ELIZADE UNIVERSITY, ILARA-MOKIN,
ONDO STATE, NIGERIA

DEPARTMENT OF MECHANICAL ENGINEERING

FIRST SEMESTER EXAMINATIONS
2020/2021 ACADEMIC SESSION

COURSE: MEE 303 – Theory of Machine (2 Units)
CLASS: 300 Level Automotive and Mechanical Engineering
TIME ALLOWED: 2 ½ Hours
INSTRUCTIONS: Answer Question No. **ONE (1)** and any other **THREE (3)** questions.

HOD'S SIGNATURE

Date: March, 2021

QUESTION ONE *(25 Marks)*

a. Define the following terms:
   i. kinematic link,
   ii. kinematic pair
   iii. kinematic chain
   iv. degree of freedom
   v. theory of machine
b. List the types of link you know
c. The acceleration of a kinematic link has two components, name and explain with the aid of a diagram
d. State Newton's first and second laws
e. Differentiate between a structure and machine
f. What is tribology and why is its study important for an engineer?
g. Draw a belt and pulley profile showing the tight and slack side.
h. Draw the free body diagram for static force equilibrium of the crank slider mechanism shown in **figure 1**

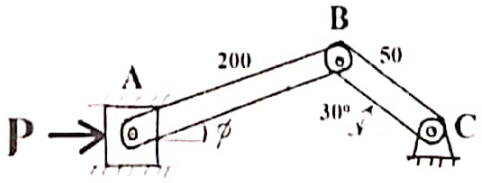

Figure 1

i. State two conditions for static equilibrium
j. Define the following as it relates to theory of machine:
   1. Kinematic
   2. Dynamics
   3. Kinetics,
   4. statics

QUESTION TWO *(15 Marks)*

a) Draw a gear tooth profile and show the following
   i. outer diameter,
   ii. addendum,
   iii. dedendum,
   iv. clearance,
   v. face width,
   vi. top land,
   vii. total/whole depth

b) List four (4) factors on which the amount of power transmitted by a belt depends.
c) A gear-set consisting of 15-tooth pinion gear meshed with a 40-tooth gear has a pressure angle of 14.5° and circular pitch of 7 inch. Find the gear ratio, diametral pitch, base pitch, pitch diameters for pinion and gear, center distance, addendum, dedendum, whole/total depth, clearance and outside diameters.

QUESTION THREE *(15 Marks)*

a) What is balancing? List three adverse effect of unbalanced forces in a machine.
b) Consider the arrangement of link ABCDE (*Figure 2*), state what type of chain is it.

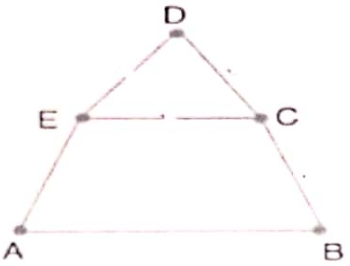

Figure 2

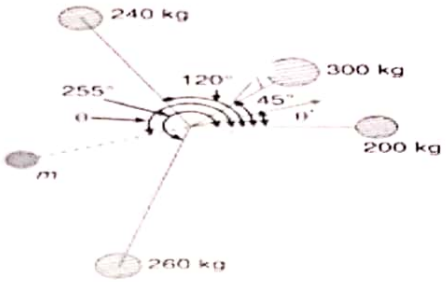

Figure 3

c) Four masses M_1, M_2, M_3 and M_4 are 200 kg, 300 kg, 240 kg and 260 kg, respectively. The corresponding radii of rotation are 0.7 m, 0.35 m, 0.4 m and 0.32 m, respectively and the angles between successive masses are 45°, 75° and 135° (***See figure 3***). Find the position and magnitude of the balance mass required, if its radius of rotation is 0.5 m.

QUESTION FOUR *(15 Marks)*

a) Define simple harmonic motion (SHM) and state two examples of a body exhibiting SHM.
b) Calculate the spring constant of a mass spring system that has a mass of 500 g and oscillate with a period of 0.002 minute.
c) A point moves with simple harmonic motion. When this point is 75 cm from the mid path, its velocity is 15 m/s and when 3000 mm from the center of its path its velocity is 3 m/s. Find its angular velocity, periodic time and its maximum acceleration.

QUESTION FIVE *(15 Marks)*

a) The motion of a particle is given by $a = t^3 - 3t^2 + 5$, where a is the acceleration in m/s^2 and t is the time in seconds. The velocity of the particle at t = 1 second is 6.25 m/s, and the displacement is 10 metres. Calculate the displacement and the velocity at t =1.5 seconds.
b) The displacement of a point is given by $s = 2t^3 + t^2 + 6$, where s is in metres and t in seconds. Determine the displacement of the point when the velocity changes from 8.4 m/s to 18 m/s. Find also the acceleration at the instant when the velocity of the particle is 30 m/s.
c) Define belt slip and creep.

QUESTION SIX **(15 Marks)**

a) A pulley is driven by a flat belt running at a speed of 600 m/min. The coefficient of friction between the pulley and the belt is 0.3 and the angle of lap is 160°. If the maximum tension in the belt is 700 N; find the power transmitted by a belt.
b) List any six (6) important factors upon which the selection of a belt drive depends
c) An engine shaft running at 120 rpm. is required to drive a machine shaft by means of a belt. The pulley on the engine shaft is of 2 m diameter and that of the machine shaft is 1 m diameter. If the belt thickness is 5 mm; determine the speed of the machine shaft when;
   i. there is no slip. ii. there is a slip of 3 %