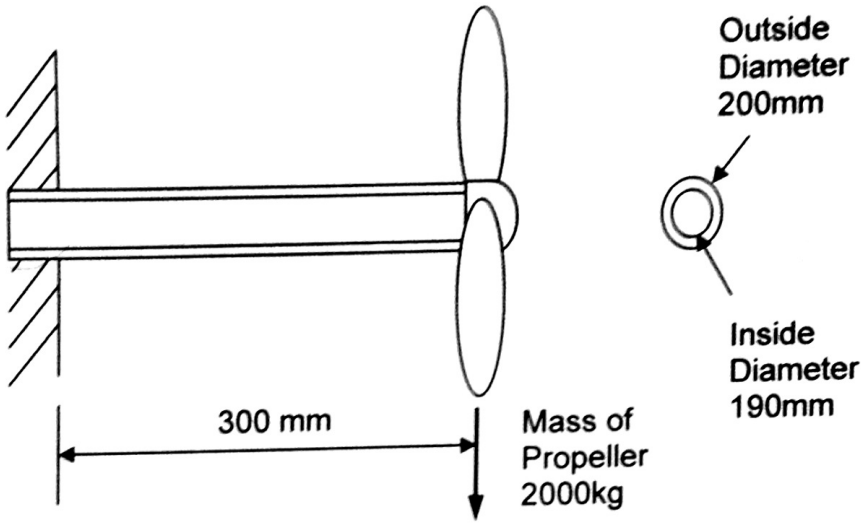
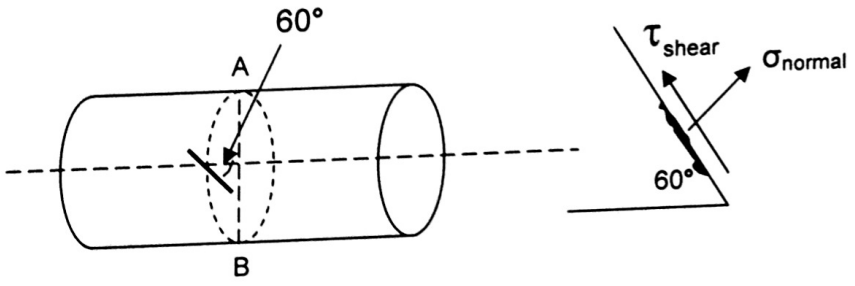
Assessment

Evidence of Achievement Required	Marks possible	Marks awarded
Question 1		
		
A propeller shaft on a vessel shown above can be assumed to act as a cantilever. You are to work out the maximum power that a galvanised steel and brass shaft could carry. The brass propeller revolves at a maximum of 150 rev. min^{-1}.		
a) Calculate the second moment of area of the shaft.	2	
b) Calculate the maximum bending moment on the shaft.	2	
c) Identify the radius at which the maximum bending stress occurs.	2	
d) Calculate the maximum stress in the shaft due to the bending effect only.	2	
e) Calculate the maximum stress that each shaft could carry due to the torsion effect so that the material does not yield.	2	
f) Calculate the polar second moment of area of the shaft.	2	
g) Calculate the maximum torque that each shaft can carry.	2	
h) Calculate the maximum power each shaft can carry.	2	
i) If the vessel's engine is rated at 750 kW, identify which of the above two materials you would recommend the shaft should be made of. State one major disadvantage of this material.	2	
Choose a suitable material for the shaft that would overcome this disadvantage and state why. Use the data provided to assist in your response.	2	

Property Table

Material	Yield Stress Nmm^{-2}	Ultimate Tensile Stress Nmm^{-2}	Modulus of Rigidity, G $kNmm^{-2}$	Modulus of Elasticity, E $kNmm^{-2}$
Galvanised Steel	250	375	83	207
Copper	62	206	39	83
Brass	103	324	37	69
Untreated Wood	10.3	17.9	0.55	9.6

During routine visual inspection, a small crack is observed mid-way along the shaft and at 60° angle to the longitudinal axis of the shaft.



Neglecting any stresses in the y plane. Determine;

a) Normal stresses at the crack as it passes through points A and B — **5**

b) Shear stress as it passes through positions A and B. — **5**

Question 2

A submarine has an internal diameter of 2 metres. If the maximum stress allowed in the material is 110 MN/m^2, determine the maximum working depth for wall thicknesses of 30mm, 40mm and 50mm. — **15**

Ignore any internal pressure.

Density of sea water = 1030 kg/m^3.

Compare values given by both Thin and Thick Cylinder Theories.

Which theory is preferred, and why? — **15**

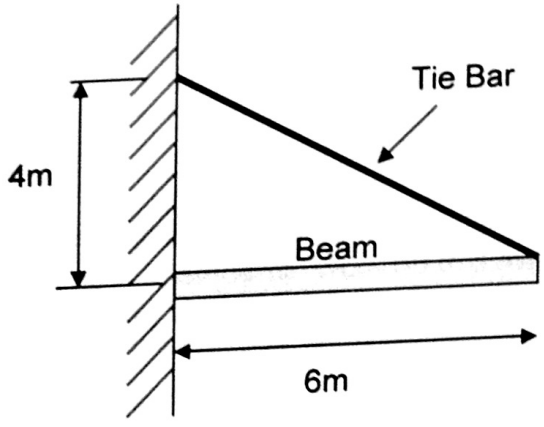
Question 3

An aluminium tie bar 20 mm in diameter is used to support a steel cantilever beam 6 m long. When constructed the bar held the beam horizontal at a temperature of 26°C. If during the winter the temperature falls to 3°C, calculate, ignoring the thermal expansion of the beam:

1	the linear expansion of the tie bar	2	
2	the tensile force on the beam, including shear force diagram	4	
3	the maximum bending moment on the beam, including bending Moment diagram	4	
4	the thrust on the beam, including thrust diagram	4	
5	a suitable diameter for the beam.	12	
6.	vertical deflection of the beam caused by the temperature change in the tie rod	4	

Take:

- aluminium tie bar, $\alpha = 23 \times 10^{-6}\ K^{-1}$ and $E = 70$ GPa
- steel beam, ultimate tensile strength 460 Mpa, use a FOS of 4.



Your work must be presented to a high standard and be neat and well structured. Any work used that is not your own must be referenced accordingly using the Harvard Referencing Style.	10	