

**National Institute of Technology Hamirpur
Department of Chemical Engineering**

B.Tech. 3rd Year (Semester V)

**End Semester Exam
Process Equipment Design [CHD-314]**

Max Marks :50

Time : 2 Hrs

Date: 14/12/20

Exam Time: 10:00AM-12:00 PM

Submission Upto: 12:15 PM

INSTRUCTIONS

- Write Name, Roll No, Program, Semester, Department, Subject Name and Subject Code, Date of Examination and number of pages on top of first sheet
- Put signature with date on bottom of each sheet of answer booklet
- Take the scan and make pdf (don't take photo) of the answer sheet, name the pdf of answer sheet as rollnumbersubjectcode.pdf and upload it on google class.
- If any how answer sheet can not be uploaded on google class then only email it on rshyam@nith.ac.in. Submission should be within 15 Minutes of end exam time. Late submission will lead to partial or zero mark
- Retain the hardcopies of answer sheets and handover after returning back to institute
- Use of IS 2825-1969 code, appendices and tables uploaded on google class is allowed
- Make appropriate assumptions if needed

Question 1. A process vessel is designed for the maximum operating pressure of 600 kN/m^2 . The vessel has the nominal diameter of 1.2m. The vessel is made of IS 2002-1962 Grade 1 steel material and working temperature is 300°C . The vessel is to be fabricated according to Class III of Indian standard having single welded butt joint with backing strip. The corrosion allowance is suggested to be 3mm for the whole service life of vessel. Above process vessel is to be provided with a conical head of half apex angle of 45° , determine the thickness of the head. **(15)**

α	20°	30°	45°	60°
Z	1.0	1.35	2.05	3.2

Question 2. From the data given below, calculate the area of ring pad required for the nozzle opening in a cylindrical shell, (15)

Outside diameter of shell	2m
Working pressure	4MN/m ²
Wall thickness of shell	0.06m
Corrosion allowance	2mm
Weld joint efficiency factor	0.9
Allowable stress	100MN/m ²
Nozzle outside diameter (seamless)	0.3m
Nozzle wall thickness	0.016m
Inside protution of nozzle	Not desired
Length of nozzle above surface	0.15m

Question 3. A cylindrical vessel of 2.5m outside diameter and 10m length is supported by 4 lugs. The vessel is filled with liquid upto certain height, total weight of the liquid being 250kN. Operating pressure of vessel is 1.2MN/m² (g). Weight of the shell alone, without head, liquid or any attachment is 200kN. Vessel is covered with elliptical head of 10kN on one side and flat head of 2 kN on the other side. Corrosion allowance for above design is 3mm. Vessel is class I vessel and is fully radiographed. The vessel is made up of IS 2002-1962 Grade I material and design temperature is 300⁰C. The wind pressure on the vessel in 1kN/m² and time period of oscillation (T) is 0.4s. The height of vessel from foundation is 1m and height of bracket from foundation is 4m. Bolt circle diameter is 2.6m. The allowable stress of base and gusset plates is 90MN/m² and Poison's ratio is 0.3. Calculate,

- (a) Standard thickness of the shell
 (b) Calculate minimum thickness of horizontal plates for l = b = h = 160mm (15)

Table 10.2 Constants for Moment Calculation³

<u>b/l</u>	<u>1.0</u>	<u>1.2</u>	<u>1.4</u>	<u>1.6</u>
γ_1	0.555	0.350	0.211	0.125
γ_2	0.135	0.115	0.085	0.057

Question 4. A cylindrical shell is made up of carbon steel with $E = 20 \times 10^9$ N/m² and Poisson's ratio of $\mu = 0.3$. The strain gauge reading from the three gauges at the opening corners are, $\epsilon_x = 350 \times 10^{-6}$, $\epsilon_y = 300 \times 10^{-6}$, $\epsilon_z = 250 \times 10^{-6}$. Find out the stresses in the three directions at the opening corners. (5)