

**COLLEGE OF ENGINEERING AND TECHNOLOGY**

**SCHOOL OF BIOENGINEERING, DEPARTMENT OF CHEMICAL ENGINEERING**

**B. Tech. Open elective**

**ACADEMIC YEAR 2023-24 – ODD SEMESTER**

**Continuous Learning Assessment II** **A**

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| Course Code: **18CHO104T** | Course Title: **PROCESS PLANT SAFETY** | | |
| Sem & Year: V & III year | Date: 13/10/2023 | Duration: 100 Minutes | Max. Marks: 50 |

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|  | **Course Outcomes (COs)** | **Program Outcomes (POs)** | | | | | | | | | | | | | **PSOs** | | | |
|  |  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 1 | | 2 | 3 |
| **CO2** | *Understand the various aspects of Chemical plant safety* | 1 | 2 | 3 | - | 1 | - | - | - | - | - | - | - | - | | - | - |
| **CO3** | *Understand the various aspects of Industrial accidents and Fire safety* | - | 1 | - | - | - | - | - | - | - | - | - | 3 | - | | 2 | - |

**Part A Answer the Following 10x1 Marks = 10 Marks**

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| **Q. No.** | | **Questions** | | | | | | | | **CO** | | **BL** | | **PO** | | **Marks Scored** |
| **1.** | | Methane is an example of --------------   1. **Flammable gas** 2. Non-Flammable gas 3. Flammable liquid 4. Toxic gas | | | | | | | | 2 | | L2 | | 1,3 | |  |
| **2.** | | The HAZCHEM code for LPG gas is 2WE, in this ‘W’ relates to what?   1. Fire extinguisher type 2. Property of the chemical 3. Evacuation of the personnel 4. **Personal Protective equipment** | | | | | | | | 2 | | L2 | | 1,3 | |  |
| **3.** | | The four routes by which toxic chemicals can enter the body include:   * 1. **Inhalation, ingestion, absorption and injection**   2. Inhalation, constipation, instigation and investigation   3. Inhalation, indigestion, transmission of bodily fluids and interjection   4. Inhalation, Interjection, Injection and Investigation | | | | | | | | 2 | | L1 | | 1,3 | |  |
| **4.** | | The label danger on a chemical container most accurately signifies   1. That the hazards can cause serious injury 2. That the hazards can cause less than serious injury 3. **That users should be careful when using, handling or storing the chemical** 4. The chemical container should be disposed | | | | | | | | 2 | | L1 | | 1,3 | |  |
| **5.** | | -------------- is the maximum concentration of a toxic substance which the worker can tolerate 8 hours a day   1. Short term exposure limit 2. Long term exposure limit 3. **Threshold limit value time weighted average** 4. Ceiling value | | | | | | | | 2 | | L2 | | 1,3 | |  |
| **6.** | | To help prevent accidents, people who use tools must   1. Be very careful 2. Not wear glasses 3. **Be trained and authorized to use them** 4. Not be sleepy | | | | | | | | 3 | | L1 | | 1,3 | |  |
| **7.** | | ------------- accident causation theory states “within a given set of workers, there exists a subset of workers who are more liable to be involved in accidents”   1. Domino theory 2. Pure chance theory 3. Biased liability theory 4. **Accident Proness theory** | | | | | | | | 3 | | L2 | | 1,3 | |  |
| **8.** | | The following extinguisher is suitable for cotton or other textile fibres   1. **Water** 2. Soda acid 3. Foam 4. Dry chemicals | | | | | | | | 3 | | L2 | | 1,3 | |  |
| **9.** | | During fire extinguishing, if we remove the fuel, then the method is called   1. Smothering 2. **Starvation** 3. Cooling 4. Inhibiting | | | | | | | | 3 | | L2 | | 1,3 | |  |
| **10.** | | The acronym for FSI in safety performance is   1. Frequency safety index 2. **Frequency safety incidence** 3. Frequency severity index 4. Frequency severity incidence | | | | | | | | 3 | | L1 | | 1,3 | |  |
| **Q.No.** | **1** | | **2** | **3** | **4** | **5** | **6** | **7** | **8** | | **9** | | **10** | |  | |
| **Ans.** |  | |  |  |  |  |  |  |  | |  | |  | |  | |

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**Part B Answer the following 4 x 4 Marks = 16 Marks**

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| **Q. No.** | **Questions** |
| **11.** | Write any two chemical reaction hazards of process industries.  **Nitration**   * All nitration reactions are potentially hazardous because of the explosive nature of the products and the strong oxidizing tendency, characteristic of the nitrating agent. * The nitration reaction and the oxidation side reaction are highly exothermic. Therefore, these reactions may be extremely rapid and become uncontrollable. * Close temperature control must be maintained.   **Polymerization**   * Polymerization is the joining together of molecules to form chains or other linkages * Chain reactions proceed quickly following slow initiation. Heat effects can be sudden, especially where catalysts are used, and may become uncontrollable, particularly as the viscosity of the reaction mixture increases. |
| **12.** | List any four crucial causes for pressure vessel accidents.   * If Boiler is unattended at the time of accident * Unexpected rapid increase in steam pressure and consequently safety valves failing to function, disruption occurred * If periodical independent inspection is not done * If the controls to the burners were defective |
| **13.** | Explain the Domino theory.  According to W.H. Heinrich (1931), who developed the so-called domino theory, 88% of all accidents are caused by unsafe acts of people, 10% by unsafe actions and 2% by “acts of God”. He proposed a “five-factor accident sequence” in which each factor would actuate the next step in the manner of toppling dominoes lined up in a row.   * In the same way that the removal of a single domino in the row would interrupt the sequence of toppling * Heinrich suggested that removal of one of the factors would prevent the accident and resultant injury; with the key domino to be removed from the sequence being number 3. |
| **14.** | Differentiate fire triangle and fire tetrahedron with a neat model diagram.    The **fire triangle** is **used to** show the three elements that when present together can cause a **fire to** start. These three ingredients are fuel, heat and oxygen, under all circumstances they **should** be kept apart **to** avoid a **fire** starting.  Of Burning  Chain Reaction  Energy  Oxidizer  (Fuel)  A **tetrahedron** can be described as a pyramid which is a solid having four plane faces. Essentially all four elements must be present for **fire** to occur, fuel, heat, oxygen, and a chemical chain reaction. |

**Part C Answer the following 2 x 12 Marks = 24 Marks**

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| **Q. No.** |  |
| **15.** | Explain the classification of dangerous chemicals in detail. Discuss the safe handling and storage methods of oxidisers and corrosives.  **CLASS 1- EXPLOSIVES**  An explosive substance is a solid or liquid substance which itself capable of producing chemical reactions and gas at such a temperature, pressure and speed to cause damage to surroundings  Causes:   1. Mass explosion hazard 2. Projection hazard 3. Fire hazard and either minor blast hazard or minor projection hazard 4. Give rise to radiant heat 5. Burn one after another producing minor blast   **CLASS 2 – GASES: COMPRESSED, LIQUIFIED OR DISSOLVED UNDER PRESSURE**  2.1 Flammable gases – Chemical which mixes in air in its gaseous state at normal pressure and becomes flammable. Its BP at normal pressure is below 20 °C  2.2 Non Flammable, Non toxic gases - gases which are transported at a pressure not less than 286 kPa at 20 °C or as refrigerated liquid and which are **asphyxiant or oxidizing**  2.3 Toxic Gases – toxic or corrosive to humans as they pose a hazard to health (LC50 value =< 5000ppm  **CLASS 3 – FLAMMABLE LIQUIDS**  These are liquids or a mixtures of liquids / liquids containing solids in solution or suspension which has a flash point <61 °C  **CLASS 4**  4.1 Flammable solids (easy ignition by external sources such as sparks, flames)  4.2 Spontaneously combustible (spontaneous heating under normal conditions, heating up in contact with air)  4.3 Dangerous when wet (liq/sol interact with water – flammable spontaneous)  **CLASS 5**  5.1 Oxidizing substances (directly/indirectly evolve oxygen  5.2 Oxygen peroxides – liable to exothermic decomposition at normal/elevated temp  **CLASS 6:**  6.1 Toxic substances – liable either to cause death/serious injury /harm human health  6.2 Infectious substances – containing viable microorganisms, including bacterium, virus, parasite, fungus causes diseases to human & animals  **CLASS 7:**  Radioactive materials – spontaneously emit radiation  **CLASS 8:**  Corrosives – severely damaging living tissues  **CLASS 9:**  Miscellaneous Dangerous substances and articles   1. Substances not falling with other classes /divisions 2. Lachrymatory substances not falling with other classes     Safe handling and storage |
| **16.** | Define Ergonomics and explain the various safe guarding methods.  **Ergonomics**  Ergonomics (from the Greek word ergon meaning work, and nomoi meaning natural laws), is the science of refining the design of products to optimize them for human use.  The study of people's efficiency in their working environment.  **Fixed Guard**  Provides a barrier - a permanent part of the machine, preferable to all other types of guards.  **Interlocked Guard**  When this type of guard is opened or removed, the tripping mechanism and/or power automatically shuts off or disengages, and the machine cannot cycle or be started until the guard is back in place  **Adjustable Guard**  Provides a barrier which may be adjusted to facilitate a variety of production operations  **Pullback Device**  Utilizes a series of cables attached to the operator’s hands, wrists, and/or arms  !Primarily used on machines with stroking action  !Allows access to the point of operation when the slide/ram is up  !Withdraws hands when the slide/ram begins to descend  **Restraint Device**  Uses cables or straps attached to the operator’s hands and a fixed point  !Must be adjusted to let the operator’s hands travel within a predetermined safe area  !Hand-feeding tools are often necessary if the operation involves placing material into the danger area |
| **17.** | Explain the various active fire protection systems in industries.   * **Fire suppression**   Fire can be controlled or extinguished, either manually (firefighting) or automatically   * **Sprinkler systems** * They are usually located at ceiling level and are connected to a reliable water source, most commonly city water   **Categories of Active Fire Protection**   * **Fire detection** * Fire is detected either by locating the smoke, flame or heat, and an alarm is sounded to enable emergency evacuation as well as to dispatch the local fire department. * **Hypoxic air fire prevention** * Fire can be prevented by hypoxic air. Hypoxic air fire prevention systems, also known as oxygen reduction systems are new automatic fire prevention systems that reduce permanently the oxygen concentration inside the protected volumes so that ignition or fire spreading cannot occur. * **Requirement of Water** * The quantity of water required for fire extinction depends upon the magnitude of fire and duration taken to extinguish it. * The size of main ring, dry riser and wet riser, for fire fighting within a building, is designed keeping in mind that a distant hydrant will discharge about 1000 litres per minutes at 3.5 kg/sq.cm pressure. And at any given time at least two hydrants are in operation. * **Systems of Fire Fighting**   **It may be broadly classified as external (City) and Internal ( Building) fire fighting System**  **External Fire fighting System**   * Fire hydrant are generally located at a distance apart of about 90 m to 120 m in inhabitant area and about 300 m in an open area. One fire hydrant for every 4000 to 10000 sq. area is normally provided. * Hydrants are generally provided at street crossings, water demands of one litre per head per day is considered for fire hydrants. Fire hydrants are of two types pillar or post hydrant and sunk or flush hydrants.   **Fire Hose System**   * This system involves the installation of vertical riser pipe with hose connections at strategic points throughout the building. * The standpipe or riser can be kept filled with water is know as wet riser system otherwise it is known as dry riser system   **Automatic Sprinkler System**   * **Automatic sprinklers are connected to a water distribution system.** * **A sprinkler nozzle is closed by a fusible plug that melts at a predetermined temperature, above normal room temperature, releasing water to fall on the source of heat** * Sprinklers have the advantage of quickly supplying water to fire before it gain dangerous headway and of preventing the access of air to the fire by smothering it with water. * **An automatic sprinkler head is a fire extinguisher nozzle, closed in a state of readiness by a heat sensitive release element**. * The sprinkler may be classified as : * **(a) Sprinkler based on Release**: * Fusable element Sprinkler is opened under the influence of heat by the melting of eutectic metal or chemical. * **(b)Glass bulb sprinklers** are opened under the influence of heat by the destruction of the glass bulb through pressure of the fluid enclosed therein.   **Fire Extinguisher Types**  **PRESSURIZED WATER**   * Class “A” fires only * 2.5 gal. water *(up to 1 minute discharge time)* * Has pressure gauge to allow visual capacity check * 30-40 ft. maximum effective range * Can be started and stopped as necessary * Extinguishes by ***cooling*** burning material below the ignition point.   **CARBON DIOXIDE (CO2)**   * Class “B” or “C” fires * 2.5-100 lb. of CO2 *(8-30 seconds discharge time)* * Has *NO* pressure gauge--capacity verified by weight * 3-8 ft. maximum effective range * Extinguishes by *smothering* burning materials * Effectiveness *decreases* as temperature of burning material increases. |
| **18.** | A fertilizer manufacturing industry, employs 800 people for its production. The data provided below is two years accident data.   |  |  |  |  | | --- | --- | --- | --- | | **Year** | **Occupational injury** | **Average hours worked** | **Days lost due to injury** | | 2018 | 17 | 3000 | 650 | | 2019 | 19 | 3250 | 700 |   Calculate Frequency rate, Incidence rate, Severity rate, Frequency severity Incidence, Frequency severity rate, Safe-T-Score |

**Attainment Level (H:76 to 100%; M :50 to 75%; L: ≤ 50%)**

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|  | **Quality** | **Marks Scored** | **% of Marks** | **Attainment** |
| **CO2** | **L1 = 18 Marks** |  |  | **H/M/L** |
| **L2 = 19 Marks** |
| **CO3** | **L1 = 6 Marks** |
| **L2 = 19 Marks** |
| **L3 = 12 Marks** |  |
| POs/PSOs: | **1,3** | | | |
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