7. (a) Elucidate the 'Risk Management Process' with its salient features in different industrial companies.

(b) What is FMEA method for hazard Analysis?

(c) Seventy-five people are tested for skin irritation because of a specific dose of a substance. The responses are recorded on a scale from 0 to 10, with 0 indicating no response and 10 indicating a high response. The number of individuals exhibiting a specific response is given in the following table:

Response:	0	1	2	3	4	5	6	7	8	9	10	Total individuals
No. of individual affected	0	5	10	13	13	11	9	6	3	3	2	75

(i) Plot a histogram of the number of individuals affected versus the response.
(ii) Determine the mean and the standard deviation.
(iii) Plot the normal distribution on the histogram of the original data.

3 + 5 + 4 = 12

Group – E

8. (a) Mention the 14 elements of process safety management.

(b) What are the four significant disasters? Give an overiew of the incidence.

(c) Describe the importance of "corrosion" and "erosion" in regard to safety of the people and equipments of thermal power plants and process industries where steam generation and storage tanks of highly volatile and inflammable substances are commonly in place.

4 + 4 + 4 = 12

9. Write short notes on any three. **(3 × 4) = 12**
(i) Fire hazards and prevewnton
(ii) Safety programme
(iii) Flammability limits
(iv) Bhopal tragedy
(v) Safety system and disaster management.

SAFETY AND HAZARDS ANALYSIS
(CHEN 4181)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) OSHA stands for
(a) Organisational Standard Health Administration
(b) Occupational Safety and Health Association
(c) Occupational Safety and Health Act
(d) Outstanding Safety and Health Activities.

(ii) Risk is defined as
(a) P x E   (b) P/E   (c) E/P   (d) P + E.
[P= Probability of occurrence of an accident, E = severity of the damage/injury].

(iii) BLEVE stands for
(a) Bubbling Liquid Emergency Vapour Exit
(b) Boiler Liquid Excessive Vapour Explosion
(c) Boiling Liquid Expanded Vapour Explosion
(d) Boiling Liquid Extended Vapour Exit.

(iv) Fire hazard due to inflammable materials like methane does not continue to happen when the concentration of the material in air is
(a) more than the LFL only   (b) less than the UFL only
(c) within LFL & UFL   (d) outside the LFL and UFL.

(v) What functional area is typically responsible for functions related to design, construction, standards, and repair?
(a) Engineering   (b) Facilities
(c) Logistics   (d) Research and Design.

(vi) HAZOP study stands for
(a) Hazard Operation study   (b) Hazardous Operations study
(c) Hazard and Operability study   (d) Hazard Optimisation study.

(vii) The delay between exposure and observable effects is _____.
(a) down time
(b) latency period
(c) effect delay
(d) synergism

(viii) LFL of a given flammable substance decreases with
(a) temperature
(b) pressure
(c) increasing heats of combustion
(d) concentration.

(ix) Calculate the incidences rate for a company if the recordable incidents are 40 and the total hours worked are 1,500,000.
(a) 2.6
(b) 5.3
(c) 8.7
(d) 10.2.

(x) What are the two main causes of incidents in the workplace?
(a) unsafe acts and unsafe people
(b) unsafe people and unsafe machines
(c) unsafe conditions and unsafe machines
(d) unsafe acts and unsafe conditions.

Group – B

2. (a) What are the measures for determining effectiveness of a safety programme implemented in the industry?

(b) What are the ingredients of engineering ethics that should be maintained by the engineering people involved in the industry?

(c) Three process units are in a plant. The units have FARs of 0.5, 0.3, and 1.0, respectively.
  (i) What is the overall FAR for the plant, assuming worker exposure to all three units simultaneously?
  (ii) Assume now that the units are far enough apart that an accident in one would not affect the workers in another. If a worker spends 20% of his time in process area 1, 40% in process area 2, and 40% in process area 3, what is his overall FAR?

4 + 4 + 4 = 12

3. (a) How would you mathematically express upper flammability limits UFL and LFL of hazardous flammable substances with examples including mixture of flammable gaseous components?

(b) Explain the disastrous phenomenon of BLEVE and how this is mitigated for the safety of the working people or the users?

(c) What is the UFL$_{mix}$ of a mixture gasescomposed of 1% CH$_4$, 2% C$_2$H$_6$ and 3% propane by volume at temperature of 50^0 C and pressure of 2 atm? Given, UFL$_{25^0C\,\&\,1\,atm,\,CH4}$ = 15 % , UFL$_{25^0C\,\&\,1\,atm,\,C2H6}$ = 12.5 % and UFL$_{25^0C\,\&\,1\,atm,\,C3H8}$ = 9.5 %.

3 + 4 + 5 = 12

Group – C

4. (a) Define 'Risk' in industrial operations.

(b) The water flow to a chemical react for cooling coil is controlled by the system as shown in Fig. 1. The flow is measured by a differential pressure (DP) device, the controller decides on an appropriate control strategy and the control valve manipulates the flow of coolant. Determine the overall failure rate, the unreliability, the reliability, and the MTBF for this system. Assume a 1-yr period of operation. Fig.1: Flow control system components are linked in series.
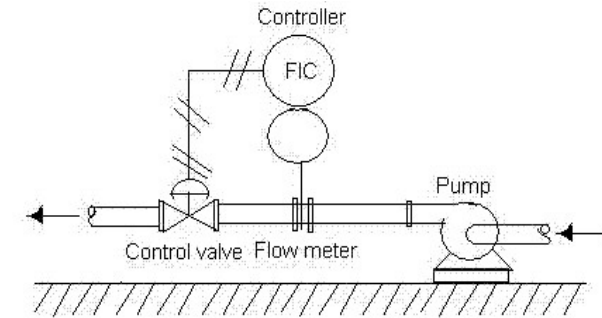

Fig. 1

Component	Failure rate μ (faults/yr)	Reliability $R = e^{-\mu t}$	Failure probability $P = 1 - R$
Control valve	0.60	0.55	0.45
Controller	0.29	0.75	0.25
DP cell	1.41	0.24	0.76

6 + 6 =12

5. (a) Mention the various methods of hazards analyses and discuss the usefulness of the methods specific to the type of hazards and risks.

(b) How would you conduct HAZOP study method for hazard analysis?

(c) What is FMEA method for hazard analysis and mention its applicability in the safety aspect of industrial operations.

4 + 4 + 4 = 12

Group – D

6. (a) Write the merits and demerits of Fault Tree Analysis with example.

(b) Compare between 'Fault Tree' and 'Event Tree' Analysis.

6 + 6 = 12