UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: October 2019

Module Number: ME 5303 **Module Name: Mechanical Engineering Design**

[Three Hours]

[Answer **all questions**, each question carries ten marks]

All assumptions must be stated clearly. Sketches and diagrams are to be provided where required. Symbols stated herein denote standard parameters.

Q1. a) Define the term "flywheel", a component mostly utilized in heavy machineries.

[1.0 Mark]

b) Figure Q1 shows a turning moment diagram of a particular machine. Discuss the "Fluctuation of Energy" during the turning span of 0^0 -180^0 and necessity of fixing a flywheel accoding to the motion depicted by the diagram.

[2.0 Marks]

c) Discuss the types of stresses govern in a flywheel rim.

[1.0 Mark]

d) The turning moment diagram for a petrol engine is drawn to the following scales: Turning moment, 1 mm = 5 N-m; Crank angle, 1 mm = 1^0. The turning moment diagram repeats itself at every half revolution of the engine and the areas above and below the mean turning moment line, taken in order are 295, 685, 40, 340, 960, 270 mm^2. Determine the mass of 300 mm diameter flywheel rim when the coefficient of fluctuation of speed is 0.3% and the engine runs at 1800 rpm. Also, determine the cross-section of the rim when the width of the rim is twice of the thickness.
Assume the density of rim material as 7250 kg / m^3 and following governing equation is given. $\Delta E = m.R^2.\omega^2.C_S$

Where,
m = Mass of the flywheel in kg
R = Radius of the flywheel in meters
ω = Maximum and minimum angular speeds during the cycle in rad/s

i) Draw a suitable turning moment diagram for given details.

[1.0 Mark]

ii) Calculate the maximum and minimum energy.

[1.0 Mark]

iii) By using the maximum and minimum energy levels, calculate the mass of the flywheel rim.

[2.0 Marks]

iv) Determine the cross section of the flywheel rim.

[2.0 Marks]

Q2. a) In cases where we are providing access or clearance, the good practice dictates that the 95%le values must be used. Similarly, if we are considering a design in which reach is the critical factor, the 5%le values must be employed. Figure Q2 and Table Q2 shows the anthropometric data for adults aged 19 to 65 years. All dimensions are in millimeters.

i) If you are asked to design a door for office entrance, specify the height of your design. Consider the additional clearance as 100 mm.

[2.0 Marks]

ii) If you are asked to design a control panel that can be reached from a fixed position, specify the length to the control panel from the fixed position. Consider that the design is done incorporating the ergonomic concepts.

[2.0 Marks]

b) Your company was asked you to design an adjustable computer chair for the adults within 5%le and 95%le range. Use the data given in Table Q2 and answer the following questions.

i) Specify the minimum height and maximum height of the seat from floor. Consider that 45 mm should be added as high heel footwear height and 25 mm as flat shoes for females and 25 mm for males. Write the arguments that you made to get the decision.

[4.0 Marks]

ii) Calculate the minimum effective seat depth required for your proposal by assuming that a value of 50 mm is adequate for this purpose.

[2.0 Marks]

Q3. a) Explain the requirement of "Parts interchangeability" in Machine Design.

[2.0 Marks]

b) Sketch three basic types of fits achievable between a pair of mating shaft and hole.

[3.0 Marks]

c) Explain "Shaft basis" and "Hole basis" systems in fits and tolerances. Why is the "Hole basis" system preferred when compared to "Shaft basis" system?

[3.0 Marks]

d) What would be the adverse effects of selecting incorrect fits between a hole-shaft pair?

[2.0 Marks]

Q4. Life Cycle Assessment (LCA) at the product design stage is becoming increasingly significant because of growing sustainability concerns in the world. Figure Q4 shows the outline of LCA process.

a) Consider component parts in a disposable shaving razor and an reusable electric shaver. Compare the energy usage and CO_2 emissions of the two products, at the following stages of the product LCA.

i) Material production starting from natural resources
ii) Product manufacturing processes
iii) Product use

[6.0 Marks]

b) Why should the combustion of parts or products at their end of life as a disposal method be avoided?

[2.0 Marks]

c) Describe an example of Re-engineering or upgrading a product rather than simply discarding it.

[2Marks]

Q5. Assume that you are required to design an engine driven winch system for a boat repair facility to pull boats out of water and launch them after repairing. The maximum mass of the boat to be handled is 5000 kg. The boat is placed on an existing cradle weighing 1000 kg. Then, the cradle is pulled on steel wheels and two rails fixed on a concrete ramp.

a) Give a block diagram (not a 3D sketch) for the winch system that you propose, indicating all main components and sub-systems required.

[2.0 Marks]

b) i) Describe four major safety issues that you anticipate if the winch system has to be operated manually.

[2.0 Marks]

ii) How would you address the safety issues mentioned in (b) (i) above?

[2.0 Marks]

c) If the winch system is located outdoor, identify four durability issues of the system and propose remedial actions to address them.

[2.0 Marks]

d) What are the design features proposed in your design to protect the winch system from theft, user misuse and vandalism?

[2.0 Marks]

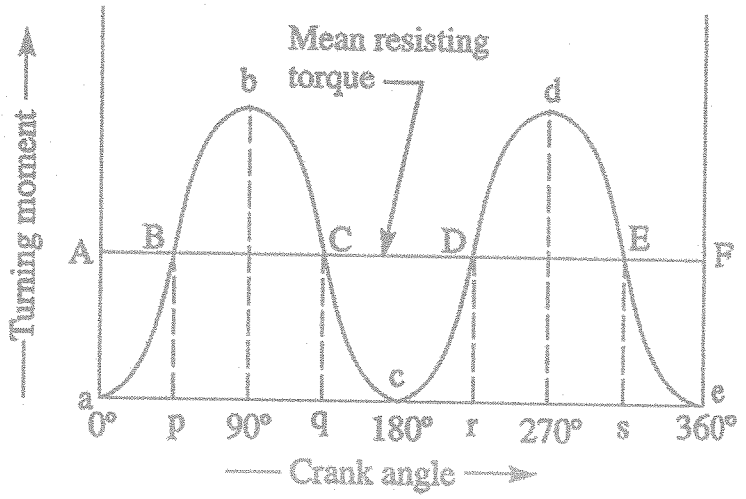

Figure Q1 (b): Turning Moment Diagram

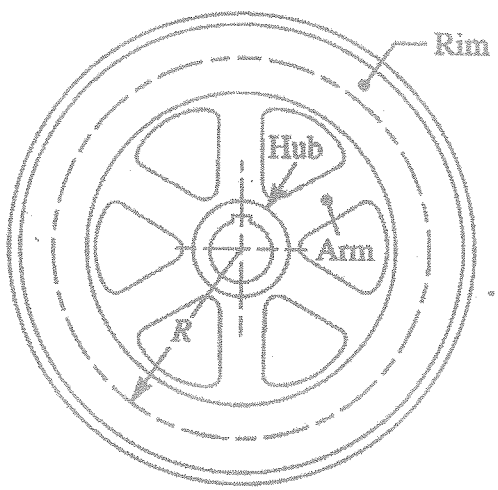

Figure Q1(d): Components of a flywheel

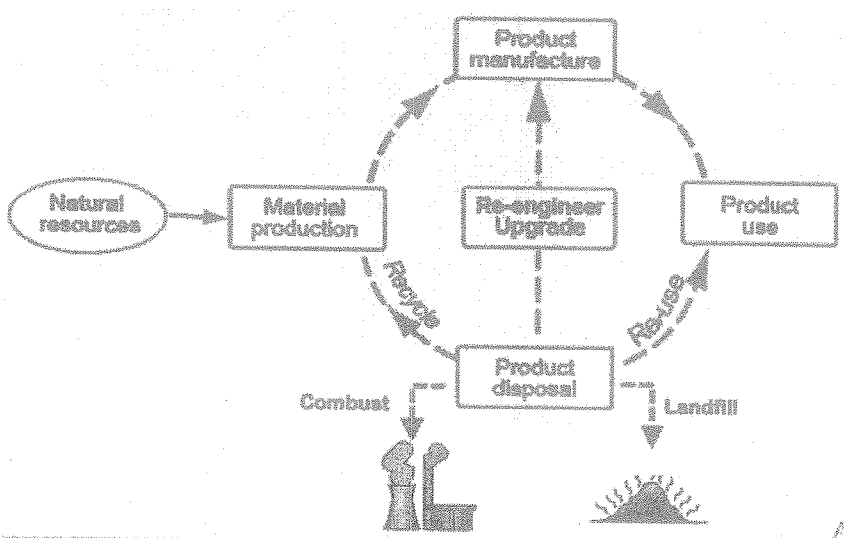

Figure Q4: Outline of LCA process