UNIVERSITI
TEKNOLOGI
PETRONAS

FINAL EXAMINATION
JANUARY 2025 SEMESTER

COURSE	**:**	**CBM5113/CCM5113 – PRINCIPLES OF PROCESS SAFETY MANAGEMENT**
DATE	**:**	**13 APRIL 2025 (SUNDAY)**
TIME	**:**	**2:30 PM – 5:30 PM (3 HOURS)**

INSTRUCTIONS TO CANDIDATES

1. This is an **OPEN BOOK** exam.
2. Answer **ALL** questions in the Answer Booklet.
3. Begin **EACH** answer on a new page in the Answer Booklet.
4. Indicate clearly answers that are cancelled, if any.
5. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions, if any.
6. **DO NOT** open this Question Booklet until instructed.

Note :

i. There are **SIX (6)** printed pages in this **double-sided** Question Booklet including the cover page and appendix.

1. JME Chemicals Sdn Bhd recently experienced a minor hazardous vapor release during a routine reactor startup. An investigation revealed that some operators were unfamiliar with emergency shutdown procedures, and new engineers lacked knowledge of process hazard analysis (PHA). Further audits showed outdated safety documents, insufficient training for new hires, and poor knowledge sharing between experienced and new staff. Management is now reviewing ways to improve Process Safety Competency to prevent future incidents. As a Process Safety Consultant, you have been hired to assess the company's weaknesses and propose strategies to enhance process safety. Discuss the competency gaps at JME Chemicals and recommend a structured approach to improve Process Safety Competency for both operators and engineers.

[25 marks]

2. A refinery unit operating at high temperatures and pressures, handling flammable and hazardous chemicals, recently experienced an uncontrolled pressure buildup in a distillation column, leading to an emergency shutdown. Investigations revealed that operators failed to recognize early warning signs of rising pressure. Further assessment identified key safety gaps, including a lack of employee awareness of process hazards and risk assessments conducted solely for compliance rather than as a continuous safety practice. The management aims to enhance hazard identification and risk management to prevent future incidents and has engaged you as a Process Safety Specialist to lead this effort. Deduce probable causes that leads to the issues and recommend effective methods to enhance operators' awareness of hazards and their ability to respond to early warning signs of process failures. Justify your recommendations.

[25 marks]

3. A management of change (MOC) procedure was developed by a student in the process safety course using the Texas City Refinery Explosion as the case study as shown in **APPENDIX I**. Based on the information given, evaluate the MOC procedure and identify its advantages and shortcomings. Propose improvement that can be made to the MOC procedure in accordance with the recommended system for management of changes. State and justify all assumptions used.

[25 marks]

4. On June 1, 1974, a catastrophic explosion occurred at a chemical plant in Flixborough, UK, resulting in 28 fatalities, 36 injuries, and extensive structural damage. The explosion was one of the most significant process safety failures in history, highlighting critical weaknesses in mechanical integrity, hazard assessment, and management of change (MOC). This disaster underscores the importance of leading and lagging indicators in preventing major industrial accidents. **TABLE Q4** shows the identified leading and lagging process safety key performance indicators (KPIs) from the incident. Using the KPIs identified in the table, design a process safety performance dashboard for a facility aiming to prevent another Flixborough-like incident using the four-tier approach by API RP 754. Clearly state all assumptions and justifications for your design.

TABLE Q4: KPIs Identified based on Flixborough Incident

No.	Process Safety Key Performance Indicators (KPIs)
1	The explosion that resulted in 28 fatalities and widespread damage.
2	Small leaks detected in the temporary piping system prior to the explosion.
3	The activation of emergency shutdown systems due to abnormal pressure readings.
4	Lack of formal safety audits and hazard assessments for the modified piping system.
5	Workers not being trained in process hazard recognition before the disaster.
6	Unreviewed Management of Change (MOC) procedures before plant modifications.

[25 marks]

- END OF PAPER –

APPENDIX I

Management of Change (MOC) Procedure

Title	Management of Change for Process Modifications in the Isomerization Unit
Document ID	MOC-REF-2025-001
Revision	1.0
Proposed Change	Upgrade the blowdown drum and vent stack system to prevent direct release of hydrocarbons into the atmosphere
MOC Review and Approval Process	
Initiation	• Request submitted by Process Safety Engineer. • Justification: Existing vent stack design poses a high risk of flammable vapor release.
Hazard Review	• Identified risk: If liquid hydrocarbons enter the blowdown drum, vapor clouds may form and ignite. • Recommended action: Replace the open vent stack with a flare system to burn off excess hydrocarbons safely
Classification Review	• Process engineers confirm that a flare system is the best solution. • Operations and maintenance confirm that training is needed for new equipment.
Implementation Plan	• Install a sealed flare system to replace the atmospheric vent stack. • Update all startup and shutdown procedures. • Train all operators on the new system.
Testing and Validation	• Conduct controlled startup trials with the flare system. • Monitor pressure relief system performance.
Documentation and Monitoring	• Update P&ID drawings, SOPs, and emergency response plans. • Conduct a post-installation review to evaluate system performance.