ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE, NIGERIA

DEPARTMENT OF AUTOMOTIVE ENGINEERING

SECOND SEMESTER EXAMINATIONS

2018/2019 ACADEMIC SESSION

COURSE: ATE 536 – Vehicle Design (3 Units)

CLASS: 500 Level, Automotive Engineering

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer **questions 1, 2** and **any other three**

Date: July, 2019

HOD's SIGNATURE

Design information:

ABC Farms specialises in growing and marketing potatoes. The farms recently secured a contract to supply their farm produce to a major distribution located 200 *km* from the farms. Feasibility studies showed that transportation via road would be the most economic and technical option. The farm products are pre-packaged into units that weigh 500kg each and have cuboid shape with 1.0*m* x 0.5*m* x 1.0*m* dimensions. Design requirements (*State assumptions*):

Question 1

Define necessary parameters and analyse the preliminary requirements as stated:

i. Use Evaluation Matrix to choose the best type of vehicle. (*Hints: Possible options are left to your discretion.*) **...10 marks**

ii. Determine the maximum weight and number of units of farm produce that can be supplied at any one time. (*Hints: Use payload limit of the vehicle chosen as reference.*) **...5 marks**

iii. Give schematic illustration of the vehicle chosen and the farm produce. (*Hints: show load locations, dimensions, etc.*) **...5 marks**

iv. Determine the value and location of the equivalent load of vehicle chosen and load. **...10 marks**

v. Determine resultant force on each wheel. **...10 marks**

Question 2

Establish the structural rigidity of the vehicle through shear force and bending moment analysis **...15 marks**

Question 3

Establish Equations of Motion (EOMs) relating to vibration of rear and front wheels of the vehicle. **...10 marks**

Question 4

Specify steering moment ratio (MR), mechanical advantage (MA), and mechanical efficiency ($\eta_{mech.}$). **...10 marks**

Question 5

Specify the vehicle braking parameters and calculate braking efficiency of the vehicle. **...10 marks**

Question 6

With the aid of schematic illustration, describe the driveline of the vehicle chosen. **...10 marks**

Question 7

What will be the effect on vehicle dynamics, with respect to stability, if:

a) Payload limit of chosen vehicle is exceeded. **...5 marks**

b) Farm produce to be supplied is eccentrically loaded on the vehicle.

List of equations and additional information:

Steering

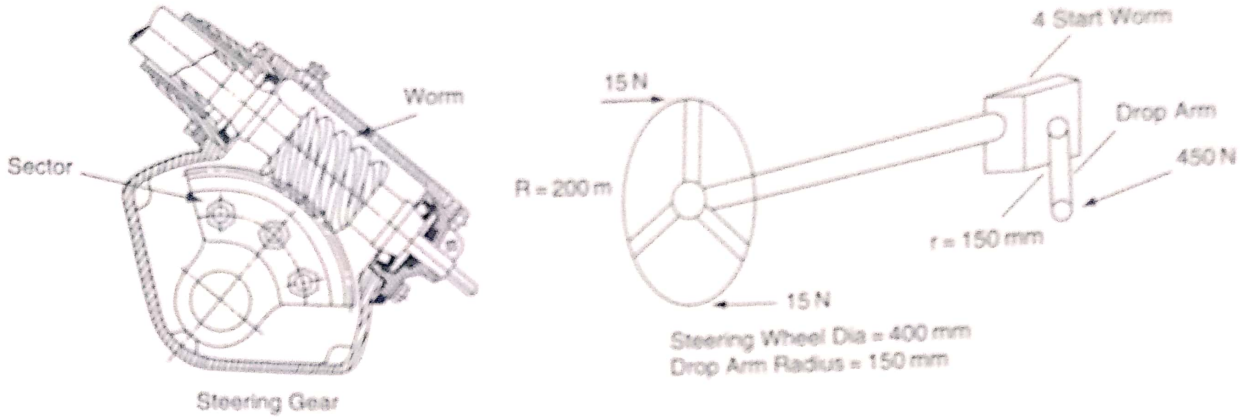


Figure 1: Worm and sector steering gear

$$MR = \frac{distance\ moved\ by\ effort}{distance\ moved\ by\ load} = \frac{2\pi R}{\frac{\alpha}{\beta} \times 2\pi r}$$

$$\eta_{mech.} = \frac{MA}{MR}$$

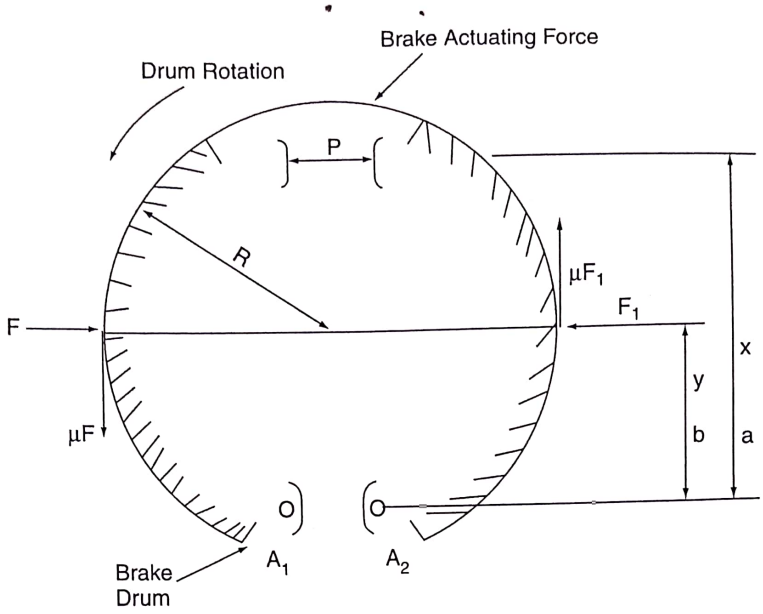
where,

R = Radius of steering wheel

r = Steering drop arm length

Take: $\alpha = 4$; $\beta = 48$.

ıg system



Drum Radius = R Actuating Force = P

F and F_1 = Normal Force Created by P μF and μF_1 = Friction Forces

Action of Leading Shoe

Taking Moments about Pivot A_1

$$Px = Fy - \mu FR$$

$$F = \frac{Px}{(y - \mu R)}$$

Action of Trailing Shoe

Taking Moments about Pivot A_2

$$Px = F_1 y + \mu F_1 R$$

$$\therefore F_1 = \frac{Px}{(y + \mu R)}$$

The Force F at the Leading Shoe is Greater than F_1 At the Trailing Shoe.

Figure 1: Drum brake

Take: $x = 12cm;\ y = 24cm;\ R = 15cm;\ \mu = 0.4; P = 2{,}000{,}000N.$

Hydraulic diameter, $d = 50mm$

Effective radius of the brake disc, $Re = 150mm$

Braking torque (two pads) $= 2R\mu PA$

Braking efficiency $= \frac{a}{g} \times 100\%$

Take: Maximum braking deceleration, $a = 7ms^{-2}$; Acceleration due to gravity, $g = 9.81ms^{-2}$