Accelerated Rate Calorimeter(ARC), Reactive Calorimeter(RC), Reaction System Screening Tool(RSST) - Principles of operations, Controlling parameters, Applications, advantages. Explosive Testing, Deflagration Test, Detonation Test, Ignition Test, Minimum ignition energy Test, Sensitiveness Test, Impact Sensitiveness Test(BAM) and Friction Sensitiveness Test (BAM), Shock Sensitiveness Test, Card Gap Test.

UNIT III RISK ANALYSIS QUANTIFICATION AND SOFTWARES 12

Fault Tree Analysis and Event Tree Analysis, Logic symbols, methodology, minimal cut set ranking - fire explosion and toxicity index(FETI), various indices - Hazard analysis(HAZAN)- Failure Mode and Effect Analysis(FMEA)- Basic concepts of Reliability- Software on Risk analysis, CISCON, FETI, HAMGARS modules on Heat radiation, Pool fire, Jet, Explosion. Reliability softwares on FMEA for mechanical and electrical systems.

UNIT IV CONSEQUENCES ANALYSIS 12

Logics of consequences analysis- Estimation- Hazard identification based on the properties of chemicals- Chemical inventory analysis- identification of hazardous processes- Estimation of source term, Gas or vapour release, liquid release, two phase release- Heat radiation effects, BLEVE, Pool fires and Jet fire- Gas/vapour dispersion- Explosion, UVCE and Flash fire, Explosion effects and confined explosion- Toxic effects- Plotting the damage distances on plot plant/layout.

UNIT V CREDIBILITY OF RISK ASSESSMENT TECHNIQUES 12

Past accident analysis as information sources for Hazard analysis and consequences analysis of chemical accident, Mexico disaster, Flixborough, Bhopal, Seveso, Pasadena, Feyzin disaster(1966), Port Hudson disaster- convey report, hazard assessment of non-nuclear installation- Rijnmond report, risk analysis of size potentially Hazardous Industrial objects- Rasmussen masses report, Reactor safety study of Nuclear power plant **TOTAL: 60 PERIODS**

REFERENCES:

1. Loss Prevention in Process Industries-Frank P. Less Butterworth-Hein UK 1990 (Vol.I, II and III)
2. Methodologies for Risk and Safety Assessment in Chemical Process Industries, Commonwealth Science Council, UK
3. Course Material Intensive Training Programme on Consequence Analysis, by Process Safety Centre, Indian Institute of Chemical Technology, Tarnaka and CLRI, Chennai.
4. ILO- Major Hazard control- A practical Manual, ILO, Geneva, 1993.
5. Brown, D.B. System analysis and Design for safety, Prentice Hall, 1976.

2161ME138	SAFETY IN ENGINEERING INDUSTRY	L	T	P	C
		3	0	0	3

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-grindingshaping-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.

TOTAL: 45 PERIODS

REFERENCES:

1. Philip E. Hagan, John Franklin Montgomery, James T. O'Reilly "Accident Prevention Manual" – NSC, Chicago, 2009.
3. Charles D. Reese, "Occupational Health and Safety Management", CRC Press, 2003.

COURSE CODE	ELECTRICAL SAFETY	L	T	P	C
2161ME167		3	0	0	3

UNIT I CONCEPTS AND STATUTORY REQUIREMENTS 9

Introduction – electrostatics, electro magnetism, stored energy, energy radiation and electromagnetic interference – Working principles of electrical equipment-Indian electricity act and rules-statutory requirements from electrical inspectorate-international standards on electrical safety – first aid-cardio pulmonary resuscitation(CPR).

UNIT II ELECTRICAL HAZARDS 9

Primary and secondary hazards-shocks, burns, scalds, falls-human safety in the use of electricity. Energy leakage-clearances and insulation-classes of insulation-voltage classifications-excess energy-current surges-Safety in handling of war equipment-over current and short circuit current-heating effects of current-electromagnetic forces-corona effect-static electricity –definition, sources, hazardous conditions, control, electrical causes of fire and explosion-ionization, spark and arc-ignition energy-national electrical safety code ANSI.

Lightning, hazards, lightning arrestor, installation – earthing, specifications, earth resistance, earth pit maintenance.

UNIT III PROTECTION SYSTEMS 9

Fuse, circuit breakers and overload relays – protection against over voltage and under voltage – safe limits of amperage – voltage –safe distance from lines-capacity and protection of conductor-joints-and connections, overload and short circuit protection-no load protection-earth fault protection.

FRLS insulation-insulation and continuity test-system grounding-equipment grounding-earth leakage circuit breaker (ELCB)-cable wires-maintenance of ground-ground fault circuit interrupter-

use of low voltage-electrical guards-Personal protective equipment – safety in handling hand held electrical appliances tools and medical equipment.

UNIT IV SELECTION, INSTALLATION, OPERATION AND MAINTENANCE 9

Role of environment in selection-safety aspects in application - protection and interlock-self diagnostic features and fail safe concepts-lock out and work permit system-discharge rod and earthing devices-safety in the use of portable tools-cabling and cable joints-preventive maintenance.

UNIT V HAZARDOUS ZONES 9

Classification of hazardous zones-intrinsically safe and explosion proof electrical apparatus-increase safe equipment-their selection for different zones-temperature classification-grouping of gases-use of barriers and isolators-equipment certifying agencies.

TOTAL: 45 PERIODS

REFERENCES:

1. "Accident prevention manual for industrial operations", N.S.C., Chicago, 1974
2. Power Engineers – Handbook of TNEB, Chennai, 2002.
3. Martin Glov Electrostatic Hazards in powder handling, Research Studies Pvt. Ltd., England, 1988.
4. Fordham Cooper, W., "Electrical Safety Engineering" Butterworth and Company, London, 1993.

2161ME168	SAFETY IN PROCESS INDUSTRIES	L	T	P	C
		3	0	0	3

UNIT I SAFETY IN PROCESS DESIGN AND PRESSURE SYSTEM DESIGN 9

Design process, conceptual design and detail design, assessment, inherently safer design chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipment, utilities. Pressure system, pressure vessel design, standards and codes- pipe works and valves heat exchangers- process machinery- over pressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems- failures in pressure system.

UNIT II PLANT COMMISSIONING AND INSPECTION 9

Commissioning phases and organization, pre-commissioning documents, process commissioning, commissioning problems, post commissioning documentation Plant inspection, pressure vessel, pressure piping system, non-destructive testing, pressure testing, leak testing and monitoring-plant monitoring, performance monitoring, condition, vibration, corrosion, acoustic emission-pipe line inspection.

UNIT III PLANT OPERATIONS 9

Operating discipline, operating procedure and inspection, format, emergency procedures hand over and permit system- start up and shut down operation, refinery units- operation of fired heaters, driers, storage- operating activities and hazards- trip systems- exposure of personnel-colour coding of pipes and cylinders – Corrosion prevention for underground pipes.

UNIT IV PLANT MAINTENANCE, MODIFICATION AND EMERGENCY 9

Planning Management of maintenance, hazards- preparation for maintenance, isolation, purging, cleaning, confined spaces, permit system- maintenance equipment- hot works- tank cleaning, repair and demolition- online repairs- maintenance of protective devices modification of plant, problems- controls of modifications. Emergency planning, disaster planning, onsite emergency- offsite emergency.

UNIT V STORAGES 9

General consideration, petroleum product storages, storage tanks and vessel- storages layout - segregation, separating distance, secondary containment- venting and relief, atmospheric vent, pressure, vacuum valves, flame arrestors, fire relief - fire prevention and protection - LPG storages, pressure storages, layout, instrumentation, vaporizer, refrigerated storages - LNG storages, hydrogen storages, toxic storages, chlorine storages, ammonia storages, other chemical storages - underground storages - loading and unloading facilities- drum and cylinder storage- ware house, storage hazard assessment of LPG and LNG.

TOTAL: 45 PERIODS

REFERENCES:

1. Lees, F.P., “Loss Prevention in Process Industries” Butterworth publications, London, 2nd edition, 1990.
2. Sanoy Banerjee, “Industrial hazards and plant safety”, Taylor & Francis, London, 2003.

COURSE CODE	INDUSTRIAL SAFETY AND ENVIRONMENTAL LABORATORY	L	T	P	C
2161ME310		0	0	2	1

1. NOISE LEVEL MEASUREMENT AND ANALYSIS
   Measurement of noise level for various sources-Impact, continuous and intermittent. Frequency and spectrum analysis of noise

2. VIBRATION MEASUREMENT AND ANALYSIS
   Measurement of whole body vibration for various acceleration: Instrument – vibration simulator and vibration analyzer.

3. ILLUMINATION MEASUREMENT AND ANALYSIS
   Measurement of Illumination level for various sources using Lux meter.

4. THERMAL REACTIVITY TEST
   Measurement of thermal reactivity for unstable materials.

5. EXHAUST GAS MEASUREMENT AND ANALYSIS
   Measurement of Exhaust gas measurement of IC engines.

6. BREATHING ZONE CONCENTRATION
   Measurement of breathing zone concentration of dust and fumes

7. AMBIENT AIR MONITORING
   Measurement of respirable and non- respirable dust in the ambient air

8. CONSEQUENCE ANALYSIS
   Soft computing skills on developing effects of fire & explosion and dispersion.

9. STUDY OF PERSONAL PROTECTIVE EQUIPMENT
   Safety helmet, belt, hand gloves, goggles, safety shoe, gum boots, ankle shoes, face shield, nose mask, ear plug, ear muff, apron and leg guard.

10. STUDY OF FIRE EXTINGUISHERS
    Selection and demonstration of first-aid fire extinguishers: soda acid, foam, carbon dioxide (CO_2), dry chemical powder, halon.

11. STUDY ON ELECTRICAL SAFETY
    To study various electrical hazards and safety precautions to be followed.

12. STUDY ON SAFETY AUDIT
    To study the procedure of safety audit and to perform a safety audit.

TOTAL: 30 PERIODS

2162ME150	PRINCIPLES OF DISASTER MANAGEMENT		L	T	P	C
			3	0	0	3

UNIT I INTRODUCTION **9**

Philosophy of Disaster management-Introduction to Disaster mitigation Hydrological, Coastal and Marine Disasters-Atmospheric disasters Geological, meteorological phenomena-Mass Movement and Land Disasters-Forest related disasters-Wind and water related disasters deforestation-Use of space technology for control of geological disasters-Master thesis.

UNIT II TECHNOLOGICAL DISASTERS **9**

Technological Disasters-Case studies of Technology disasters with statistical details-Emergencies and control measures-APELL-Onsite and Offsite emergencies-Crisis management groups-Emergency centers and their functions throughout the country Software on emergency controls Monitoring devices for detection of gases in the atmosphere-Right to know act.

UNIT III ENVIRONMENTAL IMPACT ASSESSMENT **9**

Introduction to Sustainable Development-Bio Diversity-Atmospheric pollution-Global warming and Ozone Depletion-ODS banking and phasing out-Sea level rise-El Nino and climate changes-Eco

friendly products-Green movements-Green philosophy - Environmental Policies Environmental Impact Assessment-case studies-Life cycle.

UNIT IV POLLUTION ASPECTS **9**

Offshore and onshore drilling-control of fires-Case studies-Marine pollution and control-Toxic, hazardous and Nuclear wastes-state of India's and Global environmental issues carcinogens-complex emergencies-Earthquake disasters-the nature-extreme event analysis the immune system-proof and limits.

UNIT V POLICY INITIATIVES **9**

Environmental education-Population and community ecology-Natural resources conservation-Environmental protection and law-Research methodology and systems analysis-Natural resources conservation Policy initiatives and future prospects-Risk assessment process, assessment for different disaster types-Assessment data use, destructive capacity-risk adjustment-choice-loss acceptance-disaster aid- public liability insurance-stock taking and vulnerability analysis disaster profile of the country-national policies-objectives and standards physical event modification-preparedness, forecasting and warning, land use planning.

TOTAL: 45 PERIODS

REFERENCES:

1. Gilbert, Masters.M., "Introduction to Environmental Engineering and Science", 3rd edition, 2008.

2. Miller, Tylor.G., "Environmental Science", 14th edition 2012.

3. Bagad Vilas. "Principles of Environmental Science and Engineering", 2004.

4. Sivakumar.R., "Principles of Environmental Science and Engineering", 2005.

2162ME116	ADVANCED PLANT LAYOUT AND MATERIAL HANDLING	L	T	P	C
		3	0	0	3

Unit I Plant Location **9**

Selection of plant locations, territorial parameters, considerations of land, water, electricity, location for waste treatment and disposal, further expansions Safe location of chemical storages in the form of bullets, spheres, cylinders for LPG, LNG, CNG, acetylene, ammonia, chlorine – explosives and propellants.

Unit II Plant Layout **9**

Safe layout, equipment layout, safety system, fire hydrant locations, fire service rooms, facilities for safe effluent disposal and treatment tanks, site considerations, approach roads, plant railway lines, security towers. Safe layout for process industries, engineering industry, construction sites, pharmaceuticals, pesticides, fertilizers, refineries, food processing, nuclear power stations, thermal power stations, metal powders manufacturing, fireworks and match works.

Unit III Working Conditions **9**

Principles of good ventilation, purpose, physiological and comfort level types, local and exhaust ventilation, hood and duct design, air conditioning, ventilation standards, application. Purpose of lighting, types, advantages of good illumination, glare and its effect, lighting requirements for various work, standards- Housekeeping, principles of 5S.

Unit IV Manual Material Handling and Lifting Tackles. 9

Preventing common injuries, lifting by hand, team lifting and carrying, handling specific shape machines and other heavy objects – accessories for manual handling, hand tools, jacks, hand trucks, dollies and wheel barrows – storage of specific materials - problems with hazardous materials, liquids, solids – storage and handling of cryogenic liquids - shipping and receiving, stock picking, dock boards, machine and tools, steel strapping and sacking, glass and nails, pitch and glue, boxes and cartons and car loading – personal protection – ergonomic considerations. Fiber rope, types, strength and working load inspection, rope in use, rope in storage - wire rope, construction, design factors, deterioration causes, sheaves and drums, lubrication, overloading, rope fitting, inspection and replacement – slings, types, method of attachment, rated capacities, alloy chain slings, hooks and attachment, inspection

Unit V Mechanical Material Handling 9

Hoisting apparatus, types -cranes, types, design and construction, guards and limit devices, signals, operating rules, maintenance safety rules, inspection and inspection checklist – conveyors, precautions, types, applications. Powered industrial trucks, requirements, operating principles, operators selection and training and performance test, inspection and maintenance, electric trucks, gasoline operated trucks, LPG trucks – power elevators, types of drives, hoist way and machine room emergency procedure, requirements for the handicapped, types- Escalator, safety devices and brakes, moving walks – man lifts, construction, brakes, inspection.

TOTAL: 45 PERIODS

REFERENCES:

1. “Encyclopedia of occupational safety and health”, ILO Publication, 1985
2. “Accident prevention manual for industrial operations” N.S.C., Chicago, 1982.
3. Alexandrov. M.P. ”Material handling equipment” Mir Publishers, Moscow, 1981.
4. APPLE M. JAMES “Plant layout and material handling”, 3rd edition, John Wiley & sons.
5. Spivakosky, “Conveyors and related Equipment”, Vol.I& II Peace Pub. Moscow, 1982
6. Rudenko, N., “Material handling Equipments”, Mir Publishers, 1981.
7. Reymond, A.Kulwice, “Material Handling Hand Book - II”, John Wiley and Sons, New York, 1985.
8. “Safety and good housekeeping”, N.P.C. New Delhi, 1985.

2162ME151	FIREWORKS SAFETY	L	T	P	C
		3	0	0	3

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 Aluminium (Ai) 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-respirable, non-respirable-biological barriers-hazards-personal protective equipment pollution prevention.

UNIT III PROCESS SAFETY **9**

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 – emergency planning in fireworks – Automation of manual process.

UNIT IV MATERIAL HANDLING **9**

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. Transportation: 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

REFERENCES:

1. Ghosh, K.N. “The Principles of Firecrackers”, Economic Enterprises, Sivakasi; 1981.

2. Shanmugam. G. et al, “Fireworks safety 1999: Proceedings of the National seminar held at MSEC”, Sivakasi, on July 17 & 18, 1999.

3. Pyrotech 2013, Proceedings of the 2nd National Fireworks Conference, TamilNadu Fireworks and Amorces Manufacturers' Association (TANFAMA), 2013.

4. Conkling J., “Chemistry of Pyrotechnics: Basic Principles and Theory”, Marcel Dekker Inc., New York; 1985.

5. Shimizu. T., “Firecrackers: The Art, Science and Technique”, Maruzen Co, Tokyo; 1981.

2162ME152	SAFETY IN CHEMICAL INDUSTRY	L	T	P	C
		3	0	0	3

Unit I Safety in Process Design and Pressure System **9**

Design process, conceptual design and detail design, assessment, inherently safer design-chemical reactor, types, batch reactors, reaction hazard evaluation, assessment, reactor safety, operating conditions, unit operations and equipment, utilities. Pressure system, pressure vessel design, standards and codes- pipe works and valves- heat exchangers- process machinery- over pressure protection, pressure relief devices and design, fire relief, vacuum and thermal relief, special situations, disposal- flare and vent systems-failures in pressure system.

Unit II Plant Commissioning and Inspection **9**

Commissioning phases and organization, pre-commissioning documents, process commissioning problems, post commissioning documentation. Plant inspection, pressure vessel, pressure piping system, non -destructive testing, pressure testing, leak testing and monitoring- plant monitoring, performance monitoring, condition, vibration, corrosion, acoustic emission-pipe line inspection.

Unit III Plant Maintenance

Modification and Emergency Planning Management of maintenance, hazards- preparation for maintenance, isolation, purging, cleaning, confined spaces, permit system- maintenance equipment- hot works- tank cleaning, repair and demolition- online repairs- maintenance of protective devices- modification of plant, problems- controls of modifications. Emergency planning, disaster planning, onsite emergency- offsite emergency, APELL.

Unit IV Storages and Transportation **9**

General consideration, petroleum product storages, storage tanks and vessel- storages layout-segregation, separating distance, secondary containment- venting and relief, atmospheric vent, pressure, vacuum valves, flame arrestors, fire relief- fire prevention and protection-LPG storages, pressure storages, layout, instrumentation, vaporizer, refrigerated storages-LNG storages, hydrogen storages, toxic storages, chlorine storages, ammonia storages, other chemical storages-underground storages- loading and unloading facilities- drum and cylinder storage- ware house, storage hazard assessment of LPG and LNG Hazards during transportation – pipeline transport.

Unit V Plant Operations **9**

Operating discipline, operating procedure and inspection, format, emergency procedures-hand over and permit system- start up and shut down operation, refinery units- operation of fired heaters, driers, storage- operating activities and hazards- trip systems- exposure of personnel. Specific safety consideration for Cement, paper, pharmaceutical, petroleum, petro-chemical, rubber, fertilizer and distilleries. **TOTAL: 45 PERIODS**

REFERENCES:

1. Lees, F.P. “Loss Prevention in Process Industries” Butterworths and Company, 1996.
2. “Quantitative Risk Assessment in Chemical Process Industries” American Institute of Chemical Industries, Centre for Chemical Process safety.
3. Fawcett, H.h. and Wood, “Safety and Accident Prevention in Chemical Operations” Wiley inters, Second Edition.
4. “Accident Prevention Manual for Industrial Operations” NSC, Chicago, 1982.
5. GREEN, A.E., “High Risk Safety Technology”, John Wiley and Sons,. 1984.
6. “Petroleum Act and Rules”, Government of India. 7. “Carbide of Calcium Rules”, Government of India.

2162ME113	QUALITY AND RELIABILITY ENGINEERING	L	T	P	C
		3	0	0	3

UNIT I QUALITY CONCEPTS **9**

Basics of quality – Quality objectives – Quality control – Quality Assurance – Quality costs – Quality loss function – Statistical tolerance – Seven tools of Quality

UNIT II STATISTICAL PROCESS VARIABILITY AND CONTROL CHARTS

Process Variability - Control charts for variables and attributes – Process capability studies **9**

UNIT III ACCEPTANCE SAMPLING **9**

Design of experiments – ANOVA - Taguchi methods – Reliability – MTBF – MTTR-Acceptance sampling by variables and attributes – ASN – ATI – AOQL - IS2500 plans – MIL STD 105E

UNIT IV RELIABILITY CONCEPT AND LIFE DATA ANALYSIS 9

Reliability definition – Quality and Reliability– Reliability mathematics – Reliability parameters – Mortality of a component –Mortality curve – Useful life- Data collection –Non Parametric methods: Ungrouped/Grouped, Complete/Censored data – Time to failure distributions: Exponential, Weibull – Probability plotting – Goodness of fit tests.

UNIT V RELIABILITY MODELING, MANAGEMENT AND IMPROVEMENT 9

Different configurations – Redundancy – k out of n system – Complex systems: RBD – Baye's approach – Cut and tie sets – Fault Trees – Standby systems-Life testing methods: Failure terminated – Time terminated – Sequential Testing –Reliability growth monitoring – Reliability allocation – Software reliability-Human reliability-Analysis of downtime – Repair time distribution – System repair time – Maintainability prediction – Measures of maintainability – Inspection decisions –System Availability

TOTAL: 45 PERIODS

REFERENCES

1. Philips J.Ross, Taghuchi techniques for quality engineering, McGraw Hill, New York,1998.
2. Douglus C.Montgomery, Introduction to statistical quality control, 2nd Edition, Jhon Wiley & sons, 1991.
3. E.L. Trant, and Leavensworth, Statistical Quality Control, Mcgraw Hill, 1984

2162ME153	SAFETY IN ON AND OFF SHORE DRILLING	L	T	P	C
		3	0	0	3

UNIT I PRODUCTS 9

Petroleum and Petroleum products – Fuels- Petroleum solvents – Lubricating oils – Petroleum wax, greases – Miscellaneous product

UNIT II OPERATIONS AND HAZARDS 9

On and off shore oil operation – Construction of Installation – Pipe line Construction – Maintenance and repair activities – Safety and associated hazards

UNIT III DRILLING EQUIPMENTS AND HAZARDS 9

Drilling oil – Technique and equipment- Work position –Working condition – safety and associated hazards- lighting and its effects

UNIT IV EXTRACTION AND TRANSPORT **9**

Petroleum Extraction and transport by sea – Oil field products – Operation – Transport of crude by sea – Crude oil hazards.

UNIT V STORAGE **9**

Petroleum product storage and transport –Storage equipment –Precaution –Tank cleaning.

TOTAL: 45 PERIODS

REFERENCES:

1. Encyclopedia of Occupational Health and Safety, Vol. I & II, International Labour Organization, Geneva, 1985.

2. D.A. Ardus and C.D. Green, "Safety in Offshore Drilling: The Role of Shallow Gas Surveys (Advances in Underwater Technology, Ocean Science and Offshore Engineering)", Springer, 1st edition, 1990.

3. Jan-Erik Vinnem, "Offshore Risk Assessment: Principles, Modelling and Applications of QRA Studies", Springer, 1st edition, 2010.

2162ME154	INDUSTRIAL VIBRATION AND NOISE CONTROL	L	T	P	C
		3	0	0	3

UNIT I Basics of Vibration **9**

Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, linear and non linear vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies.

UNIT II Basics of Noise **9**

Introduction, amplitude, frequency, wavelength and sound pressure level, addition, subtraction and averaging decibel levels, noise dose level, legislation, measurement and analysis of noise,

measurement environment, equipment, frequency analysis, tracking analysis, sound quality analysis.

UNIT III Source of Noise and Control **9**

Methods for control of engine noise, combustion noise, mechanical noise, predictive analysis, palliative treatments and enclosures, automotive noise control principles, sound in enclosures, sound energy absorption, sound transmission through barriers.

UNIT IV Vibration Control **9**

Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber- Damped Vibration absorbers -Static and Dynamic Balancing- Balancing machines - Field balancing – Vibration Control by Design Modification- Active Vibration Control. 9 Hours

UNIT V Experimental Methods in Vibration Analysis **9**

Vibration Analysis Overview - Experimental Methods in Vibration Analysis - Vibration Measuring Instruments - Selection of Sensors - Accelerometer Mountings – Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics – Frequency Measuring Instruments - System Identification from Frequency Response -Testing for resonance and mode shapes.

Total: 45 PERIODS

REFERENCES:

1. SingiresuS.Rao - “Mechanical Vibrations” - Pearson Education, ISBM –81297-0179-0 -2004.

2. KewalPujara “Vibrations and Noise for Engineers, Dhanpat Rai & Sons,1992.

3. Bernard Challen and RodicaBaranescu - “Diesel Engine Reference Book” – Second edition - SAE International - ISBN 0-7680-0403-9 – 1999.

4. Julian Happian-Smith - “An Introduction to Modern Vehicle Design”- Butterworth- Heinemann, ISBN 0750-5044-3 – 2004.

5. John Fenton - “Handbook of Automotive body Construction and Design Analysis –Professional Engineering Publishing, ISBN 1-86058-073-1998.

6. Rao V. Dukkipati and J.Srinivas ,”Text book of Mechanical Vibrations”,

2162ME155	OCCUPATIONAL HEALTH AND ENVIRONMENTAL MANAGEMENT SYSTEMS	L	T	P	C
		3	0	0	3

UNIT I OHSAS STANDARD **9**

Introduction – Development of OHSAS standard – Structure and features of OSHAS 18001 – Benefits of certification-certification procedure – OH and S management system element, specification and scope - Correspondence between OHSAS 18001:2007, ISO 14001:2004 and ISO 9001:2000-Correspondence between OHSAS 18001, OHSAS 18002, and the ILO-OSH:2001.

UNITII OHSAS 18001 POLICY AND PLANNING, IMPLEMENTATION AND OPERATION **9**

General requirements, OH&S policy, Planning - Hazard identification, risk assessment and determining controls - Legal and other requirements - Objectives and programme(s), Implementation and operation - Resources, roles, responsibility, accountability and authority Competence, training and awareness - Communication, participation and consultation -

Communication - Participation and consultation, Documentation - Control of documents- Operational control - Emergency preparedness and response.

UNIT III CHECKING AND REVIEW AND GUIDELINES **9**

Checking- Performance measurement and monitoring-Evaluation of compliance-Incident investigation, nonconformity, corrective action and preventive action-Control of records-Internal audit-Management review - guidelines for implementation of 18001:2007 -Examples of items for hazard identification checklist –Comparison of risk assessment tool and methodologies.

UNIT IV ISO 14001 **9**

EMS, ISO 14001-Environmental management systems — Requirements with guidance for use-Environmental management system requirements- Environmental policy- Environmental aspects-Legal and other requirements- Objectives, targets and programme(s)- Implementation and operation- Checking- Management review- Guidance for use Principles (ISO 14004), clauses 4.1 to 4.5. Documentation requirements, 3 levels of documentation for an ISO 14000 based EMS, steps in ISO 14001.Implementation plan, Registration, Importance of ISO 14000 to the Management. Auditing Guidelines for environmental management systems auditing -General principles, Managing audit programme- Audit activities, steps in audit, Audit plan. Competence of auditors.

UNIT V ENVIRONMENT IMPACT ASSESSMENT **9**

ISO 14040(LCA), General principles of LCA, Stages of LCA, Report and Review. ISO 14020 (Eco labelling) – History, 14021, 14024, Type I labels, Type II labels, ISO 14024, principles, rules for eco labelling before company attempts for it. Advantages. EIA in EMS, Types of EIA, EIA methodology EIS, Scope, Benefits. Audit-methodology, Auditors Audit results management review-Continual improvement. **TOTAL: 45 Hours**

REFERENCES:

1. “Occupational Health and Safety Assessment Series BS (OHSAS) 18001:2007” BSI, UK, 2007.
2. “OHSAS 18002, Occupational Health and Safety Management Systems – Guidelines for the Implementation of OHSAS 18001”, OHSAS project group, 2008.
3. “ISO14001:2004, Environmental Management Systems Requirements with Guidance for Use”, ISO, 2004.
4. “Guidelines on Occupational Health and Safety Management Systems (OSH-MS)” International Labour Organization, 2001.
5. “BS 8800: 2004 Occupational Health and Safety Management

2162ME156	DESIGN OF INDUSTRIAL VENTILATION SYSTEM	L	T	P	C
		3	0	0	3

UNIT I GENERAL PRINCIPLES OF VENTILATION **9**

Introduction,-supply and Exhaust systems-Basic definitions-Principles of air flow-Acceleration of air and Hood entry losses-Duct losses Multiple hood exhaust system.

UNIT II GENERAL INDUSTRIAL VENTILATION **9**

Dilution Ventilation Principles- Dilution Ventilation for health- Dilution Ventilation for fire and explosion-Heat Control-Heat balance and Exchange-Adaptive mechanisms of the body-Acclimatisation-Acute heat disorders-Assessment of heat stress and strain-Ventilation control-and ventilation system - Radiant heat control – Enclosures and Insulation – Personal Protective Equipments-Protective suits and refrigerated suits.

UNIT III LOCAL EXHAUST HOODS AND AIR CLEANING DEVICES 9

Air contamination Characteristics –Hood types-Hood design factors Hood losses-Minimum Duct velocity-Special hood requirements-Push –pull ventilation-Hot processes-Air cleaning devices-selection –types – Explosion venting.

UNIT IV DESIGN AND TESTING OF INDUSTRIAL VENTILATION 9

Exhaust system design procedure-steps-duct segment calculations – Distribution of air flow-Plenum Exhaust system-Fan Pressure calculations-Corrections for velocity changes-Duct material – friction losses- Construction guidelines for local Exhaust system – Fan selection –Replacement and recirculated air-Distribution –Flow rate-Air conservation-Ventilation aspects of indoor air quality-Testing of ventilation system-Measurement of volumetric flow rate-Calibration of air measuring instrument- pressure measurement–Check out procedure.

UNIT V VENTILATION SYSTEM FOR SPECIFIC OPERATIONS 9

Cleaner rooms-Filling operations-foundry operations-Gas treatment Laboratory Ventilation-Machining-Metal melting furnaces-Mixing operations- Movable exhaust hoods-open surface tanks-painting operations- Mechanical surface cleaning and finishing –Welding and cutting – wood working.

TOTAL: 45 PERIODS

REFERENCES:

1. ACGIH Industrial Ventilation “A Manual of Recommended Practice for Design”, 28th edition 2013.
2. “Accident Prevention Manual for Industrial Operations” N.S.C., Chicago, 1992.
3. Jeanne Mager Stellman, “Encyclopaedia of Occupational Health and Safety”, Vol. I and II, 4th edition, published by International Labour office, Geneva, 1998. 2000.

2162ME180	SAFETY IN CONSTRUCTION INDUSTRIES	L	T	P	C
		3	0	0	3

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 work platforms 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

REFERENCES:

1. Hudson, R.,"Construction hazard and Safety Hand book, Butter Worth's, 1985.
2. Jnathea D.Sime, "Safety in the Build Environment", London, 1988.
3. V.J.Davies and K.Thomasin "Construction Safety Hand Book" Thomas Telford Ltd., London, 1990.
4. Handbook of OSHA Construction safety and health charles D. Reese and James V. Edison
5. Fulman, J.B., Construction Safety, Security, and Loss Prevention, John Wiley and Sons, 197

Vel Tech

Rangarajan Dr. Sagunthala

R&D Institute of Science and Technology

(Deemed to be University Estd. u/s 3 of UGC Act, 1956)

CURRICULUM AND SYLLABUS

for

M. Tech - Metallurgical and Materials Science

FOUNDATION COURSE					
Code	**Course**	**L**	**T**	**P**	**C**
		3	2	0	4

PROGRAMME CORE						
Sl. No	**Code**	**Course**	**L**	**T**	**P**	**C**
Theory Courses						
1	**2161ME158**	Advanced Industrial Process	3	2	0	4
2	**2161ME159**	Physical Metallurgy of Alloys	3	2	0	4
3	2161ME103	Mechanical Behaviour of Materials	3	2	0	4
4	2161ME104	Metallurgical Thermodynamics	3	2	0	4
5	2161ME105	Heat Treatment of Ferrous and Nonferrous Alloys	3	0	0	3
6	2161ME107	Material Characterization	3	0	0	3
7	**2161ME165**	Smart Materials	3	0	0	3
8	**2161ME166**	High Temperature Materials	3	0	0	3
		Total Credits				**28**
Laboratory Courses						
1	2161ME301	Materials Testing Laboratory	0	0	2	1
2	2161ME302	Metallography and Heat Treatment Laboratory	0	0	2	1
		Total Credits				**02**

PROGRAMME ELECTIVE (ANY FOUR)						
1	2162ME101	Polymers and Composite Materials	3	0	0	3
2	2162ME102	Non-Destructive Evaluation	3	0	0	3
3	2162ME104	Corrosion Engineering	3	0	0	3
4	2162ME105	Selection of Materials For Design	3	0	0	3
5	2162ME106	Ceramic Materials	3	0	0	3
6	2162ME108	Nano Materials	3	0	0	3
7	2162ME109	Failure Analysis of Engineering Components	3	0	0	3
8	2162ME110	Advanced Additive Manufacturing	3	0	0	3
9	2162ME112	Sustainable Design	3	0	0	3
10	2162ME111	Advanced Optimization Techniques	3	0	0	3
11	**2162ME190**	Surface Engineering	3	0	0	3
12	**2162ME191**	Quality, Reliability and Standards	3	0	0	3
13	**2162ME192**	Advanced Finite Element Methods	3	0	0	3
		Total Credits to be earned from Programme Elective				**12**

INDEPENDENT LEARNING COURSES					
COURSE CODE	**COURSE TITLE**	**L**	**T**	**P**	**C**
	Massive Open Online Course	-	-	-	2
2163ME501	Research Seminar [**OR**]	-	-	-	
2163ME801	Field Study [**OR**]	-	-	-	2
2163ME802	Internship	-	-	-	
2163GE401	Business Communication [**OR**]	-	-	-	2
2163GE402	Technical Writing Tools	-	-	-	
2163MG401	Research Methodology	-	-	-	2
				Total Credits	**8**

PROJECT WORK					
COURSE CODE	**COURSE TITLE**	**L**	**T**	**P**	**C**
2164ME601	Project Phase I	0	0	20	10
2164ME701	Project Phase II	0	0	32	16
				Total Credits	**26**

PROGRAMME STRUCTURE AND MINIMUM CREDITS REQUIRED

IN COURSE CATEGORIES

SECTION NUMBER	COURSE CATEGORY	MINIMUM CREDITS REQUIRED
7.2.1	**FOUNDATION COURSE**	**04**
7.2.2	**PROGRAM CORE COURSES**	**30**
7.2.3	**PROGRAM ELECTIVE COURSES**	**12**
7.2.4	**INDEPENDENT LEARNING COURSES**	**8**
7.2.5	**PROJECT WORK**	**26**
	TOTAL CREDITS	**80**

COURSE CODE	ADVANCED INDUSTRIAL PROCESSES	L	T	P	C
2161ME158		4	0	0	4

UNIT I: INTRODUCTION **12**

Introduction to manufacturing processes – different approaches – technical and economic considerations – significance of material properties with respect to selection of manufacturing process. Metallurgical aspects, microstructure variations among different production process

UNIT II: CASTINGS **12**

Conventional casting processes – advantages and limitations – melting practices – design of castings – special casting processes. Metallurgy of castings- solidification and cooling rate control

UNIT III: MATERIAL JOINING AND MACHINING **12**

Conventional material joining processes – concept of weldability – need for dissimilar joints- machining processes – concept of machinability – material examples – developments in machining processes. Metallurgy of weldments, residual strain on machining

UNIT IV: FORMING PROCESSES **12**

Rolling – forging – extrusion – drawing - sheet metal forming – classification, advantages and limitations. Metallurgical aspects of forging – forging defects and its relationship with composition

UNIT V: MODERN PROCESSES **12**

Introduction to EDM, ECM , Friction welding – Recent developments in metal joining processes, forging and mechanical alloying - concept of near net shape processing - concept and applications of rapid prototyping –metallic FDM- emerging technologies for nano – processing.

TOTAL: 60 PERIODS

REFERENCES

1. Rao.P.N, 'Manufacturing Technology', Tata McGraw Hill, 1996.
2. Kalpakjian.S, 'Manufacturing Engineering and Technology', 3rd Edition, Addison-Wesly.
3. Rusinoff.S.E, Forging and forming of metals, D.B. Taraporevala Son & Co. Pvt Ltd., Mumbai, 1995.
4. Sabroff.A. M. & Others, Forging Materials & Processes, Reinhold Book Corporation, New York, 1988.
5. Upton, Pressure Die Casting, Pergamon Press, 1985.
6. High Velocity Forming of Metals, ASTME, Prentice Hall of India (P) Ltd., New Delhi, 1990.

COURSE CODE	PHYSICAL METALLURGY OF ALLOYS	L	T	P	C
2161ME159		3	2	0	4

UNIT I: CRYSTALLOGRAPHY AND CRYSTAL DEFECTS **12**

Crystal systems - Detailed discussion of common crystal structures in metals and alloys – Crystal defects: Classification - Point, line, area and volume defects. Dislocation and slip, Twins - Voids-types and location in BCC, FCC and HCP structures - influence of defects on properties – Introduction to nanostructures, metallic glasses, Quasi-crystals

UNIT II: ALLOYING THEORY AND PHASE DIAGRAMS **12**

Types of solid solutions and compounds – Hume - Rothery rules for formation of substitutional solid solutions – Properties of solid solutions. Essential principles of solidification – Determination and uses of phase diagrams – Types of phase reactions with examples – Phase rule and its application to phase diagrams – Lever rule – Fe-C phase diagram – Classification of Fe Alloys - Concept of ternary phase diagrams-Exercise problems.

UNIT III: FERROUS ALLOYS & DIFFUSION **12**

Effects of alloying additions in steels; classifications of Steels and Cast iron, Effect of stabilizers in Fe-FeC Diagram, Austenite Stabilizer- Phase diagram, Ferrite Stabilizer- Phase diagram. Stainless Steels – Different types - Properties and Applications, Cast Iron – properties and applications.

Diffusion - Concept of activation energy- Mechanisms of diffusion - Fick's 1st Law of diffusion – Diffusion coefficient-factors affecting diffusion coefficient – Fick's 2nd Law of diffusions-inter diffusion – Kirkendall effect-Modes of diffusion (surface, volume and grain boundary) - Industrial applications - Numerical problems.

UNIT IV: NON-FERROUS ALLOYS **12**

Cast and wrought Aluminum Alloys - Classification system and grades of alloys- Age Hardenable Aluminum Alloys- Properties and Applications. Copper and its alloys: Classification of Alloys and Grades, Classification of Bronze and Brass - Copper – Zinc phase diagram, Copper –Tin phase diagram, Physical, chemical, mechanical properties and applications.

UNIT V: TITANIUM and OTHER ALLOYS **12**

Titanium and its Alloys - Stablizers, Alpha titanium alloys, Beta titanium alloys, Alpha–Beta Titanium alloys, Titanium Aluminide – properties and applications – Nickel based Alloys, Magnesium Alloys – Classifications, properties and applications, Zinc based alloys, Tin & Antimony base alloys, Refractory metals and alloys for high temperature applications.

TOTAL: 60 PERIODS

REFERENCES

1. S.H.Avner, “Introduction to Physical Metallurgy”, second edition, McGraw Hill, 1985.
2. V.Raghavan, “Physical Metallurgy”, Prentice Hall of India, 1985.
3. I.J. Polmear, ”Light Alloys: Metallurgy of Light Metals”, John Wiley & Sons 1996
4. T.V.Rajan, C.P.Sharma, Ashok Sharma, “Heat Treatment Principles and Techniques” Prentice-Hall of India Pvt. Ltd., New Delhi, 2002
5. Vijendra Singh, “Heat Treatment of Metals”, First edition, Standard Publisher Distributors New Delhi, 1998.

6. Henkel & Pense, “Structure and Properties of Engineering materials”, 2001

COURSE CODE	MECHANICAL BEHAVIOUR OF MATERIALS	L	T	P	C
2161ME103		3	2	0	4

UNIT I: STRESS -STRAIN BEHAVIOUR **12**

Strength of materials- basic assumptions, elastic and plastic behaviour, stress–strain relationship for elastic behaviour, elements of plastic deformation of metallic materials – Mohr’s circle, yielding theories

UNIT-II : DISLOCATION AND STRENGTHENING MECHANISMS **12**

Elements of theory of plasticity, dislocation theory properties of dislocation, stress fields around dislocations, application of dislocation theory to work hardening, solid solution strengthening, grain boundary strengthening, dispersion hardening.

UNIT-III: DUCTILE AND BRITTLE FAILURE **12**

Ductile and brittle fracture, Charpy and Izod testing, significance of DBTT, ECT, NDT and FATT; elements of fractography - Griffith’s theory, LEFM– COD and J integral determination of KIC, COD and J integral

UNIT-IV: FATIGUE AND CORROSION **12**

Characteristics of fatigue failure, initiation and propagation of fatigue cracks, factors affecting fatigue strength and methods of improving fatigue behaviour – testing analysis of fatigue data, mechanics of fatigue crack propagation, Corrosion- mechanism – types of corrosion – characteristics – Effect of various parameters- measurement of corrosion –Types of corrosion prevention – Corrosion fatigue

UNIT-V: CREEP **12**

Introduction to creep - creep mechanisms, creep curve, variables affecting creep, accelerated creep testing, development of creep resistant alloys, Larsen Miller parameter – Manson Hafred parameter.

TOTAL: 60 PERIODS

REFERENCES

1. Dieter G. E., ‘Mechanical Metallurgy’, 3rd Edition, McGraw Hill, 1988
2. Raghavan, V., “Physical Metallurgy”, Prentice Hall of India, 1985.
3. Suryanarayana, ‘Testing of Metallic Materials’, Prentice Hall India, 1979.
4. Rose R. M., Shepard L. A., Wulff J., ‘Structure and Properties of Materials’, Volume III, 4th Edition, John Wiley, 1984

COURSE CODE	METALLURGICAL THERMODYNAMICS	L	T	P	C
2161ME104		3	2	0	4

UNIT-I: INTRODUCTION TO THERMODYNAMICS L-9 T-6

Introduction to thermodynamics and kinetics – different approaches – emphasis on metallurgical thermodynamics, transport phenomena and applications

UNIT-II: LAWS OF THERMODYNAMICS L-9 T-6

Laws of thermodynamics and related applications – concepts of free energy and entropy – criteria for spontanity

UNIT-III: INTRODUCTION TO SOLUTIONS L-9 T-6

Introduction to solutions – partial molar entities – Gibbs Duhem relations – thermodynamic aspects of metallic solutions and salt melts – Raoult's Law and Henry's Law - regular and quasi chemical models.

UNIT-IV: THERMODYNAMIC ASPECTS OF PHASE DIAGRAMS L-9 T-6

Thermodynamic aspects of phase diagrams – similarity in thermodynamic approach towards different classes of materials – thermodynamic aspects of defect formation in metals and ceramics – approaches used in chemical modeling

UNIT-V: PRINCIPLES OF METALLURGICAL KINETICS L-9 T-6

Principles of metallurgical kinetics – reaction rates and reaction mechanisms – overview of mass transfer, heat transfer and fluid flow – related applications in metallurgical processes – role of transport phenomena in mathematical and physical modeling.

TOTAL 45+30 = 75 PERIODS

REFERENCES

1. Gaskell, David R., 'Introduction to Metallurgical Thermodynamics', McGraw Hill, 1973
2. Mohanty, A. K., "Rate Processes in Metallurgy", Prentice Hall of India (EEE), 2000
3. David R. Gaskel,"Introduction to Metallurgical Thermodynamics" McGraw Hill, 2008

COURSE CODE	HEAT TREATMENT OF FERROUS AND NON-FERROUS ALLOYS	L	T	P	C
2161ME105		3	0	0	3

UNIT I: TRANSFORMATION IN STEELS **9**

Iron - Carbon equilibrium diagram: Transformations on heating and cooling, influence of alloying elements, general principles of heat treatment of steels, isothermal and continuous cooling transformations in steels. Continuous cooling curves TTT and CCT diagrams. Mechanism of pearlitic, bainitic and martensitic transformations.

UNIT II: HEAT TREATMENT PROCESSES **9**

Annealing, Normalizing, Hardening - retained austenite - measurement and methods of its elimination, hardenability studies- Jominy end quench test, Grossman's experiments. Tempering-Hollomon & Jaffe tempering correlations, Austempering and Martempering, Precipitation hardening, thermo-mechanical treatment, inter-critical heat treatment, other heat treatment processes - splat cooling. Induction and Flame hardening

UNIT III: CASE HARDENING **9**

Introduction, carburizing: principle, carbon potential, mechanism, application of Fick's law, depth of carburization and its control, methods of carburizing, heat treatment after carburizing, structure, properties and common problems in carburizing. Nitriding: introduction, steels used, mechanism, effect of microstructure, white layer, nitriding methods, ion nitriding and nitro-carburizing. Induction and flame hardening: principle, methods, operating variables. Measurement of case depth

UNIT IV: HEAT TREATMENT EQUIPMENT **9**

Various heating media used for heat treatment. Temperature and atmosphere control, carburizing atmosphere and carbon potential measurement, nitriding gas atmospheres. Quenching media and their characteristics. Various heat treatment furnaces, fluidized bed furnaces, cryo chamber, cryo treatment of steels, sealed quenched furnace, plasma equipment.

UNIT V: HEAT TREATMENT OF SPECIFIC ALLOYS **9**

Heat treatment of carbon steels, various types of tool steels, high speed steels, maraging steels and die steels. Heat treatment of gray cast irons, white cast irons, malleabilising and S.G irons, Austempering of S.G.Iron – Heat treatment of aluminium alloys – copper alloys and nickel alloys – Defects in heat treated parts: causes and remedies. **TOTAL: 45 PERIODS**

REFERENCES

1. Rajan, T. V., Sharma C. P., Ashok Sharma., "Heat Treatment Principles And Techniques" Prentice-Hall of India Pvt. Ltd., New Delhi, 2002
2. Vijendra Singh, "Heat Treatment of Metals", First edition, Standard Publisher Distributors New Delhi, 1998.
3. American Society for Metals, "Metals Handbook Vol. 4", ASM Metals Parks. Ohio, USA, 1991

4. Prabhudev. K H. “Handbook of Heat Treatment of Steels”, Tata McGraw-Hill Publishing Co., New Delhi, 1988.
5. Novikov,.I., “Theory of Heat Treatment of Metals”, MIR Publishers, Moscow, 1978
6. Thelning K. E., “Steel and its heat treatment”, Bofors Handbook, 1975.

COURSE CODE	MATERIAL CHARACTERIZATION	L	T	P	C
2161ME107		3	0	0	3

UNIT-I: METALLURGICAL MICROSCOPE 9

Numerical aperture, limit of resolution, depth of field and depth of focus - lens defects and correction- bright field and dark field illumination - polarised light, phase contrast, interference contrast, hot-stage, in-situ techniques, quantitative metallography

UNIT-II: X-RAY DIFFRACTOMETER 9

Generation of X-rays- Bragg’s law, Powder, rotating crystal and Laue methods, stereographic projections and reciprocal lattice; X-ray residual stress measurement

UNIT-III: SCANNING ELECTRON MICROSCOPE 9

Secondary Electrons, Back Scattered Electrons, Auger Electrons – properties, working principle construction and applications of Scanning Electron Microscope – Elemental analysis by WDS and EDS systems - Fracture Analysis of samples

UNIT-IV: TRANSMISSION ELECTRON MICROSCOPE 9

Working principle, construction and applications of TEM, TEM specimen preparation techniques;

UNIT-V: OTHER TECHNIQUES 9

X-ray fluoroscopy, spectrometry, Auger spectroscopy, DTA, DSC and TGA, working principle, applications – Types and applications of strain gauges

TOTAL: 45 PERIODS

REFERENCES

1. Smallman R. E., ‘Modern Physical Metallurgy’, 4th Edition, Butterworths, 1985
2. Philips V. A., ‘Modern Metallographic Techniques and their Applications’, Wiley Inderscience, 1971
3. Cullity B. D., ‘Elements of X-ray Diffraction’, 4th Edition, Addison Wiley, 1978
4. Loretto M. H., ‘Electron Beam Analysis of Materials’, Chapman and Hall, 1984

COURSE CODE	SMART MATERIALS	L	T	P	C
2161ME165		3	0	0	3

UNIT I: INTRODUCTION TO INTELLIGENT MATERIALS **9**

Intelligent materials: Primitive functions of intelligent materials; Intelligence inherent in materials; Materials intelligently harmonizing with humanity; Intelligent biological materials.

UNIT II: SMART MATERIALS AND STRUCTURAL SYSTEMS **9**

Actuator materials; Sensing technologies; Micro-sensors; Intelligent systems; Hybrid smart materials; Passive sensory smart structures; Reactive actuator-based smart structures; Active sensing and reactive smart structures; Smart skins

UNIT III: ELECTRO-RHEOLOGICAL (ER) FLUIDS **9**

Electro-Rheological (ER) Fluids: Suspensions and electro-rheological fluids; electro-rheological phenomenon; Charge migration mechanism for the dispersed phase; Electro-rheological fluid actuators.

Piezoelectric Materials: Background; Piezoelectricity; Industrial piezoelectric materials; Smart materials featuring piezoelectric elements.

UNIT IV: SHAPE MEMORY MATERIALS **9**

Background on shape-memory alloys; Applications of shape-memory-alloys; Continuum applications: structures and machine systems; Discrete applications; Impediments to applications of shape-memory-alloys; Shape-memory-plastics.

Fibre-optics: an overview; Advantages of fibre-optics; Light propagation in an optical fibre; Embedding optical fibre in fibrous polymeric thermosets; Fibre-optic strain sensors.

UNIT V : PIEZOELECTRIC VIBRATIONS ABSORBER SYSTEMS **9**

Introduction; The single mode absorber, theory, design solution, extension including viscous modal damping, the electromechanical coupling coefficient, inductance, experimental results; The multimode absorber, derivation of transfer function, design solution, self-tuning absorber, performance function, control scheme.

TOTAL: 45 PERIODS

REFERENCES

1. M.V. Gandhi, and B.S. Thompson, Smart Materials and structures (2nd edition), Chapman & Hall, 1992
2. Guran, H.S. Tzou, G.L. Anderson, and M. Natori, Structure Systems: Smart Structures, Devices and System (Part 1), and Materials and Structures (Part 2), World Scientific Publications, 1998

3. U. Gabbert, and H.S. Tzou, Smart Structures and Structuronic System, Kluwer Academic Publishers, 2001
4. H.T. Banks, R.C. Smith, and Y.W. Qang, Smart Material structures: Modeling, Estimation and Control (6th edition), John Wiley & Sons, 1999
5. Bryan Culshaw, Smart Structures and Materials, Artech House, 1996
6. Mel Schwartz, Encyclopedia of Smart Materials, 2 Volume set, March 2002

COURSE CODE	HIGH TEMPERATURE MATERIALS	L	T	P	C
2161ME166		3	0	0	3

UNIT I: HIGH TEMPERATURE FAILURES **9**

Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage, ductile fracture due to microvoid coalescence – diffusion controlled void growth, fracture maps for different alloys and oxides.

UNIT II: CREEP **9**

Factors influencing functional life of components at elevated temperatures, high temperature failure – creep, creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate. Expressions for rupture life for creep, Monkman - grant relationship.

UNIT III: OXIDATION AND HOT CORROSION **9**

Oxidation, Pilling – Bedworth ratio, kinetic laws of oxidation – defect structure and control of oxidation by alloy additions – sulphation, hot gas corrosion deposit, modified hot gas corrosion, effect of alloying elements on hot corrosion.

UNIT IV: FERROUS SUPER ALLOYS **9**

Iron based super alloys composition control, strengthening mechanisms, precipitation hardening, properties and applications

UNIT V: NON-FERROUS SUPER ALLOYS **9**

Nickel based super alloys and cobalt based super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase – embrittlement, solidification of single crystals.

TOTAL: 45 PERIODS

REFERENCES

1. Raj R, “Flow and Fracture at Elevated Temperatures” American Society for Metals, 1985
2. Hertzberg R. W, “ Deformation and Fracture Mechanics of Engineering Materials”, 4th Edition, John Wiley, 1996
3. Courtney T. H, “Mechanical Behaviour of Materials”, McGraw Hill, 1990.
4. Ceramic processing and Sintering by M.N. Rahman, Mercel Dekker,2003

5. Handbook of advanced ceramics, parts 1 and 2, S. Somiya, Academic press,2006

COURSE CODE	MATERIALS TESTING LABORATORY	L	T	P	C
2161ME301		0	0	2	1

1. Tensile Testing of Carbon steels using Universal testing machine
2. Tensile testing of Aluminum alloys using Universal testing machine
3. Hardness Measurements of carbon steels using Rockwell hardness Tester
4. Hardness Measurements of carbon steels using Brinell Hardness Tester
5. Hardness Measurements of carbon steels using Vicker's Hardness Tester
6. Impact Testing of different Materials
7. Fatigue life measurements of Aluminum Metal
8. To find the Modulus of rigidity of the material of a spring by conducting Compression

TOTAL: 30 PERIODS

COURSE CODE	METALLOGRAPHY AND HEAT TREATMENT LABORATORY	L	T	P	C
2161ME302		0	0	2	1

List of Experiments

1. Sample preparation for metallographic examination
2. Microscopic examination of Plain carbon steels
3. Microscopic examination of Cast Iron
4. Microscopic examination of Stainless steels
5. Microscopic examination of steels and Tool steels
6. Microscopic examination of Annealed, Normalized and Quenched carbon steels
7. Microscopic examination of Magnesium alloys
8. Microscopic examination of Aluminum alloys
9. Microscopic examination of Titanium Alloys
10. Microscopic examination of Copper alloys

TOTAL: 30 PERIODS

COURSE CODE	POLYMERS AND COMPOSITE MATERIALS	L	T	P	C
2162ME101		3	0	0	3

UNIT I: POLYMERS AND ELASTOMERS **9**

Polymers – Introduction, Types of Polymers – Thermosets Vs Thermoplastics, Polymerization-addition polymerization, Condensation Polymerization, Classes and types of thermoplastics: Amorphous Vs Semi-crystalline, High performance plastics, Properties, scope and limitations. Natural and Synthetic rubbers (Different Standards) like – NR, SBR, BR, IIR, NBR, SBR, fluorocarbons, silicone, etc – their functional properties and applications. Study of various additives like peptizers, antioxidants, accelerators, activators, fillers, carbon black, chords and fabrics, blowing agents, colorants, processing aids like – tackifiers, plasticizers, extender oils etc. Processing of rubbers by - extrusion, calendaring and injection molding

UNIT II: POLYMERS MANUFACTURING PROCESS **9**

Injection molding, Reaction injection molding (RIM), Transfer molding, Extrusion, compression molding, blow molding, scopes and limitations of various manufacturing processes, mold making, safety in handling of materials, hands on training on processes and applications.

UNIT III: COMPOSITES AND POLYMER MATRIX COMPOSITES **9**

Definition; Types; General properties and characteristics, Rule of Mixture; Matrix materials – characteristics, Reinforcing materials – particles, fibers- fiber length, continuous, discontinuous, short fibers, Young's Modulus – Continuous Aligned Fiber, Discontinuous fiber, whiskers and Properties. Fiber Reinforced Reinforcing materials – particles, fibers, whiskers; Properties of reinforcing materials; Matrix materials; Additives; Properties of FRP materials; applications.

UNIT IV: METAL AND CERAMIC MATRIX COMPOSITES **9**

Introduction – Matrix Material – types, advantages and characteristics, Reinforcing materials - types, advantages and characteristics – Types of MMC- Aluminum Metal Matrix Composites, Titanium Metal Matrix Composites and magnesium based composites. Ceramic Matrix Composites – carbon- carbon composites, Alumina based Composites, Titanium carbide-based composites – Applications.

UNIT V: COMPOSITE MANUFACTURING **9**

Manufacturing Processes: Open mold processes – Hand layup, Spray up, Vacuum bag, Pressure bag & autoclave, Centrifugal casting, Filament winding; Closed mold processes – Compression molding, Resin transfer molding (RTM), Injection molding, Pultrusion; SMC & DMC products, etc.

TOTAL: 45 PERIODS

REFERENCES

1. Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier
2. Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 lGB, UK.
3. Ceramic matrix composites, K.K. Chawala, 1st ed., (1993) Chapman & Hall, London.
4. Advances in composite materials, G. Piatti, (1978) Applied Science Publishers Ltd., London.
5. Premamoy Ghosh, Polymer Science and Technology, Second Edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2002
6. Composite materials, K.K. Chawala, 2nd ed., (1987) Springer-Verlag, New York.
7. Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.

COURSE CODE	NON-DESTRUCTIVE EVALUATION	L	T	P	C
2162ME102		3	0	0	3

UNIT I: VISUAL INSPECTION AND LIQUID PENETRANT TESTING **9**

Non Destructive Testing – definition, Benefits and advantages, Visual Inspection- tools, applications and limitations – Liquid Penetrant Inspection - principles, types and properties of penetrants and developers, Procedural steps involved in Liquid Penetrant Testing Water Washable and Post Emulsification Testing methods, Advantages and limitations, Industrial Applications of LPI.

UNIT II: MAGNETIC PARTICLE INSPECTION AND EDDY CURRENT TESTING **9**

Magnetic particle inspection - Introduction, principles, types of magnetization methods – continuous and residual methods, procedural steps, advantages and limitations, Industrial applications, Eddy Current Testing – Introduction, Principle, Skin effect, Lift off, Types of probes, Types of display methods, advantages, limitations and applications.

UNIT III: ULTRASONIC TESTING **9**

Ultrasonic testing (UT) - Nature of sound waves, wave propagation - modes of sound wave generation - Ultrasonic wave generation, Attenuation of sound waves, types of transducers- Normal probes, angle probes, types of Display systems – A Scan, B Scan and C Scan display systems, types inspection techniques – Transmission and reflection methods, Calibration Blocks, advantages, disadvantages and applications.

UNIT IV: RADIOGRAPHY **9**

Radiography testing (RT) – Principles, Radiation sources – X rays and Gamma rays, Attenuation of radiation, Shadow formation, enlargement and distortion, Radiographic films and screens, Inspection techniques – single wall single image, double wall single image, double wall double image, panoramic and multiwall multi images techniques, Radiation hazards, protection, Real time radiography, Advantages and limitations and industrial applications.

UNIT V: ACOUSTIC EMISSION AND THERMOGRAPHY **9**

Principle of AET, Instrumentation, Applications - testing of metal pressure vessels, Fatigue crack detection in aerospace structures – Thermography - Principles, types, applications, advantages, limitations and application

TOTAL: 45 PERIODS

REFERENCES

1. Practical Non – Destructive Testing, Baldev raj, Narosa Publishing House (1997).
2. Non-Destructive Testing, B.Hull and V.John, Macmillan (1988)
3. ASM Metals Handbook “Failure Analysis and Prevention”, ASM Metals Park. Ohio, Vol.10, 10th Edition, 1995
4. Colangelo.V.J. and Heiser.F.A., “Analysis of Metallurgical Failures”, John Wiley and Sons Inc. New York, USA, 1974.
5. Krautkramer, Josef and Hebert Krautkramer, Ultrasonic Testing of Materials, 3rd edition, New York, Springer-Verlag (1983).

COURSE CODE	CORROSION ENGINEERING	L	T	P	C
2162ME104		3	0	0	3

UNIT I: BASICS OF CORROSION **9**

Principles of corrosion phenomenon: Thermodynamics and kinetics: emf / galvanic series, Pourbaix diagram, exchange current density, passivity, Evans diagram, flade potential.

UNIT II: TYPES OF CORROSION **9**

Different forms of corrosion: atmospheric / uniform, pitting crevice, inter-granular, stress corrosion, corrosion fatigue, de-alloying, high temperature oxidation – origin and mechanism with specific examples.

UNIT III: CORROSION TESTING AND MONITORING **9**

Corrosion testing and monitoring techniques, non – Electrochemical methods, weight loss method, Tafel linear polarization and impedance techniques, lab, semi plant & field tests, susceptibility test.

UNIT IV: CORROSION PREVENTION **9**

Corrosion prevention through design, coating, inhibitors, cathodic, anodic protection, specific applications, economics of corrosion control.

UNIT V: CORROSION IN INDUSTRIES **9**

Corrosion & its control in industries: power, process, petrochemical, ship building, marine and fertilizer industries. Some case studies – corrosion and its control in different engineering materials: concrete structures, duplex, super duplex stainless steel, ceramics, composites and polymers. Corrosion auditing in industries, corrosion map of India

TOTAL: 45 PERIODS

REFERENCES

1. Fontana. M.G., Corrosion Engineering, Tata Mcgraw Hill, 3rd Edition, 2005
2. Jones. D.A. Principles and Prevention of Corrosion, 2nd Edition, Prentice Hall, 1996.

COURSE CODE	SELECTION OF MATERIALS FOR DESIGN	L	T	P	C
2162ME105		3	0	0	3

UNIT I: INTRODUCTION TO MATERIALS DESIGN **9**

Classification of design – Classification of materials – Engineering materials and their properties applied to design - Technologically important properties of materials, Physical, Chemical, Mechanical and Electrical properties of materials. Selection of materials - Principles of design optimization - Future trends – CAD, Criteria of selection of materials like properties, cost, manufacturing process, availability, legal and safety factors

UNIT II: MATERIALS FOR MECHANICAL FAILURE RESISTANCE **9**

Stiffness, strength, ductility, theories of failure, notch sensitivity – Materials selection for various types of loading - ties, columns, beams, shafts, and shells – Materials selection for fracture and fatigue resistance.

UNIT III: MATERIALS FOR CORROSION AND WEAR RESISTANCE **9**

Materials for atmospheric, soil, water, acid and alkaline resistance, Corrosion prevention coatings, material for Chemical and Petroleum industries, materials and coatings for wear resistance.

UNIT IV: MATERIALS FOR HIGH AND LOW TEMPERATURES **9**

High temperature strength and stability, Hot hardness requirements, High temperature steels and super alloys, ductile to brittle transition-HSLA steel, low temperature materials.

UNIT V: MATERIALS FOR AUTOMOBILE INDUSTRY **9**

Criteria of selecting materials for automotive components viz cylinder block, Cylinder head, piston, piston ring, Gudgeon pin, connecting rod, crank shaft, crank case, cam, cam shaft, engine valve, gear wheel, clutch plate, axle, bearings, chassis, spring, body panel - radiator, brake lining etc. Application of non-metallic materials such as composite, ceramic and polymers in automobile

TOTAL = 45 PERIODS

REFERENCES

1. Michael F. Ashby, Materials Selection in Mechanical Design, Butterworth-Heinemann, 4th Edition, 2011.
2. Michael F. Ashby, Hugh Shercliff, David Cebon, Materials – Engineering, Science, Processing, and Design, Butterworth-Heinemann, 2007.
3. Gladius Lewis, Selection of Engineering Materials, Prentice Hall Inc. New Jersey, USA, 1995.
4. Charles J A and Crane. F A.A., Selection and Use of Engineering Materials, 3rd Edition, Butterworths, London UK, 1996.
5. Hiroshi Yamagata, The Science and Technology of Materials in Automotive Engines, CRC Press, 2005.
6. D. Mann, Automotive plastics and composites – Worldwide markets and trends to 2007, Elsevier Advanced Technology, 1999.
7. Ulrich, K. and Eppinger, S., Product Design and Development, McGraw-Hill, 4th Edition, 2007.

COURSE CODE	CERAMIC MATERIALS	L	T	P	C
2162ME106		3	0	0	3

UNIT I: TRADITIONAL CERAMICS **9**

History – definition – whiteware – heavy clayware – classification – raw materials, batch calculation, mixing, forming, drying, firing, glazing, decoration. heavy clayware products – face bricks, paving bricks, hollow bricks, roofing tiles, sewer pipes, stoneware pipes, floor tiles, vitrified tiles.

UNIT II: CERAMIC COATINGS **9**

Introduction, classification, Glaze – Segar formula, raw materials, glaze preparation and application, firing, glaze defects – Enamels – substrate preparation, enamel preparation, enamel coatings.

UNIT III: GLASS **9**

Introduction, classification, preparation– raw materials, mixing, charging, melting, processing, manufacture of glass products-flat ware and hollow ware.

UNIT IV: REFRACTORIES **9**

Definition – production - demand & growth of refractories in India - Layout of a refractory plan, classification of refractory, fundamental properties of refractories, factors for selection and use of refractories. Types of refractories – silica, alumina silicate, basic and special refractories

UNIT V: ADVANCED CERAMICS **9**

Introduction, properties and applications of – oxides, carbides, nitrides; Advanced ceramic Products – ceramic fibers, glass ceramics

TOTAL: 45 PERIODS

REFERENCES

1. F. Singer and S. Singer, Industrial Ceramics, Oxford and IBH Publishing Co., 1991.
2. Ryan W, Properties of Ceramic Raw Materials, Pergamon Press, 2nd Edn., 1978.
3. SudhirSen, Ceramic White ware, Oxford & IBH Publishing Co., New Delhi, 1992.
4. Tailor J.R and Bull A.C, Ceramic Glaze Technology, Pergamon Press, NY, 1986.
5. Heinz G. Pfaender, Schott Guide to Glass, Chapman and Hall, 1996.
6. Nandi D.N, Handbook of Refractories, Tata McGraw – Hill Publishing Co., New Delhi, 1991.
7. Norton F.H, Fine Ceramics: Technology and Applications, McGraw – Hill Co., NY, 1978.
8. Mohamed N.Rahaman, Ceramic Processing, Taylor & Francis, 2007.
9. Rexford Newcomb Jr, Ceramic Whitewares : History, Technology and Applications, Pitman Publishing Corporation, 1947.

COURSE CODE	NANO MATERIALS	L	T	P	C
2162ME108		3	0	0	3

UNIT I: INTRODUCTION TO NANOMATERIALS **9**

Nanoscale materials – Introduction, Definition about Nano Materials, Advantages and limitations of nanoscale materials, - Historical development of nanomaterials – Issues in fabrication and characterization of nanomaterials – Types of nanomaterials – nanoparticles, nanolayers, nanotubes, comparison of physical and mechanical properties of nanomaterials.

UNIT II: SYNTHESIS OF NANOMATERIALS **9**

Top down and Bottom Up approaches – E-beam and ion beam lithography, Ball milling, Mechanical alloying, Etching techniques, Micro and nano machining, PVD, CVD, Sol-gel, Spray conversion processing, Wet chemical synthesis, Self aseembly, Growth mechanisms of nanowires.

UNIT III: CHARACTERIZATION TECHNIQUES **9**

X-ray diffraction, Small angle X-ray scattering, Scanning Electron Microscope, Transmission Electron Microscope, Atomic Force Microscope, Scanning Tunneling Microscope, Nanoindentation

UNIT IV: NANOCOMPOSITES **9**

Metal-metal, metal-oxide, metal-ceramic nanocomposites - their preparation techniques and functionalities, Super hard nanocomposites - its designing and improvements of mechanical properties. Fractal based glass-metal nanocomposites - designing and properties, Polymer nanocomposites with CNT, nanoclay, nanosilica, grapheme – their processing and properties.

UNIT V: APPLICATIONS OF NANOMATERIALS **9**

Nanoelectronics, MEMS/NEMS, Nano sensors, Nano catalysts, Food and agriculture, Cosmetics/consumer goods, Structural applications, Defence and space applications, Energy applications, Automotive industry, Water treatment and environment, Nano-medical applications, Textiles, Paints **TOTAL: 45 PERIODS**

REFERENCES

1. Pradeep T “Nano: The Essentials”, McGraw Hill Publishing Co. Ltd., 2007
2. Mick Wilson et al, “Nanotechnology”, Overseas Press (India) Pvt. Ltd., 2005.
3. Charles P. Poole, Jr., Frank J. Owens, “Introduction to nano technology”, Wiley, 2003.
4. Gunter Schmid, “Nanoparticles: From Theory to Applications”, Wiley-VCH Verlag GmbH & Co., 2004.
5. LM Liz-Marzán, PV Kamat, Eds., Nanoscale Materials, Kluwer Academic Publishers, Boston-2003.
6. KJ Klabunde, Ed., Nanoscale Materials in Chemistry, John Wiley & Sons Inc., New York.-2001.
7. CP Poole, FJ Owens, Eds., Introduction to Nanotechnology, John Wiley & Sons Inc., New Jersey.-2003.

8. HS Nalwa, Ed., Encyclopedia of Nanoscience and Nanotechnology-2004.
9. LV Interante, MJ Hampden- Smith, Eds., Chemistry of Advanced Materials- An Overview, Wiley VCH-1998.

COURSE CODE	FAILURE ANALYSIS OF ENGINEERING COMPONENTS	L	T	P	C
2162ME109		3	0	0	3

UNIT I: INTRODUCTION TO FAILURE ANALYSIS **9**

Griffith's crack theory, stress intensity factor, stress analysis of cracks, strain energy release rate, Derivation of relationship between strain energy release rate and stress intensity factor, crack tip plastic zone

UNIT II: FRACTURE ANALYSIS **9**

Fracture mode

transition: Plane stress vs. plane strain, crack opening displacement, plane strain fracture toughness (KIC) testing, Fracture toughness determination with elastic plastic analysis (JIC), concept of R-curve and Fracture toughness measurement using it, Microstructural aspect of fracture toughness.

UNIT III: FATIGUE ANALYSIS **9**

Fatigue stress life approach, Basquin's equation, Fatigue strain life approach, Low cycle fatigue, Cofin- Manson's equation, Fatigue total strain life relation, Fatigue life prediction, Neuber's analysis for notched specimens, Fatigue crack growth rate, Paris law, fatigue life calculation using this approach.

UNIT IV: CRACK ANALYSIS **9**

Mechanism of fatigue crack nucleation and propagation, factors affecting fatigue crack growth rate, influence of load interaction, short fatigue crack; stress corrosion cracking and KIscc determination.

UNIT V: CORROSION ANALYSIS **9**

Corrosion fatigue, temper embrittlement, hydrogen embrittlement, liquid metal embrittlement, neutron embrittlement.Fractographic analysis of ductile, brittle, fatigue and high temperature fractured surfaces. Failure analysis: Steps involved; case studies of some engineering failures.

TOTAL: 45PERIODS

REFERENCES

1. Failure Analysis of Engineering Materials(Hardcover) by Charles Brooks, Ashok Choudhury
2. Practical Engineering Failure Analysis by Hani M. Tawancy, Anwar UI-Hamid and Nureddin M. Abbas, CRC Press – 2004.
3. Hertzberg, R.W., Deformation and fracture mechanics of engineering materials, John Wiley.
4. Dieter, G.E., Mechanical Metallurgy, McGraw Hill

5. Metal Hand book, Failure analysis and prevention (Volume- XI), ASM Pub.
6. Metal Hand book, Fractography (Volume- XII), ASM Pub.

COURSE CODE	ADVANCED ADDITIVE MANUFACTURING	L	T	P	C
2162ME110		3	0	0	3

UNIT I: INTRODUCTION **9**

Rapid prototyping system – practical applications– Basic operations– CAD Model-Translator– supports-slice–merge–prepare–build–cleaning–finishing–benefits of Rapid prototyping-comparison with conventional manufacturing process

UNIT II: STEREOLITHOGRAPHY FUNDAMENTALS **9**

Rapid prototyping process - The Stereo Lithography apparatus(SLA) – data gathering – data analysis – part preparation — part building – Initial consideration in part building– selecting the resin – selecting system – verifying part1 files – slicing – slice resolution –slice units – post processing fundamentals – part removal – cleaning – post curing – part finishing

UNIT-III: RAPID PROTOTYPING TECHNOLOGIES **9**

Types- Selective Laser Sintering (SLS)–Solid Ground Curing (SGC)–Laminated Object Manufacturing (LOM)–Fused Deposition Modeling (FDM)–Three Dimensional Printing (TDP)

UNIT IV: CASE STUDIES **9**

Rapid prototyping for rapid products–Exhaust manifold–Investment cast prototypes- Texas Instruments, USA-RP & Min automotive–medicine

UNIT V: TRENDS IN RAPID PROTOTYPING **9**

Laser Engineering Net Shaping (LENS), Ballistic particle Manufacturing – rapid tooling Magics, Mimics – application of rapid prototyping in medical field – Future development–Rapid prototyping in Indian scene - advances in rapid prototyping research developments in rapid prototyping

TOTAL: 45 PERIODS

REFERENCES

1. Rapid Automated Prototyping: An Introduction Industrial Press Inc. New York.
2. Chowdia M.P(ED), Agile Manufacturing, International Conference on Agile Manufacturing, Bangalore, Feb22–24, 1996, Tata Mc Graw Hill Pub Co., Ltd., New Delhi, 2012.
3. Dickens PM, Research Developments in rapid prototyping, Journal of Engineering

Manufacture, pp261-265,2010
4. Paul F Jacobs, Rapid Prototyping and Manufacturing fundamentals of stereo lithography, 1st Edition, Society of Manufacturing Engineers, Dearborn, Michigan, 2012.
5. Donald E Lacourse, Handbook of Solid Modelling, Mc Graw Hill Inc., New York,2012

COURSE CODE	ADVANCED OPTIMIZATION TECHNIQUES	L	T	P	C
2162ME111		3	0	0	3

UNIT I: INTRODUCTION **9**

General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objective function, design constraints – Classification of optimization problem. Single variable and multivariable optimization, Techniques of unconstrained minimization

UNIT II: DECISION ANALYSIS **9**

Golden section, Random, pattern and gradient search methods – Interpolation methods; Optimization with equality and inequality constraints. Hooks and Jeeves Method

UNIT III: NON-LINEAR OPTIMIZATION **9**

Decision Trees, Utility theory, Game theory, Multi Objective Optimization, MCDM- Goal Programming, Analytic Hierarchy process

UNIT IV: NON-TRADITIONAL OPTIMIZATION-1 **9**

Classes P and NP, Polynomial time reductions, Introduction to NP- Hard problems, Overview of Genetic algorithms, Simulated Annealing, neural network-based optimization

UNIT V: NON-TRADITIONAL OPTIMIZATION-2 **9**

Particle Swarm optimization, Ant Colony Optimization, Optimization of Fuzzy Systems

TOTAL: 45 PERIODS

REFERENCES

1. Singiresu S.Rao, “Engineering optimization – Theory and practices”, New Age International Publishers, 2013.
2. Ravindran – Phillips –Solberg, “Operations Research – Principles and Practice”, John Wiley India, 2007.
3. Fredrick S.Hillier and G.J. Liberman, “Introduction to Operations Research”, McGraw Hill Inc. 2017.

4. Kalymanoy Deb, “Optimization for Engineering Design”, PHI, 2012.
5. Christos H. Papadimitriou, Kenneth Stieglitz, “Combinatorial Optimization”, PHI 2006.
6. Marius Durea, “An Introduction to Nonlinear optimization theory”, De Gruyter 1st edition 2014.

COURSE CODE	SUSTAINABLE DESIGN	L	T	P	C
2162ME112		3	0	0	3

UNIT I: SUSTAINABILITY AND ITS APPLICATION **9**

Sustainability: Past and Present, The Classic Design and Manufacture Model, The Taguchi Approach to Quality Manufacturing, The Taguchi Analogy Applied to Sustainable Engineering Design, Sustainable Sourcing (Eco sourcing),Design for Sustainable Manufacture (Sustainable Manufacture Value, or SMV),Design for Sustainable Use (Sustainable Use Value, or SUV) Design for Sustainable Maintenance, Design for Sustainable Disposal (Sustainable Disposal Value, or SDV),The Measurement of Sustainability, Sustainable Engineering Design: Necessity or Luxury?

UNIT II: THE TOOLS OF THE DESIGN PROCESS AND MANAGEMENT OF DESIGN **9**

Introduction – Development Processes, Systematic Approach to Design, Design Methods, Classic Brainstorming, Brain Writing, Imaginary Brainstorming, Word-Picture Associations and Analogies, Methods of Generating Associations and Analogies, TILMAG, The Morphological Box, Design and Planning Methods

UNIT III: COMMUNICATION FOR ENGINEERS AND PERFORMANCE PREDICTION **9**

Communication Overview, Written Communication, Project Reports/Technical Reports, Academic Publishing (Technical or Journal Papers), Graphical Communications, General Drawing Application
Performance Prediction-Historical Aspects of Analysis, Materials Testing Factor of Safety, Consolidation of Safety in Structures and Devices, Computing Power, Fatigue Strength Prediction, Performance Prediction Methodology and Application, Checks and Balances

UNIT IV: DESIGN FOR TOTAL CONTROL **9**

Traditional Approaches, the Sustainability Umbrella Model. Total Design Control, A New Design Approach (The Umbrella of Sustainable Design), The Sustainable Design Function, Manufacturing, Lifetime Usage, Maintenance, End-of-Life Disposal

UNIT V: DRIVERS OF SUSTAINABILITY IN DESIGN **9**

Legislation, Effectiveness of International Environmental Regimes and Legislation, Non legislative Measurement and Guidance Tools, Other Drivers of Sustainable Design, Conclusion - Strategic Sustainable Design - Triple Bottom Line— The 3P Approach, Benefits to Producers and Buyers of

Designed-in Sustainability, The Sustainability Measurement and Certification Industry, Predicting the Future - Unsustainable Futures, The Engineers' View, Conclusion **TOTAL: 45 PERIODS**

REFERENCES

1. Johnson & Gibson, Sustainability in Engineering Design, 1st Edition, Academic Press, 2014
2. David T. Allen, Sustainable Engineering: Concepts, Design and Case Studies, Prentice Hall Publications, 2011
3. Braden R. Allenby, The Theory and Practice of Sustainable Engineering, Prentice Hall Publications, 2011
4. Marc J. Epstein, Making Sustainability Work: Best Practices in Managing and Measuring Corporate Social, Environmental, and Economic Impacts, Greenleaf Publishing, 2014

COURSE CODE	SURFACE ENGINEERING	L	T	P	C
2162ME190		3	0	0	3

UNIT I: BASIC CONCEPTS OF TRIBOLOGY AND CORROSION **9**

Introduction to Tribology, Surface degradation, Wear and Corrosion, Types of Wear, Adhesive, Abrasive, Oxidative, Corrosive, Erosive and Fretting Wear, Roles of Friction and Lubrication – Overview of different forms of Corrosion, Introduction to Surface Engineering, Importance of Substrate

UNIT II: CHEMICAL / THERMOCHEMICAL TREATMENTS **9**

Chemical and Electrochemical Polishing, Significance, Specific Examples, Chemical Conversion Coatings, Phosphating, Chromating, Chemical Colouring, Anodizing of Aluminium Alloys, Thermochemical Processes – Industrial Practices

UNIT III: ELECTRO AND ELECTROLESS COATINGS **9**

Surface Pre-Treatment, Deposition of Copper, Zinc, Nickel and Chromium – Principles and Practices, Alloy Plating, Electro composite Plating, Properties of Electro Deposits, Electroless Plating of Copper, Nickel-Phosphorous, Nickel-Boron, Electroless Composite Plating, Application areas, Properties, Overview of Test Standards (ASTM) for assessment of Quality deposits

UNIT IV: VAPOUR DEPOSITION **9**

Definitions and Concepts, Physical Vapour Deposition (PVD), Evaporation, Sputtering, Ion Plating, Plasma Nitriding, Process Capabilities, Chemical Vapour Deposition (CVD), Metal Organic CVD, Plasma Assisted CVD, Specific Industrial Applications

UNIT V: SURFACING **9**

Thermal Spraying Techniques, Advanced Spraying Techniques – Plasma Surfacing, Detonation Gun and High Velocity Oxy-Fuel Processes, Laser Surface Alloying, Laser Cladding, Specific Industrial Applications, Test for Assessments of Wear and Corrosion behaviour of Surface Engineered Components

TOTAL: 45 PERIODS

REFERENCES

1. Sudarshan T.S, "Surface modification technologies" – An Engineer's guide", Marcel Dekker, Newyork, 1989
2. Varghese C.D, "Electroplating and other surface treatments – A Practical guide", TMH, 1993
3. D. L.Smith. Thin-Film Deposition: Principles and Practice. McGraw-Hill, 1995.
4. M. Ohring. The Materials Science of Thin Films. Academic Press, 2001.
5. ASM Metals Hand Book, "Surface Engineering", Volume 18, 9th Edition, 1998
6. Bunshah R.F, "Handbook of deposition technologies for films and coatings science and technology applications", Noyes, New York, 1994.
7. L.I. Maissel and R. Glang (Eds.), Handbook of Thin film Technology, McGraw- Hill, 1970.

COURSE CODE	QUALITY, RELIABILITY AND STANDARDS	L	T	P	C
2162ME191		4	0	0	4

UNIT I: QUALITY CONCEPTS **12**

Basics of quality – Quality objectives – Quality control – Quality Assurance –Total Quality Control- Quality costs – Quality loss function – Statistical tolerancing – Seven tools of Quality

UNIT II: STATISTICAL PROCESS VARIABILITY AND CONTROL CHARTS **12**

Process Variability - Control charts for variables and attributes – Process capability studies

UNIT III: ACCEPTANCE SAMPLING **12**

Acceptance sampling by variables and attributes – ASN – ATI – AOQL - IS2500 plans – MIL STD 105E

UNIT IV: RELIABILITY CONCEPT AND LIFE DATA ANALYSIS **12**

Reliability definition – Quality and Reliability– Reliability – MTBF – MTTR – Reliability parameters – Mortality of a component –Mortality curve – Useful life- Data collection – Non-Parametric methods: Time to failure distributions: Exponential, Weibull – Probability plotting – Reliability modeling -Different configurations – Redundancy – k out of n system – Complex systems: RBD – Bayes approach – Cut and tie sets – Fault Trees – Standby Systems-Life testing methods

UNIT V: QUALITY STANDARDS **12**

ISO 9000, 9001,9002,9003 SYSTEMS – Environmental management – Implementation of Quality standards and their management- Management Representative roles- ES 14000 - quality standards- DIN standards.

TOTAL: 60 PERIODS

REFERENCES

1. Philips J.Ross, Taghuchi techniques for quality engineering, McGraw Hill, New York, 2005.
2. Douglas C.Montgomery, Introduction to statistical quality control, 6th Edition, John Wiley & sons, 2008.
3. E.L. Grant, and Leavensworth, Statistical Quality Control, McGraw Hill, 2007
4. Besterfield – Total Quality Control – McGraw hill, 1997
5. Charles Ebeling, An Introduction to Reliability and Maintainability Engineering, McGraw Hill Education; 12th edition, 2017.
6. Divya Singhal, Implementing ISO 9001: 2008 Quality Management System, Prentice Hall India Learning Private Limited; 2nd edition 2012.

COURSE CODE	ADVANCED FINITE ELEMENT METHODS	L	T	P	C
2162ME192		4	0	0	4

UNIT I : INTRODUCTION **12**

Modeling and Discretization – Interpolation, Elements, Nodes and degrees-of-freedom - Computational Procedures–Stiffness Matrices – Boundary Conditions-Solution of Equations- Ritz method, Variational Method, Method of weighted residuals, etc – Boundary Element Technique

UNIT II: BASIC ELEMENTS **12**

Interpolation and shape functions - element matrices-linear triangular elements (CST)-quadratic triangular elements – bilinear rectangular elements-quadratic rectangular elements-solid elements-higher order elements-nodal loads-stress calculations-example problems

UNIT III: ISOPARAMETRIC ELEMENTS **12**

Introduction-bilinear quadrilateral elements – quadratic quadrilaterals – hexahedral elements – Determination of Shape Functions – Numerical Integration – quadrature – static condensation – load considerations –stress calculations -examples of 2D and 3D applications.

UNIT IV: FINITE ELEMENT FORMULATION FOR STRUCTURAL APPLICATIONS **12**

Linear elastic stress analysis-2D and axisymmetric problems –Structural vibration – mass and damping matrices – damping – Harmonic response – direct integration techniques – explicit and implicit methods– Case studies.

UNIT V: HEAT TRANSFER AND FLUID MECHANICS APPLICATIONS **12**

Nonlinear Problems – Element formulation – Heat Conduction and Fluid flow – Transient Thermal Analysis - Incompressible and rotational flow – Applications for heat conduction and 2D stress analysis- Case Studies.

TOTAL: 60 PERIODS

REFERENCES

1. Chandrupatla & Belagundu, “Finite Elements in Engineering”, Prentice Hall of India Private Ltd., 2010.
2. C.A. Brebbia and S. Walker, Boundary Element Techniques in Engineering, Newness Butterworths, 2011.
3. Cook, Robert Davis et al, Concepts and Applications of Finite Element Analysis, Wiley, John & Sons, 2012.
4. O.C.Zienkiewicz, The Finite Element Method, 3rd Edition, Tata McGraw-Hill, 2010.
5. C.S. Desai and J.F. Abel, Introduction to Finite Element Method, Affiliated East- West Press, 2012.