Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
Online End Semester Examination, December 2020

Course: BBS & Human Factor Engineering **Semester: III**
Program: B Tech FSE **Time 03 hrs.**
Course Code: HSFS 2009 **Max. Marks: 100**

Instructions:

SECTION A

S. No.		Marks	CO
Q 1	ABC organization generally observes weekends as nonworking days, a worker employed here met an accident on Friday evening, owing the finger injury he left early from returned to work on Monday morning. Whether this accident need to be considered as a reportable accident? Discuss.	**5**	**CO2**
Q 2	Which of the following is NOT a leading indicator of safety performance? a) No of risk assessment completed b) Man-hours of training c) Accident frequency rate d) Participation in safety meetings	**5**	**CO1**
Q 3	Which OISD standard deals with work permit system? a) OISD 101 b) OISD 105 c) OISD 110 d) OISD 118	**5**	**CO1**
Q 4	In a company 500 workers are working in morning shift in night shift and 500 workers are employed. Number of working days are 100 per year. Average working hours for any employee are 10 hours per day. No of Reportable accidents are 10 and no of non-reportable injury is 1. Calculate the reportable accident severity rate. a) 1 b) 10 c) 100 d) Data Insufficient	**5**	**CO3**
Q 5	The best way to modify human behavior is to control antecedents A) True B) False	**5**	**CO2**
Q 6	Which of the following is NOT a type of Man-Machine System? A) Manual System B) Mechanical System C) Automated System D) Computer Integrated System	**5**	**CO1**
	SECTION B		
Q 7	Why the 'percentile' concept in used in ergonomic designs?	**10**	**CO3**
Q 8	What is the philosophy of behavior based safety? Prepare a table showing possible antecedents and consequences of safe and at risk behavior related to the usage of safety helmet in an organization	**10**	**CO2**

<table>
<tr><td>Q 9</td><td>What is CTD? Discuss any four specific CTD. Explain the ergonomic measures to avoid CTD.</td><td>10</td><td>CO3</td></tr>
<tr><td>Q 10</td><td>An organization that manufactures components for the automotive industry is based on a single site and employs 750 people. The table below provide recent accident data recorded at the company.

<table><tr><td>Year</td><td>No. of accidents</td><td>No. of near misses</td><td>Average hours worked</td><td>Days lost due to accidents</td></tr><tr><td>2016</td><td>10</td><td>4</td><td>3520</td><td>500</td></tr><tr><td>2017</td><td>12</td><td>8</td><td>3500</td><td>80</td></tr><tr><td>2018</td><td>12</td><td>10</td><td>3500</td><td>600</td></tr><tr><td>2019</td><td>15</td><td>17</td><td>3530</td><td>600</td></tr></table>
Calculate the accident frequency, severity and incidence rate for these years. Also, comment on the safety performance of the organization.</td><td>10</td><td>CO5</td></tr>
<tr><td>Q 11</td><td>Define confined space. State FOUR potential hazards in a confined space and how these hazards can be effectively managed?</td><td>2+ 8</td><td>CO2</td></tr>
<tr><td colspan="4">SECTION-C</td></tr>
<tr><td>Q 12</td><td><u>Bhopal Disaster Case study:</u>
On the night of 2nd -3 rd December, methyl isocyanate (MIC) a deadly gas leaked over the city of Bhopal from the plant of union carbide India limited(UCIL) at Bhopal, Madhya Pradesh which manufactured pesticides. It leads to several thousand deaths and more than 500,000 people being exposed to MIC and other hazardous chemicals and causing a disaster which is sometimes referred to as the world’s worst industrial disaster.
The chemical spill turned the UCIL factory into a gas chamber. The people were running, dying, vomiting. The city ran out of cremation grounds. The government had no idea on how to help the affected people. The plant was controlled by UCIL which is a subsidiary of the used based company UCC (Union Carbide Corporation), which provided negligible help to deal with the ongoing tragedy.
The main problem was nobody knew anything about its antidote or how to treat the toxin. The disaster resulted in people suffering from ailments such as anemia, tuberculosis but nobody</td><td>20</td><td>CO4</td></tr>
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could find the complete health effects caused by MIC and how to treat it. The treatment research was even more complicated by the fact that children born to mothers who were exposed to the gas were also the victims of the release.

Another factor which makes it worse is that till date, even after 32 years there has been no closure in the report on what actually caused the disaster. Negligent management and poor maintenance standards being observed caused the routine pipe maintenance to backflow of water into the MIC storage tank triggering the disasters claimed by the government and the local activists, while at the same time UCC still claims that it was caused by water entering the tank due to some act of sabotage.

The leak and its effects:

The UCC facility used three tanks to store 15000 gallons of liquid MIC produced which and it was to be kept under pressure using inert nitrogen which helped the pumping of MIC when needed and also kept impurities at bay. The safety regulations specified that the maximum50% of the tank should be used for storage. Another disadvantage of using MIC was that it had to be stored at 0degree Celsius at all times to keep it inert.

In the last days, October 1984, the E610 tank lost its ability to maintain the nitrogen pressure which halted the production of MIC in the plant. The production was soon started again despite a failed attempt of reestablishment of the system and the 42 tons of remaining MIC was ignored.

On the night of 2nd December 1984 around 10:30 pm, with the MIC safety systems not working to their full efficiency, water from a connecting pipe was introduced in the E610 tank causing a catastrophic exothermic reaction damaging the system and causing the leak of MIC. It did not take long for the gas to spread over the city of Bhopal causing great panic among the residents.

The initial effects were breathlessness, severe irritation in the eyes, coughing, a feeling of suffocation and burning of the respiratory tract. People realizing the symptoms ran away from the plant. Several thousand people were victims and had died before the following morning. The primary factors causing the deaths were choking, collapse of circulatory systems, changes in the lungs and improper functioning of the kidneys are a few among many. The neo natal mortality rate rose manifold. The Indian council of medical research (ICMR) was forbidden to give out the data to the public but estimates say that more than 500,000 people were affected by it. The few implications known were in eyes, respiratory tracts, neurological systems and psychological effects.

What caused the leak and how it could have been avoided:

The route chosen for the production of the pesticide sevin using mic as an intermediate, was itself a major mistake as it had a lot of complications tagged with it. The liquid MIC had to be stored at 0 degree Celsius at all times even while transporting it in barrels from the storage to the production house which is next to impossible. And for proper use it had to be kept at a high pressure using inert nitrogen which was again required a strong technical system. Other manufactures were using an alternate MIC free route for producing sevin.

The MIC supervisor ignored the complaint by the workers of a pollution caused by MIC leak and made the decision to consider it after the tea time which gave the gas enough time to escape to the city. Even after this mistake, the alarm for the residents near the plant was not used to its function and most of the people figured it out when they started to feel its symptoms.

The safety specifications set up by the UCC were not implemented properly and were given a blind eye whenever it caused a malfunction. The storage tanks were filled much over the specified limit of 50%.the refrigeration system used to maintain the temperature of liquid MIC was not in working condition since January 1982. The flare tower used to burn the MIC was faulty and also of improper size to deal with a leak of MIC. The storage system was lacking the specifications needed to control a leak of this magnitude. The production workers were not trained properly about the safety procedures to follow at all times. This was done to reduce the training time n costs of training being bared by the company.

All the effects of the disaster could have been mitigated if the government had information about the effects and composition of the chemicals used. The UCC used trade secrecy as a right to contain information about the true composition of the leaked gases. Though it was known that upto 300 toxic chemicals but insufficient research was done and that too only on animals. it was a clear case of criminal negligence.

The diseases could have been managed if the government had been given the complete information about the composition of chemicals used and their long-term effects on the human body. ICMR started 24 studies about the effects of MIC but unfortunately none of them were completed and were shut down by 1994.

a. What are the different evidences that you will scrutinize to identify the root cause of this accident? (5 Marks)
b. Identify the potential root causes using 4M analysis (15 Marks)