



**SHRI RAWATPURA SARKAR UNIVERSITY, RAIPUR,  
CHHATTISGARH  
FACULTY OF ENGINEERING**

# **Shri Rawatpura Sarkar University, Raipur**



**Examination Scheme & Syllabus**

**for**

**M.Tech.(Health Safety & Environment  
Engineering)**

**Semester-I**

(Effective from the session: 2022-23)



**SHRI RAWATPURA SARKAR UNIVERSITY, RAIPUR,  
CHHATTISGARH  
FACULTY OF ENGINEERING**

**Two Years M.Tech. Programme  
Scheme of Teaching and Examination  
M.Tech. First Semester Health Safety & Environment Engineering  
Outcome Based Education (OBE) and Choice Based Credit System  
(CBCS)  
(Effective from the session: 2022-23)**

S.N	Course Code	Course Title	Hours per week			Credit	Examination Scheme			Sem End Exam Duration (Hrs)
			L	T	P		Continuous Evaluation	Sem End Exam	Total	
1.	MENHS101T	Advanced Computational Methodology	3	1	-	4	30	70	100	3
2.	MENHS102T	Statutory Rules & Regulation	3	1	-	4	30	70	100	3
3.	MENHS103T	Occupational Health & Safety Management	3	1	-	4	30	70	100	3
4.	MENHS104T	Elective -I	3	1	-	4	30	70	100	3
5.	MENHS105T	Electrical Safety	3	1	-	4	30	70	100	3
6.	MENHS106P	Health, Safety & Environment – I Lab	-	-	4	2	15	35	50	-
7.	MENHS107P	Industrial Safety - Lab	-	-	4	2	15	35	50	-
						24			600	

**L- LECTURE T- TUTORIAL P- PRACTICAL  
ELECTIVE-I**

<b>I</b>	Behavior Based Safety	MENHS104A
<b>II</b>	Environmental & Pollution Control	MENHS104B
<b>III</b>	Human Factor Engineering.s	MENHS104C



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<b>Course Title</b>	<b>ADVANCED COMPUTATIONAL METHODOLOGY</b>				
<b>Course Code</b>	<b>MSCCP101T</b>				
<b>Course Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>TC</b>	
	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	
<b>Prerequisites</b>	<b>ENGINEERING MATHEMATICS –I, II &amp; III</b>				
<b>Course objectives</b>	<p><b>This course will enable students to:</b></p> <ul style="list-style-type: none"> <li>• To represent the problems mathematically.</li> <li>• To optimize the solutions.</li> <li>• To analyze the result numerically and linguistically by fuzzy theory.</li> <li>• Emphasize the meaning and purpose of these techniques and their use in solving Engineering Problems.</li> </ul>				
<b>Course Contents</b>	<p><b>UNIT – I</b>  <b>Graph Theory And Its Application</b>            Basic Terminology. Simple graph. Multi graph, Types of graph .Path .Cycles. Eulerian and Hamiltonian graph. Shortest path problem Representation of graph. Trees and their properties. Spanning Tree. Binary Tree. Tree traversal.</p> <p><b>UNIT – II</b>  <b>Fuzzy Set And Its Applications</b>            Fuzzy sets-Basic definitions, <math>\alpha</math>-level sets. Convex fuzzy sets. Basic operations on fuzzy sets. Types of fuzzy sets. Cartesian products, Algebraic products. Bounded sum and difference, t-norms and t-conorms. The Extension Principle- The Zadeh’s extension principle. Image and inverse image of fuzzy sets. Fuzzy numbers. Elements of fuzzy arithmetic.</p> <p><b>UNIT – III</b>  <b>Cryptography And Its Application</b>            Introduction to the Concepts of Security: The need for security, Security Approaches, Principles of Security, Types of Attacks. Cryptographic Techniques: Plain Text and Cipher Text, Substitution Techniques, Transposition Techniques Encryption and Decryption, Symmetric and Asymmetric Key Cryptography, Steganography, Key Range and Key Size, Possible Types of Attacks. DES, RSA, Digital Signature.</p> <p><b>UNIT - IV</b></p>				



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	<p><b>Statistical Analysis</b></p> <p>Expectation and variance of random variable. Sampling Distribution. Testing a Hypothesis. Level of significance. Confidence limits. Test of significance for large sample. Central limit theorem. Test of significance for means of two large samples. Sampling Variables-small samples. Student t-distribution, Chi-square test.</p> <p><b>UNIT - V</b></p> <p><b>Optimization Techniques</b></p> <p>Dynamic Programming-Deterministic and Probabilistic Dynamic programming. Inventory- Basic characteristics of an inventory system. The Economic order quantity. Deterministic models. Network analysis (PERT/ CPM).</p>
<p><b>Course outcomes</b></p>	<p><b>After the completion of course:</b></p> <ol style="list-style-type: none"> <li>1. This is the foundation of research and development in the computational domain of engineering and technology.</li> <li>2. As the prerequisite, this will be traced the thought and ideas to design the behavioral tools over the engineering range.</li> <li>3. This is a transformation from theory to application through measuring theory of natural problems and its applications.</li> </ol>
<p><b>Text Books</b></p>	<ol style="list-style-type: none"> <li>1. Calculus of Variations with Applications, Gupta, A.S. Prentice Hall of India(P) Ltd., New Delhi, 6th print, 2006</li> <li>2. Introduction to Partial Differential Equations, Sankar Rao, .K Prentice Hall of India(P) Ltd., New Delhi, 5th print, 2004</li> <li>3. Advanced Engineering Mathematics, Jain.R.K, Iyengar.S.R.K. Narosa publications 2nd Edition, 2006</li> <li>4. Numerical Methods in Science and Engineering, Grewal, B.S - Kanna Publications, New Delhi.</li> <li>5. Numerical Methods, Kandasamy.P , Thilagavathy. K and Gunavathy, S Chand and Co., Ltd., New Delhi, 5th Edition, 2007</li> <li>6. Theory and problems of Complex Variables with an Introduction to Conformal Mapping and Its applications, Schaum's outline series, Spiegel, M. R - Mc Graw Hill Book Co., 1987.</li> </ol>
<p><b>Reference Books</b></p>	<ol style="list-style-type: none"> <li>1. Multi - Objective Optimization Using Evolutionary Algorithms, K. Deb(2003)John Wiley</li> <li>2. Applied Statistics &amp; Probability for Engineers: Montgomery, Douglas C. &amp; Runger, George C. (2007), 3/e,Wiley India.</li> <li>3. Parallel distributed processing Vol.1 (1986) Rumelhart, D.E and McClelland, J.L., M I T Press, 1986.</li> </ol>



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	4. Fuzzy logic implementation and applications (1996), Patyra, M.J. and Mlynek Wiley,.
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<b>Course Title</b>	<b>STATUTORY RULES &amp; REGULATION</b>				
<b>Course Code</b>	<b>MENHS102T</b>				
<b>Course Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>TC</b>	
	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	
<b>Prerequisites</b>	<b>BASIC KNOWLEDGE OF LEGAL JURISDICTION</b>				
<b>Course objectives</b>	<p><b>This course will enable students-</b></p> <ul style="list-style-type: none"> <li>• To gain and understand the basic idea of Factories Act and fundamentals of provisions relating to hazardous process, welfare, working hours, penalties etc.</li> <li>• To gain and understand a detailed idea and provisions relating to Health, Safety &amp; Environment relating to legal obligations and their applicable Acts like Dock Workers Act 1986, Explosives Act, Employers Liability act, Water Act, Air act and other relevant Environmental; Acts</li> </ul>				
<b>Course Contents</b>	<p><b>UNIT – I</b>  <b>Factories Acts</b>          Definitions, Preliminary, inspecting staff, Health, Safety, Provisions relating to hazardous processes, welfare, working hours of adults, Employment of young persons, Special provisions, Penalties, Supplemental.</p> <p><b>UNIT II</b>  <b>Dock Workers (Safety, Health And Welfare) Acts, 1986</b>          Definitions, Powers of Inspectors, Power of Govt. to direct Inquiry, Obligation of Dock workers, General Provisions relating to rules and regulations. Dock workers (SHW) Rules- Definitions, Inspection Procedure, Inquiry into certain accidents, Advisory Committee, Inquiry in Public. Dock workers (SHW) Regulations- Definitions, Power of Inspectors. Penalties, Responsibilities, Safety Officers, Reporting of accidents, Emergency Action Plan, Safety Committee, and Occupational Health services for dock workers, various safety and health regulations in brief.</p> <p><b>UNIT III</b>  <b>Explosives Acts</b>          Definitions grant of license, Notice of Accidents, Inquiry into ordinary and serious accidents, Punishment for offences, Extension of definition to other explosive substances. Petroleum Act - Definitions, Control over Petroleum import, transport, storage, production, refining and Blending, Need for license, exemption. Inspection and sampling for testing, Notice of</p>				



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	<p>Accidents and Inquiries. Petroleum Rules Definitions, brief idea on the rules relating to safety aspects in transport, storage, refining and blending of petroleum, Notice of Accidents.</p> <p><b>UNIT IV</b>  <b>Workmen Compensation Acts</b>          Workmen’s Compensation Act. ESI Act &amp; Rules. Public Liability Act &amp; Rules- Substantive provisions in the above Acts and Rules. Safety Reports, On-site &amp; Off-site Emergency Plan, Giving safety information to public. Chemical Accidents (Emergency) Planning, Preparedness and Response) Rules- Definitions, Constitution, functions &amp; powers of various Crisis groups</p> <p><b>UNIT V</b>  <b>Water Acts</b>          Definitions, Powers and Functions of Central, State and Joint Boards, Provisions regarding prevention and control of water pollution, Penalties, Central &amp; State Water Laboratories, Power to make rules, Power of supersession and overriding effect. Rules on Consent for Establishment. Air Act - Definitions, Power &amp; Functions of Boards, Prevention &amp; Control of Air Pollution, Penalties, Application for Consent as per Air Pollution Rules. Environment (Protection) Act- Definitions, general powers of central government, prevention, control and abatement of environmental pollution. EP Rules- Definitions, standards for emission, prohibition and restrictions on sitting and operation of industries. MSIHC Rules- Definitions, Duties of Authorities, Notification of Major Accidents.</p>
<b>Course outcomes</b>	<p><b>At the end of this course students will be able to-</b></p> <ul style="list-style-type: none"> <li>• Gain knowledge and to apply the knowledge on provisions relating to Hazardous process.</li> <li>• Gain knowledge on laws relevant and concerning towards welfare, working hours and health and Safety of workers engaged in industries.</li> <li>• Learn various laws relevant for inquiry into certain accidents, Advisory Committee, Inquiry in Public, and Reporting of accidents, Emergency Action Plan, Safety Committee, Occupational Health services for dockworkers, various safety and health regulations in brief.</li> <li>• Understand and learn about the legal aspects granting of license for storage, transportation and usage of explosive substance as applicable as per Petroleum Act and Explosive Act.</li> </ul>
<b>Text Books</b>	<p>1. Health Safety and Environment (Safety Management) by Ganguly &amp; Changeriya</p>
<b>Reference Books</b>	<p>1. The Petroleum Act, 1934 © Universal Law publishing          2. Statutory Instrument Practice, third edition (June 2003),          3. The Gas Cylinder Rules, 2004, Professional Book publishers.</p>



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<b>Course Title</b>	<b>OCCUPATIONAL HEALTH AND SAFETY MANAGMMENT</b>				
<b>Course Code</b>	<b>MENHS103T</b>				
<b>Course Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>TC</b>	
	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	
<b>Prerequisites</b>	<b>BASIC KNOWLEDGE HUMAN PHYSIOLOGY &amp; THE SURROUNDING FACTORS AND ITS EFFECTS.</b> <b>BASIC KNOWLEDGE OF INDUSTRIAL SAFETY.</b>				
<b>Course objectives</b>	<b>This course will enable students-</b> <ul style="list-style-type: none"> <li>• Define occupational health.</li> <li>• Explain workers' role in occupational health safety and hygiene service Programs.</li> <li>• Discuss the scope of occupational health and safety.</li> <li>• Identify the elements of a work environment.</li> <li>• Discuss the three common interactions in the work place.</li> <li>• Explain how work affect health and health affects work.</li> </ul>				
<b>Course Contents</b>	<b>UNIT – I</b> <b>Physical Hazards</b> 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 non-ionizing 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. <b>UNIT – II</b> <b>Chemical Hazards</b> 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 -				



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	<p>General Control Methods - training and education.</p> <p><b>UNIT – III</b>  <b>Biological and Ergonomical Hazards</b>          Classification of Bio hazardous agents –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 Musculoskeletal Disorders –carpal tunnel syndrome CTS- Tendon pain disorders of the neck- back injuries.</p> <p><b>UNIT – IV</b>  <b>Occupational Health and Toxicology</b>          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 – cardio pulmonary resuscitation, audiometric tests, eye tests, vital function tests. Industrial toxicology, local, systemic and chronic effects, temporary and cumulative effects, carcinogens entry into human systems.</p> <p><b>UNIT – V</b>  <b>OCCUPATIONAL PHYSIOLOGY</b>          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.</p>
<p><b>Course outcomes</b></p>	<p><b>At the end of this course students will be able to-</b></p> <ul style="list-style-type: none"> <li>• Understand concepts of federally mandated safety regulations.</li> <li>• Identify issues related to accident causation.</li> <li>• Understand business safety issues relating to People Management, Hazard Identification, Hazard, Control the Material Handling &amp; Fire Prevention and Protection.</li> </ul>
<p><b>Text Books</b></p>	<p>1. Handbook of Occupational Health and Safety, NSC Chicago, 1982.</p>
<p><b>Reference Books</b></p>	<p>1. Encyclopedia of Occupational Health and Safety, Vol. I &amp; II, International Labour Organisation, Geneva, 1985.          2. McCornick, E.J. and Sanders, M.S., Human Factors in Engineering and Design, Tata McGraw-Hill, 1982.</p>





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<b>Course Title</b>	<b>ELECTICAL SAFETY</b>				
<b>Course Code</b>	<b>MENHS105T</b>				
<b>Course Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>TC</b>	
	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	
<b>Prerequisites</b>	<b>BASIC ELECTRICAL ENGINEERING PHYSICS &amp; BIOLOGY</b>				
<b>Course objectives</b>	<p><b>This course will enable students-</b></p> <ul style="list-style-type: none"> <li>• To provide an overview of safety aspects of general workplace</li> <li>• To discuss a legislative background of electrical safety</li> <li>• To give a basic insight of hazardous areas-classification, Protection techniques for selection &amp; installation of electrical equipment to national/international (OISD/NEC/IEC/IEEE) codes &amp; standard.</li> </ul>				
<b>Course Contents</b>	<p><b>UNIT-I</b>  <b>Electromagnetism</b>          Introduction-Electrostatics-Electromagnetism –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).  <b>UNIT – II</b>  <b>Primary &amp; Secondary Hazards</b>          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 –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-Control- National Electrical Safety Code ANSI C2,Class II, Division 1&amp; 2 Lightning - Hazards - Lightning Arrestor - Installation - Earthing - Specifications - Earth Resistance - Earth Pit Maintenance.  <b>UNIT-III</b>  <b>Fuses &amp; Its Properties</b>          Fuses - 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 &amp; Connections-Means of Cutting of Power-Overload and Short Circuit Protection-No Load Protection-Earth Fault Protection-Earthing Standards-FRLS Insulation-Insulation and Continuity Test-System</p>				



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	<p>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’s.</p> <p><b>UNIT– IV</b>  <b>Roles of Environment</b>          Role of Environment in Selection-Safety Aspects in Application-Protection and Interlock-Self Diagnostic Features and Fail Safe Concepts-Surge withstand Capability Test Requirements- Lock Out and Work Permit System. -Discharge Rods and Earthing Devices-Safety in the use of Portable Tools-Cabling and Cable Joints-Preventive Maintenance</p> <p><b>UNIT– V</b>  <b>Classification of Hazardous</b>          Classification of Hazardous Zones-Intrinsically Safe and Explosion Proof Electrical Apparatus-Increased Safe Equipment-Selection for Different Zones-Temperature Classification- Grouping of Gases- Barriers and Isolators-Equipment Certifying Agencies.</p>
<p><b>Course outcomes</b></p>	<p><b>At the end of this course students will be able to-</b></p> <ul style="list-style-type: none"> <li>• Describe the phenomenon of electrical hazards associated causes, effects and prevention/protection measures.</li> <li>• Identify &amp; explain different types of current limiting devices &amp; relays and their role in safety</li> <li>• Enumerate legislative background for electrical safety (codes/standards/acts/rules, etc.,)</li> <li>• Elucidate the causes, phenomenon and effects of static charge generation and discharge prevention/protection measures.</li> <li>• Explicate the classification of hazardous areas, the protection schemes to be employed for the electrical equipment to be installed in Hazardous areas.</li> </ul>
<p><b>Text Books</b></p>	<ol style="list-style-type: none"> <li>1. Industrial Fire Protection Engineering – Robert G. Zalosh</li> <li>2. Hydro Carbon Processing Unit Volume I, II</li> <li>3. An Introduction to Fire Dynamics - Dougal Drysdale.</li> <li>4. Automatic Sprinkler performance table, Fire Journal, NFPA, 1970 Edition.</li> </ol>
<p><b>Reference Books</b></p>	<ol style="list-style-type: none"> <li>1. Evaporation from plain liquid surface into a turbulent boundary layer – By Brighton P.W.N</li> <li>2. Factory Mutual loss prevention data sheet, 1-20 protection against fire protection.</li> <li>3. Factory Mutual loss prevention data sheet 2-8, Earthquake, Protection for sprinkler system.</li> <li>4. NFPA 13, NFPA 30B, NFPA 49, NFPA 70A, NFPA 101, NFPA 325M 10. SPFE Book of Fire Protection Engineering.</li> </ol>



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<b>Course Title</b>	<b>HEALTH, SAFETY &amp; ENVIRONMENT –I LAB</b>				
<b>Course Code</b>	<b>MENHS106P</b>				
<b>Course Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>TC</b>	
	-	-	4	2	
<b>Prerequisites</b>	<b>ENVIRONMENT ENGINEERING &amp; POLLUTION CONTROL</b>				
<b>Course objectives</b>	<p><b>This course will enable students-</b></p> <ul style="list-style-type: none"> <li>• Identify and analyze physical parameters of water and wastewater.</li> <li>• Determine the concentration of Chlorides, Hardness, DO and other quality parameters.</li> <li>• Estimate BOD and COD of given wastewater samples.</li> <li>• Estimate the concentrations of water pollutant using flame photometer.</li> <li>• Estimate the concentration of air pollutant using UV spectrophotometer.</li> </ul>				
<b>Course Contents</b>	<p><b>LIST OF EXPERIMENTS</b></p> <p>List of Experiments based on syllabus:</p> <ol style="list-style-type: none"> <li>1. To Measure Sound/Noise Level at Various Location and Compare it with Standard Values Permissible for Exposure.</li> <li>2. To Determine the SPM Present in Working Atmosphere during the Working Period with the help of Respirable Dust Sampler.</li> <li>3. To Determine the RSPM present in Working Atmosphere during the Working</li> <li>4. Period with the help of Respirable Dust Sampler Standard Method for Determination of Oxide of Sulfur in Flue Gases using UV UV Spectrophotometer.</li> <li>5. Standard Method for Determination of Oxides of Nitrogen in Flue Gases using UV Spectrophotometer</li> <li>6. To Find the pH and Conductivity of given Solution.</li> <li>7. To Determine the Total suspended Solid in the given Water Samples.</li> <li>8. To Determine the SPM and Oxides of Sulfur and Nitrogen from the Stack/Chimney using Stack Monitoring kit.</li> <li>9. To Determine the SPM and Oxides of Sulfur and Nitrogen using Fugitive Emission Kit.</li> </ol>				
<b>Course outcomes</b>	<p><b>At the end of this course students will be able to-</b></p> <ol style="list-style-type: none"> <li>1. Identify and analyze physical parameters of water and wastewater.</li> <li>2. Determine the concentration of Chlorides, Hardness, DO and other quality parameters.</li> <li>3. Estimate BOD and COD of given wastewater samples.</li> <li>4. Estimate the concentration of air pollutant using UV spectrophotometer.</li> </ol>				

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<b>Course Title</b>	<b>INDUSTRIAL SAFTY- LAB</b>				
<b>Course Code</b>	<b>MENHS107P</b>				
<b>Course Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>TC</b>	
	-	-	4	2	
<b>Prerequisites</b>	<b>NOISE LEVEL, VIBRATION, BAM FRICTION</b>				
<b>Course objectives</b>	<p><b>This course will enable students-</b></p> <ul style="list-style-type: none"> <li>• To learn principles and design of experiments.</li> <li>• To investigate the performance of various Soils</li> </ul>				
<b>Course Contents</b>	<p><b>LIST OF EXPERIMENTS</b></p> <ol style="list-style-type: none"> <li><b>1. NOISE LEVEL MEASUREMENT AND ANALYSIS</b> Measurement of noise level for various sources – Impact, continuous and intermittent. Frequency and spectrum analysis of noise: Instrument – precision type of Noise level meter with frequency and spectrum analyzer.</li> <li><b>2. VIBRATION MEASUREMENT AND ANALYSIS</b> Measurement of whole-body vibration for various acceleration: Instrument – vibration simulator and vibration analyzer.</li> <li><b>3. FRICTION SENSITIVITY TEST</b> Measurement of friction sensitivity for unstable materials: Instrument – BAM friction tester.</li> <li><b>4. IMPACT SENSITIVITY TEST</b> Measurement of impact sensitivity for unstable materials: Instrument – BAM fall hammer.</li> <li><b>5. THERMAL REACTIVITY TEST</b> Measurement of thermal reactivity for unstable materials: Instrument – DSC/TGA.</li> <li><b>6. EXHAUST GAS MEASUREMENT AND ANALYSIS</b> Measurement of Exhaust gas measurement of IC engines: Instrument – Gas analyzer.</li> <li><b>7. BREATHING ZONE CONCENTRATION</b> Measurement of breathing zone concentration of dust and fumes: Instrument – personal air sampler</li> <li><b>8. AMBIENT AIR MONITORING</b> Measurement of respirable and non-respirable dust in the ambient air: Instrument – High volume sampler</li> <li><b>9. CONSEQUENCE ANALYSIS</b> Soft computing skills on developing effects of fire &amp; explosion and dispersion:</li> </ol>				

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	<p>Software – RISK PHAST V 6.6 (DNV) and ALOHA</p> <p><b>10. STUDY OF PERSONAL PROTECTIVE EQUIPMENT</b> Safety helmet, belt, hand gloves, goggles, safety shoe, gum boots, ankle shoes, face shield, nose mask, ear plug, ear muff, apron and leg guard.</p> <p><b>11. STUDY OF FIRE EXTINGUISHERS</b> Selection and demonstration of first-aid fire extinguishers: soda acid, foam, carbon dioxide (CO<sub>2</sub>), dry chemical powder, Halona.</p>
<b>Course outcomes</b>	<p><b>At the end of this course students will be able to-</b></p> <ol style="list-style-type: none"><li>1. Achieve Knowledge of Design and development of experimental skills.</li><li>2. Understand the principles of design of experiments.</li></ol>



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**Elective –I**

<b>Course Title</b>	<b>BEHAVIOR BASED SAFETY</b>				
<b>Course Code</b>	<b>MENHS104A</b>				
<b>Course Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>TC</b>	
	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	
<b>Prerequisites</b>	<b>GLOBAL SCENARIO HEALTH &amp; SAFETY MANAGEMENT</b>				
<b>Course objectives</b>	<p><b>This course will enable students-</b></p> <ul style="list-style-type: none"> <li>• To illustrate the importance and need of safety engineering.</li> <li>• To understand the concepts of global scenario of Occupational Health &amp; safety Management system.</li> <li>• To analyses the gaps between reference standards &amp; pertinent conditions of safety in India.</li> </ul>				
<b>Course Contents</b>	<p><b>UNIT-1</b>  <b>Introduction To Behavioral Based Safety</b>            Behavioral based safety – overview – psychology of behavior management – focus on behavior to manage the risk – leadership- behavior safety program for employees- measure safety program – ABC model – BBS - case study.</p> <p><b>UNIT-II</b>  <b>Introduction to HSE</b>            Hazards in Petroleum Industry, Direct &amp; Indirect costs of accidents, HSE Model &amp; Integration with Business, Safety officer role &amp; responsibility.</p> <p><b>UNIT-III</b>  <b>Regulatory Regimes And Regulatory Agencies</b>            Regulatory Laws/ Acts, Petroleum Act 1934; Indian Explosives Act, 1884; The Static &amp; Mobile Pressure Vessels, SMPV (UNFIRED) Rules, 1981. The Gas Cylinder Rules, 1981. The Indian Boilers Act, 1923; Factories Act 1948, Indian Electricity Act, 1910; The Mines Regulations, 1984; The Indian Aircraft Rules, 1937; International Maritime Organization (IMO), Dock Workers Act, 1986; Atomic Energy Act, 1962; Motor Vehicles Act, 1988, Tariff Advisory Committee, Responsibilities of an Occupier as per Factories Act 1948. Oil Industries Safety Directorate (OISD), Limitations of Indian Regulatory Bodies.</p> <p><b>UNIT-IV</b>  <b>Accidents</b>            Types and Severity of Accidents, Accident Classification, Accident – Entitlement under Workmen’s Compensation Act, Objectives &amp;</p>				



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	<p>Methodology of conducting accident Investigation, Mineral Exploitation, Material Handling Processes, Manufacturing Plant</p> <p><b>UNIT V</b></p> <p><b>Safety Policy Process &amp; Management</b></p> <p>Organization, Monitoring and Reporting, PSM and Safety Culture-an overview, Main Pillars of Process Safety Management, Emergency/Disaster Plans Objectives of DMP, On-site &amp; Off-site emergencies, Levels of emergencies, Elements of Disaster Management Plan, Mutual-aid schemes. Major Industrial Disasters: PIPER ALPHA, BHOPAL Disaster.</p>
<b>Course outcomes</b>	<p><b>At the end of this course students will be able to-</b></p> <ul style="list-style-type: none"><li>• To demonstrate the role and Responsibility of safety officers, hazards in Petroleum industry</li><li>• To apply the statutory rules and regulations applicable in Petroleum industry mainly</li><li>• Conduct Accident Investigation process and find the root cause of Accident.</li><li>• Calculate the compensation money for injured person and reporting to higher authorities.</li><li>• To explain the various elements of Process Safety Management</li><li>• To form Emergency Management plan for any Organization</li></ul>
<b>Text Books</b>	<ol style="list-style-type: none"><li>1. Industrial Loss &amp; Critical Investigation (John Walkins)</li><li>2. An introduction to Production management Techniques. (Wickens Christopher, Lee John).</li></ol>
<b>Reference Books</b>	<ol style="list-style-type: none"><li>1. Operation Forecasting &amp; modelling, CLYDE.B, STRONG, M.</li></ol>



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**Elective –I**

<b>Course Title</b>	<b>ENVIRONMENTAL &amp; POLLUTION CONTROL</b>				
<b>Course Code</b>	<b>MENHS104B</b>				
<b>Course Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>TC</b>	
	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	
<b>Prerequisites</b>	<b>POLLUTION, POLLUTANTS, WASTE WATER</b>				
<b>Course objectives</b>	<p><b>This course will enable students-</b></p> <ul style="list-style-type: none"> <li>• To develop environmental scientists and engineers and sensitize them towards environmental issues.</li> <li>• To acquire analytical skills in assessing environmental impacts through a multidisciplinary approach.</li> <li>• Understanding of basic concepts of air pollution.</li> <li>• Study of air pollution episodes. Reasoning of the entire episode, identification of the parameters, conditions, mechanisms.</li> <li>• Study of macro and micro meteorology for understanding the dispersion of pollutants.</li> <li>• Study of pollution control methods, mechanism and devices.</li> </ul>				
<b>Course Contents</b>	<p><b>UNIT-I</b>  <b>Air Pollution</b>            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- Chloro Fluoro Carbon(CFC).</p> <p><b>UNIT-II</b>  <b>Water Pollution</b>            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.</p> <p><b>UNIT-III</b>  <b>Hazardous Waste Management</b>            Hazardous waste management in India-waste identification, characterization and</p>				





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	<p>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 hazards-toxic and radioactive wastes incineration and vitrification - hazards due to bio-process-dilution-standards and restrictions – recycling and reuse.</p> <p><b>UNIT –IV</b> <b>Environmental Measurement And Control</b> Sampling and analysis – dust monitor – gas analyzer, particle size analyzer – 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.</p> <p><b>UNIT- V</b> <b>Pollution Control In Process Industries</b> Pollution control in process industries like cement, paper, petroleum - petroleum products- textile-tanneries-thermal power plants – dyeing and pigment industries - eco-friendly energy.</p>
<b>Course outcomes</b>	<p><b>At the end of this course students will be able to-</b></p> <ul style="list-style-type: none"><li>• Identify air pollution problems and interpret criteria air quality data.</li><li>• Recognize various environmental transformation processes of pollutants extreme weather condition.</li><li>• Interpret meteorological data and develop capability to assessment of project proposal, air quality pollution index for any region.</li><li>• Justify the use of pollution control equipment and their design.</li></ul>
<b>Text Books</b>	<p>1. Rao, CS, “Environmental pollution engineering: Wiley Eastern Limited, New Delhi, 1992.</p>
<b>Reference Books</b>	<p>1. S.P.Mahajan, “Pollution control in process industries”, Tata McGraw Hill Publishing Company, New Delhi, 1993. 2. Varma and Braner, “Air pollution equipment”, Springer Publishers, Second Edition.</p>



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**Elective-I**

<b>Course Title</b>	<b>HUMAN FACTOR ENGINEERING</b>				
<b>Course Code</b>	<b>MENHS104C</b>				
<b>Course Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>TC</b>	
	<b>3</b>	<b>1</b>	<b>-</b>	<b>4</b>	
<b>Prerequisites</b>	<b>ERGONOMICS, HUMAN BEHAVIOR</b>				
<b>Course objectives</b>	<p><b>This course will enable students-</b></p> <ul style="list-style-type: none"> <li>• To develop environmental scientists and engineers and sensitize them towards environmental issues.</li> <li>• To acquire analytical skills in assessing environmental impacts through a multidisciplinary approach.</li> <li>• Study of macro and micro meteorology for understanding the dispersion of pollutants.</li> <li>• Simple and complex modeling for point source, line source and area source.</li> </ul>				
<b>Course Contents</b>	<p><b>UNIT-I</b>  <b>Ergonomics and Anatomy</b>            Introduction to ergonomics: The focus of ergonomics, ergonomics and its areas of application in the work system, a brief history of ergonomics, attempts to humanize work, modern ergonomics, future directions for ergonomics            Anatomy, Posture and Body Mechanics: Some basic body mechanics, anatomy of the spine and pelvis related to posture, posture stability and posture adaptation, low back pain, risk factors for musculoskeletal disorders in the workplace, behavioral aspects of posture, effectiveness and cost effectiveness, research directions.</p> <p><b>UNIT-II</b>  <b>Human Behavior</b>            Individual differences, Factors contributing to personality, Fitting the man to the job, Influence of difference on safety, Method of measuring characteristics, Accident Proneness. Motivation, Complexity of Motivation, Job satisfaction. Management theories of motivation, Job enrichment theory. Frustration and Conflicts, Reaction to frustration, Emotion and Frustration. Attitudes- Determination of attitudes, Changing attitudes Learning, Principles of Learning, Forgetting, Motivational requirements.</p> <p><b>UNIT-III</b>  <b>Anthropometry And Work Design For Standing And Seated Works</b>            Designing for a population of users, percentile, sources of human variability,</p>				



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	<p>anthropometry and its uses in ergonomics, principals of applied anthropometry in ergonomics, application of anthropometry in design, design for everyone, anthropometry and personal space, effectiveness and cost effectiveness          Fundamental aspects of standing and sitting, an ergonomics approach to work station design, design for standing workers, design for seated workers, work surface design, visual display units, guidelines for design of static work, effectiveness and cost effectiveness, research directions.</p> <p><b>UNIT –IV</b>  <b>Man - Machine System</b>          Applications of human factors engineering, man as a sensor, man as information processor, man as controller – Man vs Machine. Ergonomics interventions in Repetitive works, handle design, key board design- measures for preventing in work related musculoskeletal disorders (WMSDs), reduction and controlling, training Anatomy and biomechanics of manual handling, prevention of manual handling injuries in the work place, design of manual handling tasks, carrying, postural stability.</p> <p><b>UNIT- V</b>  <b>Human Skill &amp; Performance</b>          A general information-processing model of the users, cognitive system, problem solving, effectiveness Principles for the design of visual displays- auditory displays- design of controls- combining displays and controls- virtual (synthetic) environments, research issues. Personal protective equipment (different types, specifications, standards, testing procedures, and maintenance).</p>
<p><b>Course Outcomes</b></p>	<p><b>At the end of this course students will be able to-</b></p> <ul style="list-style-type: none"> <li>• Identify human behavior problems and interpret criteria air quality data.</li> <li>• Recognize various environmental transformation processes of pollutants under extreme weather condition.</li> <li>• Justify the use of pollution control equipment and their design</li> </ul>
<p><b>Text Books</b></p>	<ol style="list-style-type: none"> <li>1. McCornick, E.J., Human Factors in Engineering and Design, Tata McGraw-Hill, 1982.</li> <li>2. Accident Prevention Manual for Industrial Operations, NSC, Chicago, 1982.</li> <li>3. Introduction to Ergonomics, R.S. Bridger, Taylor &amp; Francis</li> <li>4. Ergonomic design for organizational effectiveness, Michael O’Neill</li> </ol>
<p><b>Reference Books</b></p>	<ol style="list-style-type: none"> <li>1. Human factors in engineering &amp; design, MARK S. SANDERS</li> <li>2. The Ergonomics manual, Dan McLeod, Philip Jacobs &amp; Nancy Larson</li> <li>1. 3. Fitting the task to the human, Fifth edition, K.H.E.Kroemer and E.Grandjean</li> </ol>



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Board of Studies

Dr. AJAY KUMAR GUPTA  
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Mr. RAJ KUMAR BHARTI