UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	PACKAGING INDUSTRIAL MAINTENANCE
COURSE CODE	:	BNK 30103
PROGRAM ME	:	BNK
EXAMINATION DATE	:	DEC 2015 /JAN 2016
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTION ONLY

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

Q1 (a) With the help of a sketch, compare parallel misalignment and angular misalignment of shaft and pulley system and elaborate how these misalignments affect the condition of the belt and the power consumption.

(8 Marks)

(b) Herringbone gears are also called a double helical gear. Sketch herringbone gears and point out why the herringbone gears are much better option in comparison with helical gears.

(7 Marks)

(c) While inspecting a gearbox at a packaging machine. A maintenance engineer found the gear with the damage as shown in **FIGURE Q1(c)**. Diagnose the defect and predict the probable causes and propose the recommended solutions to avoid the defect from reappearing.

(5 Marks)

(d) It is required to drive a shaft in **FIGURE Q1(d)** at 720 revolutions per minute (RPM), by means of a belt from a parallel shaft, having a pulley A 300 mm diameter on it and running at 240 revolutions per minute (RPM). What size pulley is required for the shaft B.

(5 marks)

Q2 (a) Bearing can be exposed to any detrimental hazard that affects the life of bearings. Therefore, there shall be a proper procedure when unpacking bearing. Propose unpacking procedures for bearing in your plant.

(5 Marks)

(b) There are many methods in installation of bearings. Compare the heating method with hydraulic injection method. In your opinion, which one will expose to the least risk of damaging the bearing during installation.

(8 Marks)

(c) An SKF Explorer 6309 deep groove ball bearing is to operate at 2500 rpm under a constant radial load Fr = 10 kN. The desired reliability is 90% and it is assumed that the operating conditions are very clean. If the basic dynamic load rating of the bearing C is 55.3 kN, determine the basic rating life 90% of this bearing, L_{10} and L_{10h}.

(7 marks)

(d) Diagnose what failure's type of bearing in the **FIGURE Q2(d)** by giving the probable causes to the defect and recommend the appropriate solutions.

(5 Marks)

Q3 (a) **FIGURE Q3(a)** and **FIGURE Q3(b)** are two different types of coupling. Identify both types of coupling and differentiate between them in term of application.

(5 marks)

(b) Power consumption of rotating equipment in a plant is 30 Megawatts. By doing proper alignment of all these equipment to a smaller tolerance, it is expected to reduce the power consumption by 0.75%. Calculate the savings that might be gained by the plant through the plant wide shaft alignment exercise. Assume the electricity price is RM 0.45/kWh and the plant is running for 6 days/week for 52 weeks.

(5 marks)

(c) **FIGURE Q3(c)** shows one of the techniques of shaft alignment. Identify the technique and explain the advantageous and disadvantageous of this technique.

(5 marks)

(d) Differentiate between the dynamic pumps and positive displacement pump and list at least three sub pumps for each type.

(10 marks)

Q4 (a) A plant is scheduled for a yearly shutdown or turnaround. There are about 200 centrifugal pumps in the plant. Develop a plan on how to maintain and inspect the large number of pumps by addressing the actions to be taken to the pump in detail.

(10 marks)

(b) Hamni had found through statistic that the coupling of several pumps in the plant had frequently failed. Analyze the problem and give at least four reasons for the recurring problems.

(7 marks)

(c) An engineer has to determine which lifting sling has the required safety weight limit (SWL). He has to examine the SWL for grade 80 Lifting sling with 10 mm diameter, grade 60 lifting chain with 10 mm diameter, and Flexible Steer Wire Roper (FSWR) with 10 mm diameter. If the load that needs to be lifted is 3 tonnes, which lifting sling is safe to lift the load?

(8 marks)

Q5 (a) Before lifting any goods, it is vital that the load is stable to avoid any movement when the lifting process starts. Review the **FIGURE Q5(a) (i),(ii), (iii)** and identify which load/s is/are stable and which is/are not. Justify your answer.

(6 marks)

(b) As a maintenance engineer, you are assigned to develop a lubrication program in a plant. Prepare an outline that needs to be considered in developing the program.

(7 marks)

(c) In order to ensure a successful lubrication program in a plant, a survey must be conducted as the first task. Plan on how to conduct a plant lubrication survey.

(7marks)

(d) Determine the next time the lubrication of ball bearing need to be done if the bearing is working under temperature between 175 F to 200 F and surrounded with light contamination non-abrasive dust at humidity condition between 80 to 90 %. In addition, it vibrates at less than 0.3 ips velocity peak at and is positioned at 45 degree bore centerline. The bore diameter of the bearing is 50 mm and rotates at 2500 rpm.

(5 marks)

Q6 (a) By inspecting the following **FIGURE Q6(a),** diagnose the failure of the mechanical seals by proposing the type of failures and the probable causes for the failure.

(5 marks)

(b) When operating pump system, the operating parameters may differ slightly from what the system was designed for. A change in operating conditions may affect the seal performance. What are the parameters that might affect the performance mechanical shaft seal?

(5 marks)

(c) A **FIGURE Q6(c)** shows a multistage compressor. Multi stage compressor is proven to have used less energy in comparison with single stage compressor. Point out why the multi stage compressor is more efficient in energy consumption.

(5 marks)

(d) Hairul found that the energy consumption of one of its compressor has gone up. Analyze the problem and suggest what are the reasons for the increase of power consumption of a compressor and provide the solutions for it.

(5 marks)

(e) Piping layout also contribute to energy lost in compressor. Analyze on how the lost of energy can minimize in piping layout.

(5 marks)

-END OF QUESTION-

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FIGURE Q1(c)

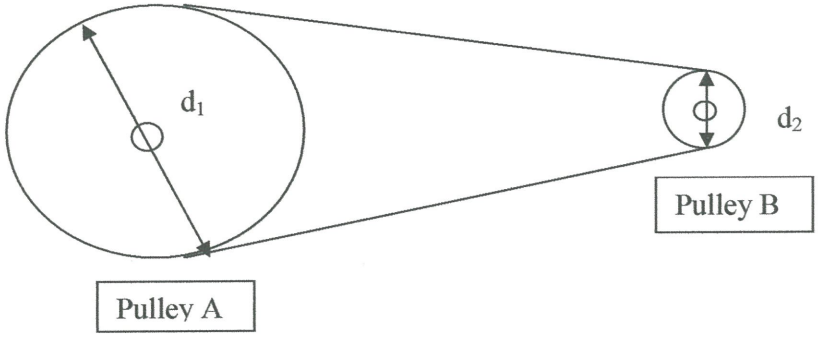

FIGURE Q1(d)

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FIGURE Q2 (d)

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FIGURE Q3(a)

FIGURE Q3(b)

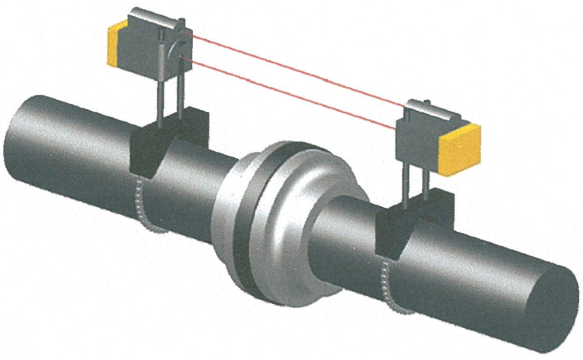

FIGURE Q3(c)

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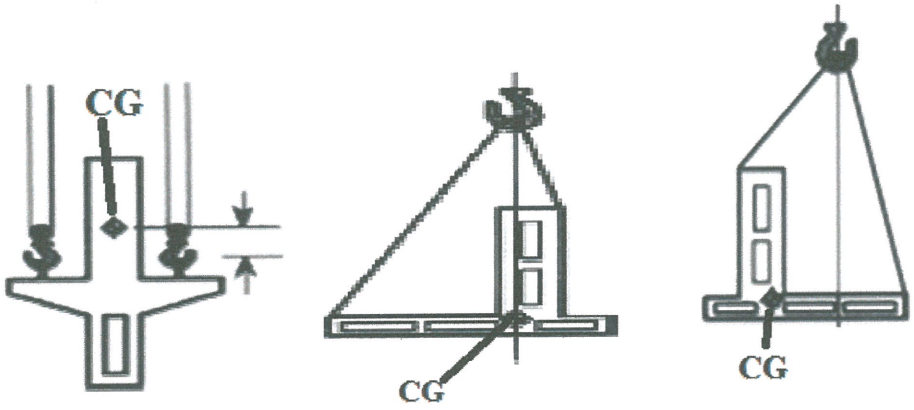

(i) (ii) (iii)

FIGURE Q5(a)

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FIGURE Q6(a)

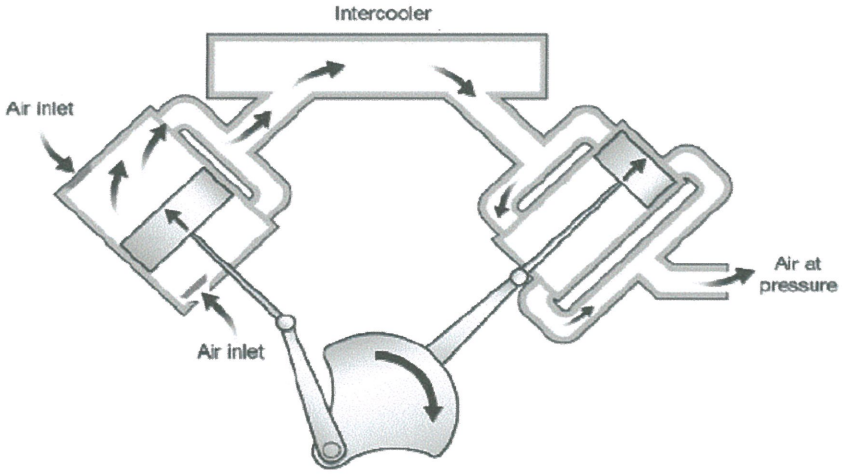

FIGURE Q6(c)

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LAMPIRAN

FORMULA and TABLES

$$T = K \times \left[\left(\frac{14{,}000{,}000}{n \times (d^{0.5})} \right) - 4 \times d \right]$$

Where:

T = Time until next relubrication (hours)

K = Product of all correction factors
Ft x Fc x Fm x Fv x Fp x Fd
(see table)

n = Speed (RPM)

d = Bore diameter (mm)

Note:
ips = inches / second
0.2 inches / second = 5 mm / sec.

Grease Interval Correction Factors

Condition	Average Operating Range	Correction Factor
Temperature Ft	Housing below 150°F	1.0
	150 to 175°F	0.5
	175 to 200°F	0.2
	Above 200°F	0.1
Contamination Fc	Light, non-abrasive dust	1.0
	Heavy, nonabrasive dust	0.7
	Light, abrasive dust	0.4
	Heavy, abrasive dust	0.2
Moisture Fm	Humidity mostly below 80%	1.0
	Humidity between 80 and 90%	0.7
	Occasional condensation	0.4
	Occasional water on housing	0.1
Vibration Fv	Less than 0.2 ips velocity, peak	1.0
	0.2 to 0.4 ips	0.6
	Above 0.4 (see note)	0.3
Position Fp	Horizontal bore centerline	1.0
	45 degree bore centerline	0.5
	Vertical centerline	0.3
Bearing Design Fd	Ball bearings	10
	Cylindrical and needle roller bearings	5.0
	Tapered and spherical roller bearings	1.0

Bearing load

1. **Dynamic equivalent radial load**

   $Pr = XFr + YFa$

2. **Life 90%**

   a. $L10 = (C/P)^P$ p=3 for ball bearing, p=10/3 for roller bearing

   b. $L_{10h} = (10^6 / 60n)L_{10}$