



SUMMER-19 EXAMINATION
Model Answer

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Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more importance (Not applicable for subject English and Communication Skills).
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.



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Q No	Sub q.no	Answer	marks
1		Answer any 5	10
1	a	Safety in industry : Industrial safety is defined as policies and protections put in place to ensure plant and factory worker protection from hazards that could cause injury.	2
1	b	Safety planning: It is the first step of safety management where in a safety manager decides in advance safety objectives, policy, procedure, strategies, rules, programmes, method, budget, schedules and necessary means for achieving these objectives, considering facts and anticipating foreseeable events that may affect safety of plant, people and environment.	2
1	c	Safety Integrity Level: SIL is defined as a relative level of risk reduction provided by a safety function, or to specify a target level of risk reduction.	2
1	d	Purpose of doing accident investigation: The purpose is to find out the real cause of the accident and then based on it, to suggest remedial measures to prevent its recurrence.	2
1	e	Interpretation of worker in factories Act 1948: "Worker" means a person [employed, directly or by or through any agency (including a contractor) with or without the knowledge of the principal employer, whether for remuneration or not], in any manufacturing process, or in cleaning any part of the machinery or premises used for a manufacturing process, or in any other kind of work incidental to, or connected with, the manufacturing process, or the subject of the manufacturing process [but does	2



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		not include any member of the armed forces of the Union].	
1	f	Various hazards in polymer plants: <ol style="list-style-type: none">1. Chemicals like formaldehyde and caprolactam cause burning in eyes, nose and throat.2. High temperature and pressure of thermic fluid may cause burn and sometimes fire3. Extrusion machines have hot surfaces which need insulation to prevent burn injury.4. Cutting machines for plastic , rubber and other hard substances need safety guard on cutting blade and machine drives.5. Charging of toxic materials need enclosed system with local and room exhaust fans and necessary respirators.6. Polyamides used to manufacture epoxy resin are skin irritant.7. Acrylonitrile used in polyacrylonitrile fibre is toxic, skin irritant and carcinogenic.8. Dimethyl formamide causes digestive effects, abdominal pain, skin effect and pancreatitis to workers exposed to it.9. Styrene monomer, acetone and organic peroxide catalyst used in making polyester resins may cause fire and explosion. Styrene vapour may cause narcosis.	1 mark each for any 2
1	g	Types of maintenance: <ol style="list-style-type: none">1. Corrective or breakdown maintenance2. Scheduled maintenance3. Preventive maintenance	½ mark each



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		4. Predictive maintenance	
2		Answer any 3	12
2	a	Process of safety planning: The steps of planning are: <ol style="list-style-type: none">1. Identify problems2. Establish objectives or goals3. Develop planning premises(eg. Land, labour, capital, market, money, time, production, public relation, employee relation, reputation, morals, policy, programmes, rules, emergencies, new inventions, etc.)4. Determine alternative course of action5. Evaluate the alternatives6. Select a course of action7. Formulate derivative (final) plan and sub pland as per need.	4
2	b	Failure Modes and Effective Analysis (FMEA): FMEA is a design tool used to systematically analyze component failure and identify the resultant effects on system operations. It is a systematic way of identifying and preventing potential failures in systems, processes, products and services before they occur. It has long been a way to predict the consequences of failures in complex systems. FMEA is a proactive tool to assist in new design or enhancement of existing processes. It doesn't require a prior accident or close call. It can be carried out manually or by using computer software, individually or team of experts. Characteristics:	4



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		<ul style="list-style-type: none">• It is a time consuming, but very useful method <ol style="list-style-type: none">1. Inductive technique(drawing of the general interference from a particular event2. Non mathematical3. Equipment oriented.4. Human errors are not considered <ul style="list-style-type: none">• It considers only one failure mode at a time.	
2	c	<p>Steps involved in accident investigation:</p> <ol style="list-style-type: none">1. Provide first aid and/or medical care to the injured persons and take action to prevent further injury or damage. This is the first priority.2. Report the accident as required by your company's policies.3. Investigate the accident as soon as possible after it occurs. This allows you to observe the conditions as they were at the time of the accident, prevents the disturbance of evidence, and allows you to identify witnesses. You will need to gather physical evidence, take photographs, and interview witnesses to understand the chain of events that led to the accident.4. Identify the causes of the accident. Note that there are usually multiple causes.5. Report your findings in a written report. in preparing the report, it is helpful to prepare step-by-step account or timeline working back from the moment of the accident, listing all possible causes at each step. This account can be helpful in preparing the final report, which should clearly explain the evidence for your conclusions.	4



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		<p>6. Develop a plan for corrective action to prevent the accident from happening again. These actions should be specific, constructive, address root causes of the accident, and address the causes described in the report.</p> <p>7. Implement your corrective action plan. It is helpful to set a deadline for implementation of corrective actions and there should be monitoring in place to ensure that they are completed.</p> <p>8. Follow up to evaluate the effectiveness of the corrective actions taken.</p> <p>9. Make adjustments as needed to continue to improve.</p>	
2	d	<p>Events leading to flixborough industrial disaster:</p> <p>The plant at Flixborough produced the raw materials for nylon. The disaster happened during the processing of cyclohexane - a highly inflammable component liquid - when a temporary bypass assembly linking two of the plant's six reactors suddenly failed, causing some of the chemical to escape. The leak then ignited to cause the blast. The rupture was caused by a massive build-up of pressure, which was triggered by a series of events that would not have been permitted to occur had the process been fully understood by Nypro's chemical engineers.</p> <p>The presence of water inside the reactors, and the simultaneous shutting down of crucial stirring equipment, caused the explosion. "In its simplest form it's a bit like throwing water on to a burning chip pan."</p>	4
3		Answer any 3	12
3	a	Hazard: A hazard in anything in the work place that has the potential to harm	2



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		<p>people. It includes objects in the workplace such as machinery or dangerous chemicals.</p> <p>Types of hazards : 1) Mechanical hazards 2) Electrical hazards 3) Noise hazards 4) Radiation hazards 5) Explosion hazards 6) Toxic hazards 7) Chemical hazards</p>	<p>½ mark each for any 4</p>
3	b	<p>Preventive maintenance: It is a system of scheduled, planned maintenance tries to minimize the problem of breakdown maintenance. It is a stich- in- time procedure. It locates weak spots in all equipment, provides them regular inspection and minor repairs there by reducing the danger of unanticipated break downs. The principle of preventive maintenance is that prevention is better than cure. Preventive maintenance involves. i. Periodic inspection of equipment and machinery to uncover conditions that lead to production break down and harmful depreciation. ii. Upkeep of plant equipment to correct such conditions while they are still in a minor stage. The key to all good preventive maintenance programs is inspection. Help can be taken of suitable statistical techniques in order to find how often to inspect.</p> <p>Advantage of preventive maintenance:</p> <ol style="list-style-type: none">1. Reduced break down and connected down time.2. Lesser odd time repairs and reduced over time to be maintenance work force.3. Greater safety for workers.4. Fewer large scale and repetitive repairs.5. Low maintenance and repair cost.6. Less stand by or reserve equipment and spare parts.	<p>4</p>



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		No. of dependents iv) Financial positions v) Home environment vi) Lack of skill and knowledge. vii)Improper attitude towards work viii)Carelessness ix) Inattentiveness.	
4		Answer any 3	12
4	a	Steps to build a safety strategic plan: <ol style="list-style-type: none">1. Decide the mission and long range objectives of an organization2. Collect and analyses the related information of mission, objectives and challenges3. Conduct resource audit by appointing the resource safety auditor4. Think regarding the strategic alternative for overcoming the challenges, competitions and environmental crisis that can be faced in future.5. Implement and control the alternative	1 mark each for any 4
4	b	Information derived from HAZAN: It is the operation in which initial study is done to determine Hazard, effect and its causes. e.g. Manufacturing of product using electricity Hazard could be assumed as , electric spark, burns, fire, sparking etc. If failure of equipment operate is done then it may cause accident Steps for carrying HAZAN operation <ol style="list-style-type: none">1) Assume the type of accident or hazard position e.g. Fire, explosion2) Find out which plant or machine or system cause the accident for storage reactor, pipe line, vessel3) Find out the initial event	4
4	c	Safety measures adopted in fertilizer industry:	1 mark



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		<p>Education and personal hygiene</p> <p>PPE and safety showers</p> <p>Process segregation</p> <p>Heat insulation and careful operation handling</p> <p>Probably handle mechanization and automation</p> <p>Proper ventilation</p> <p>Pipe line and storage tank precaution specially ammonia storage</p> <p>Catalyst handling and storage</p>	<p>each for any 4</p>
4	d	<p>Breakdown maintenance:</p> <p>This method of maintenance implies that repairs are made after the equipment is out of order and it cannot perform its normal function any longer. In such situation, production department calls on the maintenance department to rectify such defect. The maintenance people checks into the difficulty and makes necessary repairs. After rectifying the fault, maintenance people do not attend the equipment again until another failure or breakdown occurs.</p> <p>Disadvantages of breakdown maintenance(any 2)</p> <p>1) Breakdown generally occurs at in opportunate time. This leads to poor, hurried maintenance and excessive delays in production.</p> <p>2) Reduction of output.</p> <p>3) Faster plant deterioration</p> <p>4) Increased chances of accidents and less safety to both workers and machines.</p> <p>5) More spoilt material.</p> <p>6) Direct loss of profit.</p> <p>7. Breakdown maintenance cannot be employed for those plant items which are</p>	<p>2</p> <p>1 mark each</p>



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		regulated by statutory provision eg. Cranes, lifts, and pressure vessels.	
4	e	Objectives of safety audit: Objectives are: 1. To provide the safe working place to every working staff and management. 2. To identify different level of hazards in each working place or department of an organization. 3. Confirm that safety, health, fire and environmental program activities and controls are in place and functioning. 4. Verify that the facility is in compliance with internal benchmarks and government regulations. 5. Assess past and current practices to identify and correct safety impediments which may result in personal injuries, property damage or business interruption.	1 mark each for any 4
5		Answer any 2	12
5	a	Safe work place layout in industry: 1. The layout should be such that every workman has enough space to move and operate. 2. The minimum distance between each equipment should be 75 cm. 3. The floor distance should be minimum 4.5m. 4. There should be proper light and ventilation on each floor. 5. Floor must be of non skid type. 6. Windows of proper dimension should be provided to get natural day light. 7. A grid type of layout is essential with roads and fire water systems at a maximum of 300 m. centre to centre, serving two sides of each major	1 mark each for any 6



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		<p>hazard.</p> <p>8. Equipment within process unit should be located with due consideration to potential hazard.</p>	
5	b	<p>Factories Act 1948:</p> <p>(i) General duties of occupier: (any 4)</p> <p>(1) Every occupier shall ensure, so far as is reasonably practicable, the health, safety and welfare of all workers while they are at work in the factory.</p> <p>(2) Without prejudice to the generality of the provisions of sub-section (1), the matters to which such duty extends, shall include-</p> <p>(a) the provision and maintenance of plant and systems of work in the factory that are safe and without risks to health;</p> <p>(b) the arrangements in the factory for ensuring safety and absence of risks to health in connection with the use, handling, storage and transport of articles and substances;</p> <p>(c) the provision of such information, instruction, training and supervision as are necessary to ensure the health and safety of all workers at work;</p> <p>(d) the maintenance of all places of work in the factory in a condition that is safe and without risks to health and the provision and maintenance of such means of access to, and egress from, such places as</p>	2



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	<p>are safe and without such risks;</p> <p>(e) the provision, maintenance or monitoring of such working environment in the factory for the workers that is safe, without risks to health and adequate as regards facilities and arrangements for their welfare at work.</p> <p>(3) Except in such cases as may be prescribed, every occupier shall prepare, and, as often as may be appropriate, revise, a written statement of his general policy with respect to the health and safety of the workers at work and the organization and arrangements for the time being in force for carrying out that policy, and to bring the statement and any revision thereof to the notice of all the workers in such manner as may be prescribed.</p> <p>(ii) Approval, licensing and registration of factories: (any 4)</p> <ul style="list-style-type: none">• There must be the submission of the plans irrespective of the class and description of the factories to the chief inspector or the state government.• Also, the previous permission of the state government or the chief inspector shall be obtained for the site or place where the factory would be constructed or situated.• Considering the permit application for the submission of plans and the specification.• The authority certifies the nature of plans and specification.• Licensing and registration of the factories.	<p>2</p>
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	<ul style="list-style-type: none">• Fee for the registration of the license and also for the renewal.• Considering the section 7 licenses cannot be granted or renewed if no notice is being served <p>(iii) Duties of the inspector: (any 4)</p> <p>(a) Entre, with such assistants, being persons in the service of the Government, or any local or other public authority, [or with an expert] as he thinks fit, any place which is used, or which he has reason to believe is used, as a factory;</p> <p>(b) Make examination of the premises, plant, machinery, article or substance;</p> <p>(c) Inquire into any accident or dangerous occurrence, whether resulting in bodily injury, disability or not, and take on the spot or otherwise statements of any person which he may consider necessary for such inquiry;</p> <p>(d) Require the production of any prescribed register or any other document relating to the factory.</p> <p>(e) Seize, or take copies of any register, record or other document or any portion thereof, as he may consider necessary in respect of any offence under this Act, which he has reason to believe, has been committed.</p> <p>(f) Direct the occupier that any premises or any part thereof, or anything lying therein, shall be left undisturbed (whether generally or in particular respects) for so long as in necessary for the purpose of any examination under clause (b);</p> <p>(g) Take measurements and photographs and make such recordings as he</p>	2
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		<p>considers necessary for the purpose of any examination under clause (b), taking with him any necessary instrument or equipment.</p> <p>(h) In case of any article or substance found in any premises, being an article or substance which appears to him as having caused or is likely to cause danger to the health or safety of the workers, direct it to be dismantled or subject it to any process or test (but not so as to damage or destroy it unless the same is, in the circumstances necessary, for carrying out the purposes of this Act.), and take possession of any such article or substance or a part thereof, and detain it for so long as is necessary for such examination.</p> <p>(i) Exercise such other powers as may be prescribed.</p> <p>Provided that no person shall be compelled under this section to answer any question or give any evidence tending to incriminate himself.</p>	
5	c	<p>Sampling technique for petrochemical industry:</p> <p>In the petrochemical industry, representative samples of liquid petroleum gas and other high vapor pressure gases and liquids are needed for process monitoring, quality control and regulatory compliance. However, in this industry, process fluids and gases are volatile or could be harmful to the operator and the environment, or they could be dangerously altered through a chemical reaction when exposed to the atmosphere – so exposure must be avoided. Because each sample collected may pose a physical or health hazard, and operators may take hundreds of samples per year, samples must be taken safely and correctly using the appropriate equipment and containers.</p> <p>Low-emission samplers are designed to provide the greatest amount of protection for both operators and the environment, with no spillage and</p>	6



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minimal release of volatile organic compounds (VOCs) – organic chemicals that have a high vapor pressure at ordinary room temperature. Safe sampling also requires using a metal sample cylinder for collection and transport. Generally, this cylinder is a stainless-steel pressure-rated cylinder with inlet and outlet isolation valves to isolate the sample within the cylinder, and a connection method for easy removal of the cylinder assembly from the sample panel. Additional options might also be included depending on the customer application.

Sample cylinder assemblies provide two main advantages:

1. They allow for samples to be collected at or near the pressure of the process being sampled. This assures that the sample is representative – constituents that can change state with pressure reduction are not lost during sample collection. An example of this type of sample would be liquid petroleum gas or other two-phase fluids that could flash off sample constituents if the pressure were reduced during sampling.
2. Since the sample is a pressurized liquid that has a high vapor pressure, the sample cylinder assembly provides for a safe method of collection and transport as long as the maximum fill density meets regulatory requirements. The maximum fill density is the volume of a sample cylinder assembly usually expressed as a percent of total capacity. Maximum fill density is regulated by various governmental authorities to ensure safe transport of the cylinder. Regulations sometimes vary, but most limit the



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maximum fill density of transport containers for safety to 80 percent liquid fill of the cylinder at 15°C.

The most common sample connection types include speed loop and single point. In a speed loop sampling connection with a venting provision, there are two connections to the product line. There must be different pressures between the connections to initiate flow of product through the loop and the sampler. Either a centralized vent or flare collection system or a local scrubbing system (charcoal canister) is used to collect and process off gases or vapors released during the sampling process to eliminate product release to the local environment and operators.

With a single point sampling connection with a venting provision, the sampler has a single connection to the product line and no product return line. Off gases or vapors released during the sampling process are handled either through a centralized vent or flare collection system or a local scrubbing system (charcoal canister), eliminating product release to the local environment and operators.

With proper design and operation of these two connection types, release of vapors after the sample cylinder is removed from the sampler can be minimized to a very low level.

Another less preferable option is single point sampling connection without a venting provision, where off gases or vapors are released into the local environment. Because of these releases and the limited cost savings, use of this type of design has limited application.

Sample cylinder assemblies then need to be transported for analysis to ensure



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		production output is stable, efficient and safe. Representative sampling helps ensure quality, protect plant assets, and keep operators, the public and the environment safe.	
6		Answer any 2	12
6	a	Procedure of safety Auditing : Safety audit is carried out by a team whose members are not involved in the plant or activity being audited. The expertise of the team should be compatible with the type of audit. It is beneficial to include the managers of other plants or units in an audit team as well as one previous auditor of the same unit. Audits are carried out in a formal way using a carefully drawn up checklist of items and descriptive standards for each item. A line manager or supervisor of the plant under audit should be asked to accompany the auditor inspecting it. He should be informed of all corrections and improvements required by the auditors so that he can start taking the necessary steps before the audit report is submitted to management. The main object of inspection should be to determine whether the layout design and condition of equipment and protective features are upto standard and to ensure that the protective features will work in an emergency. The auditing should give a verbal report to the management on completion of audit followed by a clear and concise written report within two weeks. Various records to be examined during safety auditing: <ol style="list-style-type: none">1. Operational safety and health policy.2. Safety organization chart.	03



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		<ol style="list-style-type: none">3. Training records on safety , fire and first aid.4. Records of plant safety inspection.5. Accident investigation reports6. Accident and dangerous occurrences, statistic and analysis.7. Records of test and examination of equipment and structure.8. Safe operating procedures for various operations.9. Record of work permit.10. Record of monitoring of flammable and explosive substances at work place.11. Medical records of employees.12. Records of waste disposal.13. Maintenance procedure records.14. House keeping inspection records.15. Record of previous audits.	½ mark each for any 6
6	b	<p>Functions and duties of plant maintenance department(any 8)</p> <p>1)Inspection 2)Engineering 3) Maintenance 4) Repair 5) Overhaul 6)Construction 7) Salvage 8) Clerical work</p> <p>1)Inspection:</p> <p>i) Inspection of the plant facilities to examine their condition and to check for repairs needed.</p> <p>ii) Inspection to ensure the safe and efficient operation of plant equipment and machinery.</p>	1 mark each for any 6



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	<p>2)Engineering :</p> <p>i) Engineering involves alternations and improvement in existing plant equipment to minimize breakdown.</p> <p>ii) Engineering and consulting services to production supervision.</p> <p>3) Maintenance :</p> <p>i) Maintenance of existing plant equipment.</p> <p>ii) Engineering and execution of planned maintenance, minor installations of equipment building and replacements.</p> <p>4) Repair:</p> <p>i) To carry out corrective repair to alleviate unsatisfactory conditions found during preventive maintenance inspection.</p> <p>5) Overhaul:</p> <p>i) Overhaul is a planned, scheduled reconditioning of plant facilities such as machinery etc.</p> <p>ii) Overhaul involves replacement, reconditioning, reassembly, etc.</p> <p>6)Construction :</p> <p>i) In some organization, maintenance department is provided with equipment and personnel and it takes up construction job too.</p> <p>7) Salvage :</p> <p>i) Maintenance department may also handle disposition of scrap or surplus materials.</p> <p>8) Clerical work:</p> <p>i) Maintenance department keeps records at i) of costs, ii) of time progress on jobs pertaining to important features of building and production equipment.</p>	
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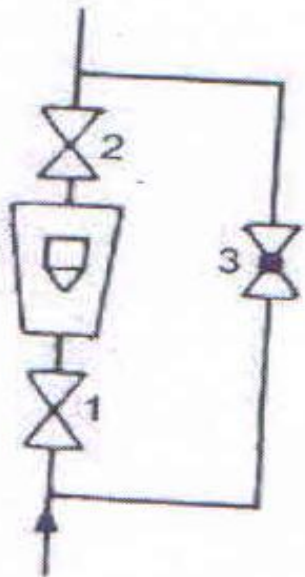
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6	c	<p>On line maintenance of Rotameter:</p> <p>In a chemical plant, it is a normal practice to do on line maintenance work. This avoids total shutdown of the equipment or plant. This is possible, if proper pipe fittings are installed at the time of erection. e.g. Suppose there is a Rota meter in pipe line. If we desire to replace a broken glass pipe of Rota meter , we can close valve 1 & 2 and open 3 and divert the fluid through by pass line. After replacement of the glass pipe in the Rota meter close valve 3 and open 1 and 2. Thus it is possible to attend maintenance jobs in the line without stopping the production.</p> 	3
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