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UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program: B.Tech.(Civil Engineering) **Semester – VII**
Subject (Course): Design and Construction of Offshore Structures **Max. Marks : 100**
Course Code :CEEG415 **Duration : 3 Hrs**
No. of page/s:

Note: Attempt All Questions. Assume suitably any data not given and state clearly.

	Section A		
1.	**Sketch the configuration of a SPAR platform and explain how its cylindrical body can be held in upright position.**	**[4]**	**CO1**
2.	**A fixed bottom offshore platform is to be installed in Arabian sea . The platform carries a hull of size 50x 50mx15m with the clearance above MSL as 30m. Calculate and plot the variation of wind speed for the hull and the projecting portion of jacket to be used for calculation of wind load, at intervals of 7.5m. Assume wind velocity as 55m/s for 3 sec gust period. Use one hour averaging period for the jacket.**	**[4]**	**CO2**
3.	**The deck of a fixed jacket offshore platform can be installed on the jacket either by the lift method or by the float over method. Explain through sketches the configuration of jackets to be used in these methods, highlighting the difference between these two configurations.**	**[4]**	**CO3**
4.	**The CHS members of jacket of offshore platforms under application of load and moment can buckle locally or globally. Explain these phenomena through figures and the parameters that control these types of buckling.**	**[4]**	**CO4**
5.	**In the design of joints, the term 'hot spot' is used. Explain what is hot spot, and sketch the possible locations of hot spots in a T joint.**	**[4]**	**CO5**
	SECTION B		
6.	**(a.) During construction of members of offshore platform, construction imperfections may occur. What is 'out of roundedness' construction imperfection. Explain through figure, how it occurs.** **or** **(b) The leg of jacket of an offshore platform having 1m nominal diameter is being fabricated in factory. Due to construction imperfections little variation in diameter is observed. The diameter of leg measured through various diagonals shows the**	**[10]**	**CO3**

	least and maximum readings as 998mm and 1010mm. **Calculate the out of roundedness percentage and check if it is acceptable as per** **a. API code** **b. DNV code.**		
7.	**An offshore jacket structure is installed in sea having a brace member 10m long made up of size 800x16mm. The brace has been designed for the following loads acting on the brace member:** **Axial load = 1000 kN** **Inplane moment = 800 kNm** **Outplane moment = 600 kNm.** **However during fabrication of the member, a strain of 15 x 10^{-5} was measured while bending of the steel plates to make the brace. Neglecting residual stresses due to welding, check if the member can still carry the above loads safely. Assume the jacket to be fabricated using steel having f_y = 345 MPa.**	**[10]**	**CO3**
8.	**During installation of jack up rig at an offshore oil field site, preloading of hull is done. What is preloading operation and how it is carried out, explain briefly. Also explain how is preload calculated.**	**[10]**	**CO5**
9.	**(a)After the legs of the jack up rig are fixed in sea bed, the hull is raised to obtain the clearance above the MSL for carrying out the drilling operations. Explain how this clearance is decided.** **(b)What is Green wave effect. Explain how it can damage the jack up rig, and how it can be taken care off.**	**[10]**	**CO5**
	SECTION C		
10.	**A fixed bottom offshore platform is to be constructed in Arabian sea at a site having a depth of 100m from MSL. The platform is required to carry a hull of size 50 x 50 x 10m and mass 5000t with the clearance above MSL as 20m.** **Assuming the slope of jacket legs as 1: 10 and preliminary mass of the jacket as 4000t, :** **a. Suggest a suitable configuration of the jacket structure and calculate the natural period of vibration of jacket, before installation of the hull.** **b. Calculate the natural period of vibration of platform, after installation of**	**[20]**	**CO1 & CO2**

	the hull. **c. If a crane of m[illegible] platform will [illegible] safe against resonance, due to sea waves.** **or** **Morison's equ[illegible]ion can be used to calculate the force due to wave on a unit length of a leg of a jacket of a fixed offshore platform. Assuming an offshore platform fixed in sea, plot the variation of wave force on the entire length of the leg of jacket and explain the procedure and need for calculating the maximum shear force and overturning moment on the offshore platform.**		
11.	**A T joint is made up of a brace of size 500x16mm connected to a chord of 800x20mm . The loading on the brace is as follows:** **Axial load ccompressive = 1000KN** **Inplane moment = 300KNm** **Out plane moment = 200 KNm** **Assuming yield strength of steel as 345 MPa, Check if the joint made in the existing chord is safe.**	**[20]**	**CO4**

Following data may be used.

$F_b = [0.84 - 1.74(f_y D)/(Et)]f_y$

Qu the joint geometry factor is given as:

For Calculation of allowable axial load (P_a) in chord

For T and Y joints

Brace in axial tension

$$Q_u = 30\,\beta \qquad (6 < Qu < 30)$$

Brace in axial compression

$$Q_u = 2.8 + (20 + 0.8\,\gamma)\,\beta^{1.6} \qquad (0 < Qu < 36)$$

But not exceeding

$$2.8 + 36\,\beta^{1.6}$$

For balanced K joints

$$Q_u = (16 + 1.2\,\gamma)\,\beta^{1.2}\,Q_g$$

But not exceeding $40\,\beta^{1.2}\,Q_g$

Where Q_g is gap factor given as:

$$Q_g = 1 + 0.2\,(1 - 2.8\,(g/D))^3 \qquad \text{for g/D not less than 0.05}$$

But not less than 0.05

For Calculation of allowable in plane moment in chord (M_{ai})

$$Q_u = (5 + 0.7\,\gamma)\,\beta^{1.2}$$

For Calculation of allowable out plane moment in chord (M_{ao})

$$Q_u = 2.5 + (4.5 + 0.2\,\gamma)\,\beta^{2.6}$$

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Name of the College (Please tick, symbol is given)	:	**COES**	☑	**CMES**		**COLS**	
Program	:	**B. Tech. (Civil Engineering)**					
Semester	:	**VII**					
Name of the Subject (Course)	:	**Design and Construction of Offshore Structures**					
Course Code	:	**CEEG415**					
Name of Question Paper Setter	:	**Dr Vijay Raj**					
Employee Code	:	**40001380**					
Mobile & Extension	:	**7500212221, 1366**					
Graph Sheet							

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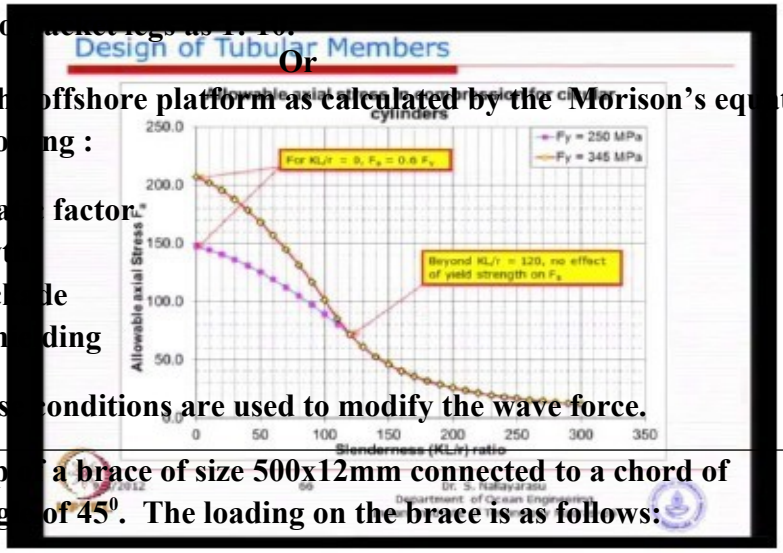
	Section A		
1.	**Sketch the configuration of a Tension leg platform and explain how heave movement can be restricted in it during drilling operations.**	**[4]**	**CO1**
2.	**A fixed bottom offshore platform constructed is to be installed in Arabian sea at a site having a depth of 100m from MSL. Assuming the tidal currant velocity at the surface of sea as 2.5m/s, plot the variation of tidal currant velocity from MSL to seabed at interval of 10m.**	**[4]**	**CO2**
3.	**During construction of offshore platforms, CHS sections are commonly used. Explain the advantages in their use. Also explain the welding problem associated with these sections.**	**[4]**	**CO3**
4.	**While designing an offshore platform, the jacket is designed by the Allowable stress method, while the deck can be designed by the Limit state method. Explain the reason why it is so done.**	**[4]**	**CO4**
5.	**Explain why in the design of joints the chord load factor is taken as 1 in case of balanced K joint, whereas it is taken less than 1 in case of T and Y joints.**	**[4]**	**CO5**
	SECTION B		
6.	**(a.) During construction of members of offshore platform, construction imperfections may occur. What is 'variation in wall thickness' and 'out of straightness' construction imperfections. Explain through figure, how it occurs.** **or** **(b) The leg of jacket of an offshore platform 12m long, having 25 mm thickness is being fabricated in factory. Due to construction imperfections 'variation in thickness' and 'out of straightness' is observed. The thickness of leg measured through various points shows the least and maximum readings as 23mm and**	**[10]**	**CO3**

	28mm. **Further a deviation of 10mm is noticed out of straightness. Calculate the total eccentricity produced and check if it is acceptable as per :** **a. API code** **b. DNV code.**		
7.	**An offshore platform is constructed in Arabian sea having a brace member 10m long made up of size 800x16mm. The brace has been designed for the following loads acting on the brace member:** **Axial load = 1000 kN** **Inplane moment = 800 kNm** **Outplane moment = 600 kNm.** **However during fabrication of the member, following residual stresses were estimated:** **a. While bending of the steel plates : 15 MPa** **b. Due to seam welding : 8 MPa** **c. Due to butt welding : 7 MPa** **Check if the design of member is still safe. Assume the jacket to be fabricated using steel having f_y = 345 MPa.**	**[10]**	**CO3**
8.	**What are requirements of foundation for legs of a jack up rig. Sketch a spudcan foundation and explain how it meets all these requirements.**	**[10]**	**CO5**
9.	**What are the advantages of jack up rigs over fixed offshore platforms. Draw a diagram of jack up rig and illustrate the following components in it:** **a. hull** **b. helipad** **c. legs** **d. drill mast** **e. drill pipe**	**[10]**	**CO5**
	SECTION C		
10.	**A fixed bottom offshore platform is to be constructed in Arabian sea at a site having a depth of 120m from MSL. The platform has a top width of 45x45m and carries a hull of mass 4000t with the clearance above MSL as 25m.** **If the mass of the jacket is 4500t, check if the platform is safe against resonance from sea waves before and after installation of deck.**	**[20]**	**CO1& CO2**

	Assuming the slope o[illegible] as 1: 10. **The wave force on th[illegible]offshore platform as calculated by the Morison's equ[illegible]tion is modified by the follo[illegible]ng :** **a. Wave kinema[illegible] factor** **b. Marine growt[illegible]** **c. Currant bloc[illegible]de** **d. Conductor sh[illegible]ding** **Explain how thes[illegible]conditions are used to modify the wave force.**		
11.	**A Y joint is made up[illegible] a brace of size 500x12mm connected to a chord of 800x20mm at an ang[illegible] of 45^0. The loading on the brace is as follows:** **Axial load tensile = 1100KN** **In plane moment = 250 KNm** **Out plane moment = 150 KNm** **Assuming yield strength of steel as 345 MPa, check if the joint made in the existing chord is safe.**	**[20]**	**CO4**

Or



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