



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 7 Examination in Engineering: October 2019

Module Number: ME 7301

Module Name: Maintenance Management

[Three Hours]

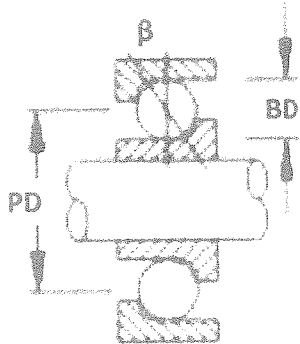
[Answer all questions, each question carries 10 marks]

- Q1. a) In the context on a manufacturing organisation, briefly explain how can the existence of a machine maintenance system involving technical staff and resources be justifiable. [3.0 Marks]
- b) In a garment production factory, the maintenance crew may operate either under the production department or the engineering department. By comparing the pros and cons of the two, suggest the best option. [4.0 Marks]
- c) Assume that you are working as the head of the maintenance department in a manufacturing organisation. Accounts division of the organisation has requested you to reduce the operational cost by 50% in the next year. State in bullet form, the actions you will be taking in the priority order. [3.0 Marks]
- Q2. a) You as the maintenance engineer of a manufacturing organisation, has to prepare the maintenance manual for a newly imported machine. List the things that you will consider in preparing the manual. Repeat the listing if the machine is an old one running for many years in your plant, where the machine manual is not available. [5.0 Marks]
- b) Assume that you are the maintenance engineer of a large manufacturing plant and you have to plan for the upcoming Christmas shut-down maintenance activities. Accordingly, during the one week shut-down period, your maintenance crew has to undertake an overhaul of a large machine and a machine layout change in a production line. There are 10 technicians in the maintenance crew, who are supervised by a maintenance supervisor, working under you. Briefly discuss how you will plan for the successful completion of both the activities during the shutdown period. [5.0 Marks]
- Q3. a) Machine condition monitoring is becoming much popular in the manufacturing industry yielding tangible benefits in the context of plant maintenance. Discuss the key benefits of machine condition monitoring by referring to different condition monitoring techniques in use. [4.0 Marks]

- c) Briefly discuss the opportunities available for a manufacturing plant by having ISO standards covering its operations.

[3.0 Marks]

Table Q3 (c): Bearing fault frequency formulas

Ball-pass frequency for the outer race of the bearing (BPFO) in Hz	$\frac{n}{2}\omega \left[1 - \left(\frac{BD}{PD} \right) \cos \beta \right]$
Ball-pass frequency for the inner race of the bearing (BPFI) in Hz	$\frac{n}{2}\omega \left[1 + \left(\frac{BD}{PD} \right) \cos \beta \right]$
Ball rotational frequency (BRF) in Hz	$\frac{PD}{BD}\omega \left[1 - \left[\left(\frac{BD}{PD} \right) \cos \beta \right]^2 \right]$
Fundamental train frequency (FTF) in Hz	$\frac{1}{2}\omega \left[1 - \left(\frac{BD}{PD} \right) \cos \beta \right]$
<p>Meaning of symbols:</p> <ul style="list-style-type: none"> • n: number of rolling elements in the bearing • ω: rotational speed of the shaft attached to the bearing (rev/sec) • BD: diameter of the rolling elements of the bearing (mm) • PD: pitch diameter of the bearing (mm) • β: contact angle of the bearing ($\beta=0$ for deep groove ball bearings) 	
 <p>The diagram shows a cross-section of a ball bearing. A central shaft is shown with a ball between it and the inner race. The contact angle β is indicated between the normal to the raceway surface and the line connecting the center of the ball to the center of the shaft. The ball diameter is labeled BD, and the pitch diameter (the diameter of the circle passing through the centers of the balls) is labeled PD.</p>	