1. Explain how structural form of offshore structures are different from that of conventional structural system

- Offshore structures - are different from conventional structures
- Innovativeness arise from the geometric form itself
- FORM-DOMINATED DESIGN
- X FUNCTION-DOMINATED DESIGN
- Loads are resisted partly by strength, partly by the geometric itself
- A variety of functions to perform: oil exploration, production, storage, transportation, research, etc.

- Offshore structures - constructed off the coast far away from the land
- No direct access to land
- No manned operations

- Offshore structures - They are unique in design
- They have special geometric form
- They are also complex - because environmental loads act on them
2. List the governing factors that control analysis and design of offshore structures

- Geometric form of the structural system
  - Depends on water depth and sea state of operation
    - Input conditions for load (wave, sea)
    - Sea state
    - H, T, wind direction, wind speed, geographic location

- Structural systems - deployed @ different water depths are not identical.
  - They vary widely - water depth especially

Structural analysis - we need to have the following input

- Offshore structures are innovative
  - Do not follow a conventional structural form

1. Geometric form - arrangement of members
2. Preliminary dimensions of these members
3. Material property (Steel, concrete, composite)
4. Loads - wave, wind, load at sea state - estimates

3. List few essential features of production platforms constructed in Gulf of Mexico (GoM)

- Summertime California
- Productive platform
- Lake Monaca

- [List of features]
  - Wind, wave, storm, high/low tide
  - High/low pressure
  - High wind, density
  - Operating + [List of supporting structures]
4. Write short notes on fixed type offshore platforms

Fixed platforms - Jacket platforms - prominent type of offshore platforms

- Fixed type
  - Base of the platform is fixed to the bed
- Reliability - stiffness - insensitive to wave loads
- Less displacements no rotation under lateral loads
- React to lateral load by stresses

Have special problems

- Construction
- Installation
- Erection
- Decommissioning

- Crane arrangements
- Special fabrication yards

Complex, high duration construction process
5. Write a brief note on Jack-up rigs

Jack-up rig

- Positively restrained
- Operating in oil exploration
- Drilling and production products
- Positive restraint by driving the legs into seafloor
- While portable, transported to site to another site
- Legs can be pulled up
- Hull floats

Jack-up - Converted rigid

Main advantage is

- Mobility
- Not fixed to any specific location
- Geometric design has a significant change
6. Explain the design concept of compliant-type offshore platforms

Compliant type

Compliance - flexibility, movement

Design concept - offshore structures

moved from ship-based to compliant-based

Gave attention to stiffness, paid paid attention to flexibility

- compliant
- freely respond to the load

loads - harmonized - not by strength but by displacement

member - local - deformation

displacement < structure < global - rigid body motion, D.K.

Compliance induce flexibility to the platform (Chakrabarti, 1972, 1974)

As they become flexible, respond to variables, environmental loads by undergoing large
displacement

Compliant structures

- restrain loads by displacement

Not all degrees of freedom - stiffness, angular position, roll, pitch

Systems components: dead and shifting, flexible - mass period, damping

Hybrid platforms
7. What do you understand by compliancy? In such platforms, what is the basic source of strength?

<table>
<thead>
<tr>
<th>Compliance - refers to flexibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Needs not remain flexible in all degrees of freedom</td>
</tr>
<tr>
<td>- Induced flexibility</td>
</tr>
<tr>
<td>- Resists loads by displacement</td>
</tr>
<tr>
<td>- Not by strength</td>
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</tbody>
</table>

Source: Compliant structures - Strongly rely on the restoring buoyancy force |
- To maintain stability |
- To ensure recovering capability |
- Undergo large displacements

<table>
<thead>
<tr>
<th>Typical wave periods (sea states)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(8m, 65)</td>
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<tr>
<td>(18m, 35)</td>
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</table>

Compliant structures

Platform - by design, does not react - flexible dock - shift dock
- Disperse loads by displacement |
- Not by structure - Pa, dm, v, etc

This is one of the important shifts in design philosophy for offshore platforms |
- Highly suitable for deep water |
- Non-restrained issue |

Structural form of compliant platforms - in general, are different from fore and aft |

Different geometric forms
8. Write a brief note on Articulated towers (AT)

Articulated Tower

- Tower is connected to the seabed using Universal Joint
- Joint - ball joint - offset rotation
- Central column - restrained laterally and axially
- \( (\theta) \rightarrow \infty \)
- \( (\Delta s) \rightarrow 0 \)
- Inverted pendulum
- Load - encountered - platform oscillates
- Compliant - compliance (C)

Moments about the base: \( M = 0 \)
- Simple foundation
- Re-centering of the platform - pendulum (inverted) action
- In addition - offers variable buoyancy effect - adds to the restoration

Advantages of compliance in AT & GTs

1) Compliance avoids concentration of high moments at the bottom
2) High shear concentrations are shifted from the bottom
3) Buoyancy chamber (CAD) ensures additional capacity of recentering
4) By compliance, Taper remain invariant results by displacement
   - not weight-based resistance
   - not displacement-based resistance - Compliance
9. What is the uniqueness in design of Tension Leg Platforms (TLPs)?

10. Write a brief note on New-generation offshore platforms

Offshore design — moved from fixed type to floating type
— we agree — this transformation is advantageous
— system is permitted to undergo large displacement
— platform undergoes large displacement in flexible d.o.f.
— in convenience to operate
— challenge in safety / safe operability

In parallel
— trade wind/low pressure
— deep draft/regular structure
— flexible (certain d.o.f.)
— rigid (certain d.o.f.)
— control the large displacement
Triceratops - Conceptualized

- Deck
- Buoyant Legs
- Tethers

Ball Joints - crucial element

Ball Joints special features:
- Restrain large displacements
- Rotating

Ball Joints - restrain transfer of forces from buoyant legs to the deck

- But transfer translational displacements

X Deck is partially isolated from the buoyant legs
- New generation platform
- Different draft - different deck

- Charles et al. (2005) - Triceratops - advantages & adaptable to ultra-deep waters