CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF MARINE ENGINEERING TECHNOLOGY

FINAL EXAMINATION
SEPTEMBER 2016 SEMESTER

COURSE CODE	:	LGB 21103
COURSE NAME	:	STRENGTH OF MATERIALS
PROGRAMME NAME	:	BET NASB & BET ME
DATE	:	17 JANUARY 2017
TIME	:	09.00 AM – 12.00 PM
DURATION	:	3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the given answer sheets.
4. Answers should be written in blue or black ink except for sketches, graphics and illustrations.
5. This question paper consists of ONLY ONE (1) section with FIVE (5) questions. Answer FOUR (4) questions ONLY.
6. Answer all questions in English.
7. Graph paper is provided together with the answer sheets.
8. Formula sheet and stress concentration charts are attached with this question paper.

THERE ARE 5 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

INSTRUCTION: Answer FOUR (4) questions ONLY.
Please use the answer booklet provided.

Question 1

(a) The plug is used to close the end of the cylindrical tube that is subjected to an internal pressure of $P = 650Pa$. Determine the average shear stress that the glue exerts on the sides of the tube needed to hold the cap in place.

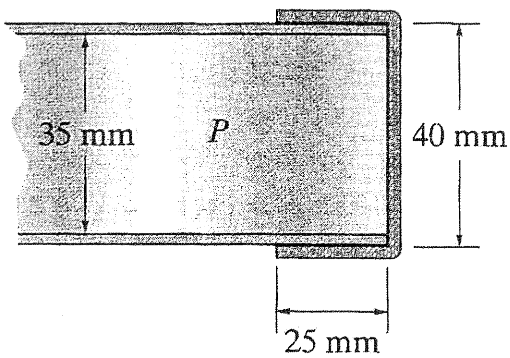

Figure 1: Capped Tube

(10 marks)

(b) A rectangular material is deformed into the position shown by the dashed lines as shown in Figure 2. Calculate the following:

i) Average normal strain along diagonals AD and CF.

(10 marks)

ii) The average shear strain at A and F.

(5 marks)

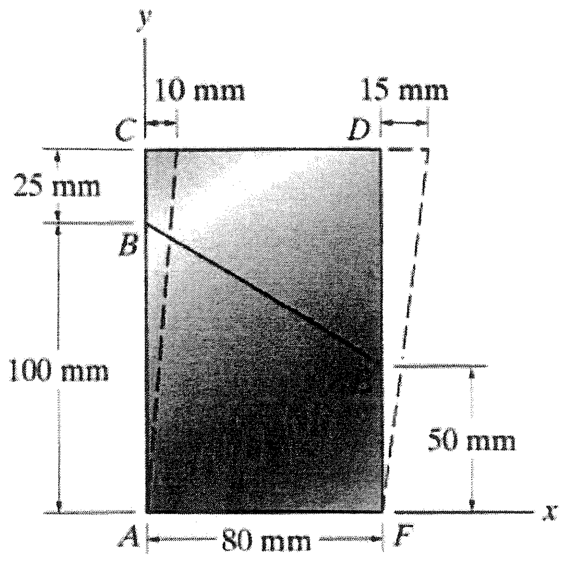

Figure 2: Deformed Material

Question 2

A tension test was performed on a steel specimen having an original diameter of 13mm and a gauge length of 50mm. The data is listed in Table 1 below. Plot a conventional stress-strain diagram and determine approximately the value of the following parameters:

a) Modulus of Elasticity (Young's Modulus).
b) Yield Stress.
c) Ultimate Stress.
d) Failure Stress (Rupture Stress).

Table 1: Stress-Strain Data for a Steel Specimen

Load (kN)	Elongation (mm)
0.0	0.0000
7.5	0.0125
23.0	0.0375
40.0	0.0625
55.0	0.0875
59.0	0.1250
59.0	0.2000
60.0	0.5000
83.0	1.0000

100.0	2.5000
107.5	7.0000
97.5	10.0000
92.5	11.5000

(25 marks)

Question 3

(a) A steel bar has a thickness of 20mm with shoulder fillets as shown in Figure 3 below. Allowable stress is given as σ_{allow} = 150MPa while E_{steel} = 200GPa. Determine the following:

i) The maximum axial load P that the steel bar can support.

(9 marks)

ii) Its elongation, neglecting the effect of the fillets

(6 marks)

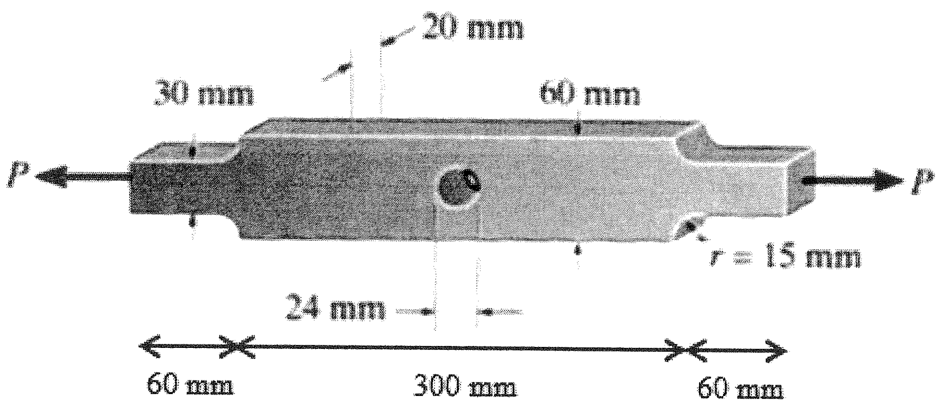

Figure 3: Steel Bar with Shoulder Fillets

(b) The joint as shown in Figure 4 below is made from three (3) steel plates that are bonded together at their seams. Determine the displacement of end A with respect to end B when the joint is subjected to the axial loads shown. Each plate has a thickness of 5mm. Take E_{steel} = 200GPa.

(10 marks)

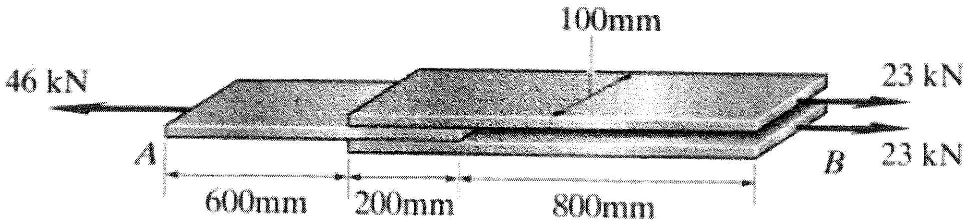

Figure 4: Bonded Steel Plates

Question 4

From the beam shown in Figure 5 below:

(a) Replace the distributed load by an equivalent resultant force and reactions.

(8 marks)

(b) Express the internal shear and moment in terms of *x*.

(10 marks)

(c) Draw the shear and moment diagrams.

(7 marks)

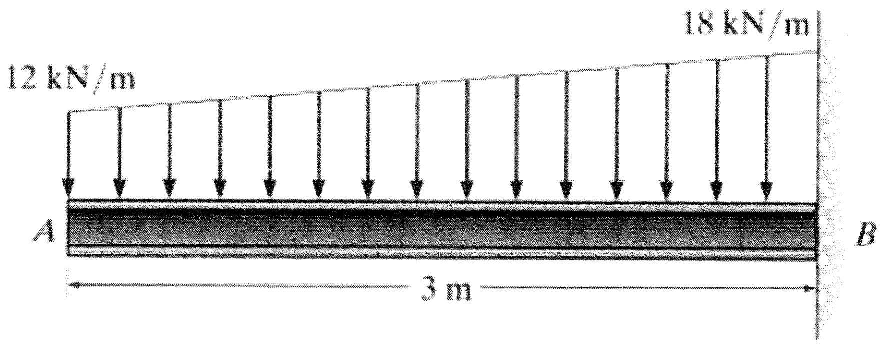

Figure 5: Distributed load applied to a cantilever beam

Question 5

(a) A motor delivers 33kW to the solid stainless steel (ss) shaft while it rotates at 20Hz. The solid shaft is supported on smooth bearings at A and B which allows free rotation of the shaft as shown in Figure 6 below. The gears C and D remove 20kW and 12kW respectively. Determine the diameter of the shaft to the nearest mm if the allowable shear stress is τ_{allow} = 56MPa and the allowable angle of twist of C with respect to D is 0.20^0. Take G_{ss} = 75GPa.

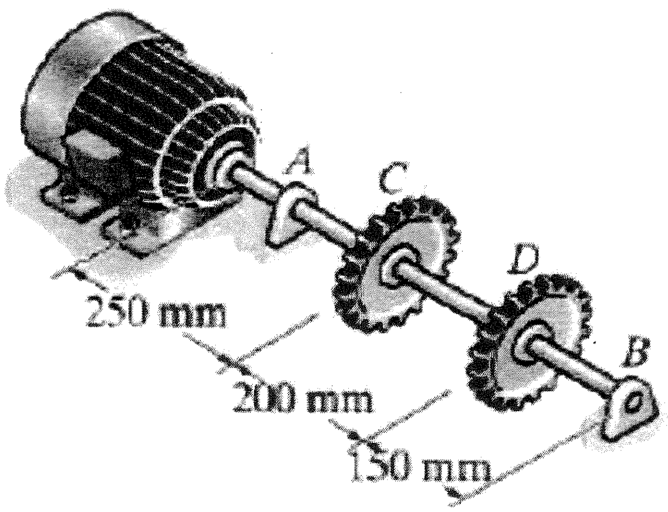

Figure 6: Motor-Gear assembly

(15 marks)

(b) The propellers of a ship are connected to a solid steel shaft that is 60m long and has an outer diameter of 340mm and inner diameter of 260mm. If the power output is 4.5MW when the shaft is rotating at 20rad/s, determine the maximum shear stress in the shaft and its angle of twist. Take G_{steel} = 75GPa.

(10 marks)

END OF QUESTION PAPER

Normal Stress	$\sigma = \frac{P}{A}$
Shear Stress	$\tau = \frac{V}{A}$
Factor of Safety	$F.S. = \frac{F_{fail}}{F_{allow}} = \frac{\sigma_{fail}}{\sigma_{allow}} = \frac{\tau_{fail}}{\tau_{allow}}$
Average normal strain	$\varepsilon_{avg} = \frac{\Delta s' - \Delta s}{\Delta s}$
Shear strain	$\gamma = \frac{\pi}{2} - \theta'$
If θ is small	$\sin\theta \approx \theta$ $\cos\theta \approx 1$ $\tan\theta \approx \theta$
Pythagoras theorem	$a^2 = b^2 + c^2$
Cosine rule	$a^2 = b^2 + c^2 - 2bc\cos\theta$
Strain	$\varepsilon = \frac{\delta}{L_0}$
Hooke's Law (Normal)	$\sigma = E\varepsilon$
Hooke's Law (Shear)	$\tau = G\gamma$
Strain Energy	$u = \frac{1}{2}\sigma\varepsilon = \frac{1\sigma^2}{2E}$
Poisson's Ratio	$\upsilon = -\frac{\varepsilon_{lateral}}{\varepsilon_{longitudinal}}$
Lateral strain	$\varepsilon_{lateral} = \frac{\delta'}{r_0}$
Longitudinal strain	$\varepsilon_{longitudinal} = \frac{\delta}{L_0}$
Modulus of Elasticity	$E = \frac{\sigma}{\varepsilon}$
Modulus of Rigidity	$G = \frac{E}{2(1+\upsilon)}$

Displacement	$\delta = \frac{PL}{AE} = \Sigma \frac{PL}{AE}$
Stress concentration factor	$K = \frac{\sigma_{max}}{\sigma_{allow}}$
Angle of distortion	$\gamma = \frac{\pi}{2} - \theta'$
Angle of distortion	$\gamma = \left(\frac{\rho}{c}\right)\gamma_{max}$
Shear stress	$\tau = \left(\frac{\rho}{c}\right)\tau_{max}$
Shear stress	$\tau = \frac{T\rho}{J}$
Maximum shear stress	$\tau_{max} = \frac{Tc}{J}$
Polar moment of inertia (solid shaft)	$J = \frac{\pi}{2}c^4$
Polar moment of inertia (hollow shaft)	$J = \frac{\pi}{2}\left(c_0{}^4 - c_i{}^4\right)$
Torque (T')	$T' = \frac{2\pi\tau_{max}}{c}\int_{c/2}^{c}\rho^3 d\rho$
Power	$P = T\frac{d\theta}{dt} = T\omega$
Power	$P = 2\pi fT$
Allowable shear stress	$\tau_{allow} = \frac{Tc}{J}$
Angle of twist	$\phi = \int_0^L \frac{T(x)dx}{J(x)G} = \frac{TL}{JG} = \Sigma\frac{TL}{JG}$
Displacement of a point on an arc	$S = \phi \cdot r$

STRESS CONCENTRATION FACTOR (K) CHARTS