Module 12 Assignment Questions

Total = 273 marks

QUESTION 1 [4 marks]
What are the points to be considered for selecting a good pump?

QUESTION 2 [4 marks]
Under what conditions/situations would the centrifugal compressor be selected?

QUESTION 3 [10 marks]
(a) What are the elements of pump reliability?

(b) What steps would you take to achieve sustainable pump reliability?

QUESTION 4 [6 marks]
What is Life Cycle Cost (LCC) with respect to pumping systems and what are the elements of the life cycle cost?

QUESTION 5 [10 marks]
Describe communication protocols and specify a few of the modern protocols in use?

QUESTION 6 [6 marks]
Name the components that are numbered in the centrifugal pump sketch below.
QUESTION 7 [4 marks]
In your own words, describe why gland packing should have some small amounts of leakage. Why gland packing may require external cooling.

QUESTION 8 [8 marks]
A pump has a volumetric flow of 60 m$^3$/hr and a differential head of 280 m. It is used to pump water (r = 1).

(a) Calculate the Hydraulic Power required by the pump.

(b) If this pump is used to pump Naphtha (r = 0.67), calculate the Hydraulic Power required by the pump.

QUESTION 9 [10 marks]
A system on site is a pressure sand filter with a service curve. The filter is backwashed using the feed pump, at a higher flow rate, shown as backwash curve.

![Centrifugal Pump Curve](image)

<table>
<thead>
<tr>
<th>flow m$^3$/h</th>
<th>Head m</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>120</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>80</td>
</tr>
<tr>
<td>8</td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>12</td>
<td>20</td>
</tr>
</tbody>
</table>

Service duty point : 3 m$^3$/h
Backwash duty point : 9 m$^3$/h

(a) What is the speed of the pump needed to achieve the service and backwash flow rates? (4 marks)

(b) What would be the best way to control the speed of the pump? Why? (2 marks)

(c) The pump is set up as a fixed speed constant pressure system (the pump runs till the system pressure reaches 550 kPa, then turns off and when pressure drops to 450 kPa, plant re-starts) to maintain a system pressure of 500 kPa at the discharge of the pump. What would be the service and backwash rates from the pump? (4 marks)

QUESTION 10 [4 marks]
State the affinity laws as applicable to centrifugal pumps?

QUESTION 11 [6 marks]
Selecting a proper pump for a service involves four primary areas to be considered for system analysis. Briefly explain them.
QUESTION 12 [5 marks]
The Pump data sheet (specification sheet) should contain information for procurement purposes. Name at least 10 important points which should be contained in the data sheet?

QUESTION 13 [5 marks]
What additional information would you ask the pump vendor to specify and confirm?

QUESTION 14 [5 marks]
Describe the steps involved in the bidding process?

QUESTION 15 [5 marks]
Briefly explain the bid review/analysis process?

QUESTION 16 [10 marks]
A pump station has been designed to lift water out of a 6 metre deep pit (vented to atmosphere) via a centrifugal pump mounted at ground level.

<table>
<thead>
<tr>
<th>Liquid conditions</th>
<th>20 °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suction pipe work losses</td>
<td>2.0 metres</td>
</tr>
<tr>
<td>NPSH safety factor</td>
<td>5.0 kPa</td>
</tr>
<tr>
<td>Vapor pressure @ 20°C</td>
<td>0.25 metres</td>
</tr>
</tbody>
</table>

(a) Calculate the Net Positive Suction Head (NPSH) for the system ?

(b) In summer the liquid temperature rises to 60 °C, this changes the water vapor pressure to 2.05 metres. What is the revised NPSH for the higher water temperature?

(c) For the NPSH result from part (b) what increase in suction pipe work size is required to have a positive NPSH result as calculated in part (a).

QUESTION 17 [6 marks]
Name at least 6 hazardous chemicals being pumped in the process industry?

QUESTION 18 [6 marks]
State the names of some of the Metallic & Non-metallic materials used in pump construction, against the following applications?

1. Hazardous Nature Fluids
2. High Temperature Fluids
3. Corrosive Fluids

QUESTION 19 [8 marks]
Name the different types of pump drive system and their selection criteria for the applications?

QUESTION 20 [4 marks]
List the types of couplings used in the pumps.
QUESTION 21 [6 marks]
The sketch below illustrates a pump drawing volatile hydrocarbons from a large surge vessel, with necessary pumping systems, instruments and controls incorporated. Describe the systems instrumentation and controls, as indicated.

QUESTION 22 [5 marks]
What are the most common centrifugal pump controls methods?

QUESTION 23 [6 marks]
Name three (3) base plate materials and configurations available for pump foundation? Briefly state the advantages and disadvantages of each.

QUESTION 24 [5 marks]
What kind of problems would you anticipate when the suction and delivery piping connections are not as per standard?
QUESTION 25 [4 marks]
Why are rubber flexible joints to be used in a pump’s suction and delivery lines?

QUESTION 26 [6 marks]
What are the objectives of testing pump performance?

QUESTION 27 [8 marks]
Describe the commissioning process for a pump

QUESTION 28 [5 marks]
(a) How is condition monitoring performed in respect to pump performance?
(b) Describe a few benefits of Remote Condition monitoring?

QUESTION 29 [6 marks]
Explain the procedure for the pump testing. Mention the test equipment required.

QUESTION 30 [5 marks]
Define a Compressor. Give at least three applications of compressors.

QUESTION 31 [4 marks]
What are the basic criteria for selection of a compressor?

QUESTION 32 [6 marks]
Expand the following abbreviations related to the rating of a compressor. Include the units involved.

- CFM
- ACFM
- FAD
- SCFM
- nl/min
QUESTION 33 [6 marks]
A reciprocating compressor is operating at 800 rpm. Suction pressure and discharge pressure are held constant by other systems that have nothing to do with the compressor. The speed is increased from 800 to 840 rpm (a 5% increase).

(a) What is the change in flowrate through the compressor. (2 marks)
(b) What is the change in pressure rise through the compressor. (2 marks)
(c) What is the change in power that must be delivered to the compressor (2 marks)

QUESTION 34 [5 marks]
Compression occurs within the cylinder as a four-part cycle that occurs with each advance and retreat of the piston (two strokes per cycle).

The four parts of the cycle are compression, discharge, expansion and intake. They are shown graphically with pressure vs. volume plotted in what is known as a P-V diagram.

Explain the sequence in the reciprocating piston movement with respect to the diagram below.

QUESTION 35 [4 marks]
Explain how the rotary motion of a prime-mover is converted into reciprocating motion in a reciprocating compressor.

QUESTION 36 [10 marks]
Define the following in relation to a reciprocating compressor.
   a) Compression Ratio
   b) Compressor Capacity
   c) Piston Displacement
   d) Clearance Volume
   e) Volumetric Efficiency

QUESTION 37 [10 marks]
Gas is compressed in a reciprocating compressor from 1 bar to 6 bar. The FAD (Free Air Delivery) is 13 dm³/sec. The clearance ratio is 0.05. The expansion part of the cycle flows the law pV^{1.2} = C. The crank speed is 360 rev/min.

Calculate the swept volume and volumetric efficiency.

QUESTION 38 [10 marks]
Name the 10 major parts of a reciprocating compressor and briefly explain their functions?
QUESTION 39 [6 marks]
For a given reciprocating compressor explain the procedure for carrying the maintenance of the following components:
- Piston and piston rings
- Cylinder
- Compressor valves

QUESTION 40 [6 marks]
What are the mechanical forces generated in a reciprocating compressor? Briefly explain them?

QUESTION 41 [6 marks]
Describe in details the principle of working of centrifugal compressors.

QUESTION 42 [4 marks]
What is surging in a centrifugal compressor?

QUESTION 43 [8 marks]
Describe the main components of the centrifugal compressors.

QUESTION 44 [6 marks]
Name three controls used in centrifugal compressors and briefly explain their functions?