FLUID STRUCTURE INTERACTIONS

ENGINEERING 8964

FINAL EXAMINATION

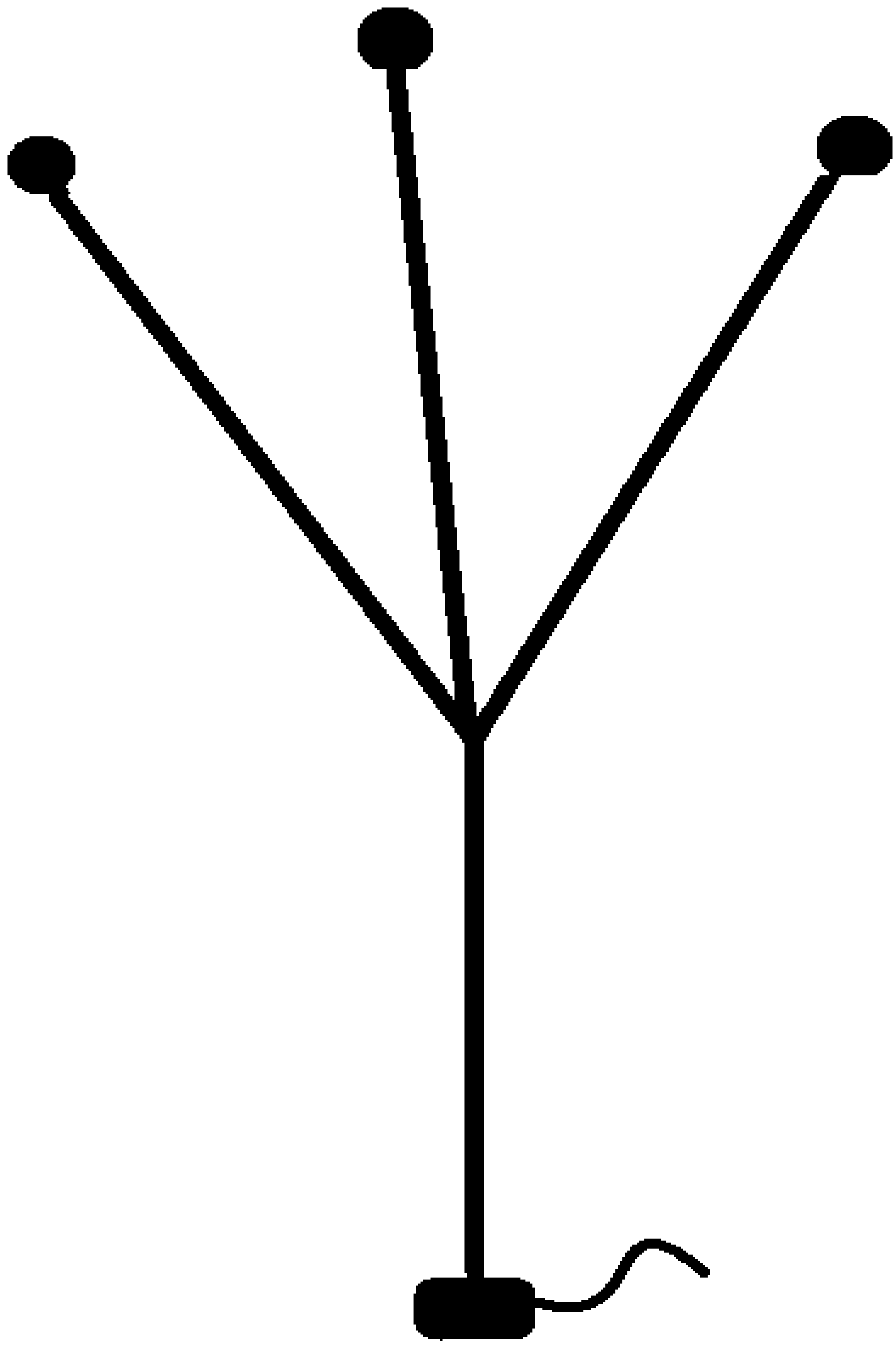
WINTER 2015

1) Give the setup, procedure and main observations of each lab and demo. Use sketches and formulas to illustrate your answers. [20]

2) Five derivation sheets are attached. Identify any 4 of the derivation sheets and add statements to them to explain the derivation steps. [16]

3) Give a physical explanation of any 4 of the following: flow induced resonance of slender structures; flow induced instability of slender structures; instabilities of wings; leakage flow instabilities; instabilities of pipes with internal flow; instabilities of panels. [16]

4) A schematic of a simple water pipe network is attached. The pump can supply a constant 1 m/s flow to the network. Each pipe has a diameter 0.1m. The length of each pipe is 10m. The [ρa] for each pipe is 10 BAR/[m/s]. At the start the valves are closed and the pump is stopped, and the pressure everywhere is 20 BAR. Determine what happens in the pipes for 3 steps in time following a sudden pump start up when friction is zero. Repeat for the case where the friction factor is 0.02. [28]



5) An oil tanker ship sits in a deep water storm sea state. Waves approach the tanker from the side or beam direction. The wave amplitude spectrum of the sea state is:

$$S_A = A/\omega^5 \, e^{-B/\omega 4}$$

$$A=346H^2/T^4 \qquad B=691/T^4$$

where the significant wave height H is 5m and the significant wave period T is 10s. The beam seas roll RAO of the tanker obtained from a 100:1 scale model wave tank test is:

ω	1	3	5	7	9	11
RAO	1.0	2.0	6.0	3.0	1.0	0.0

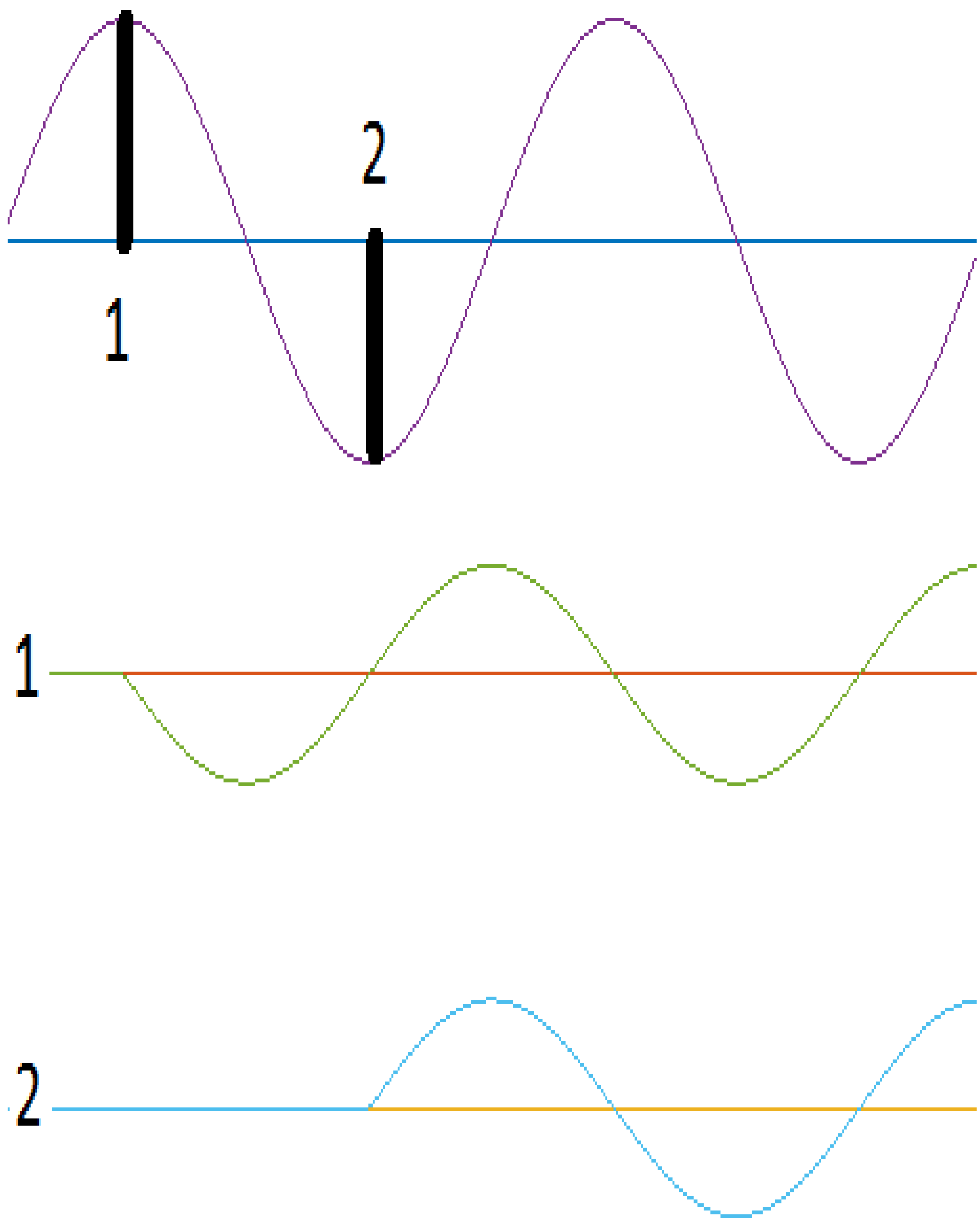
Convert the model RAO to a prototype RAO. Convert the wave amplitude spectrum to a degrees slope spectrum. Calculate the roll response spectrum. Determine the significant roll height and roll period of the tanker. Determine the probability of the roll amplitude going beyond 20 degrees. [20]

BONUS QUESTION [5]

Long wavelength waves or swells well out to sea are generated by storm pressure waves travelling over the water surface. A resonance occurs when the speed and wavelength of a pressure wave matches the speed and wavelength of a wave that can exist in the water. The pressure wave can be broken down into a series of pulses. Each pulse generates a stern wave much like that behind a boat. A schematic showing 2 pressure pulses together with the stern wave generated by each is attached. Use this sketch to explain the resonance phenomenon.

BONUS QUESTION [5]

Reduce the general panel flutter critical speed equation down to the simpler form for a laminar wind blowing over deep water. Give reasons why certain terms can be dropped or modified.



2
1
1
2