ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE, NIGERIA

DEPARTMENT OF AUTOMOTIVE ENGINEERING

FIRST SEMESTER EXAMINATIONS

2019/2020 ACADEMIC SESSION

HOD'S SIGNATURE

COURSE: ATE 401 – Automotive Systems Design (3 Units)

CLASS: 400 Level Automotive Engineering

TIME ALLOWED: 3 Hours

INSTRUCTIONS: Answer **any three (3)** questions from SECTION A and any other **two (2)** from SECTION B.

Date: February, 2020

SECTION A (Answer any three questions from this section)

Question 1 (Engine Cylinder Design)

Toyota (Nigeria) Limited currently engaged the Department of Automotive Engineering, Elizade University Ilara-Mokin, Ondo State to design engine cylinders of three different specifications for a four-stroke internal combustion engine. Copy and complete the **parametric specification table** below and determine which cylinder you will recommend among the three. **[12 Marks]**

Parametric Specification Table

S/N	D, mm	*l*, mm	L_c, mm	P_m, N/mm²	n, rpm	IP, Kw	BP, kW	η_{mech}, %	P, N/mm²	A, Mm	σ_c, N/mm²
Cyl. 1		1.5D		0.35	600		8	90	$10P_m$		35
Cyl. 2		1.5D		0.35	600		7		$10P_m$		35
Cyl. 3		1.5D		0.35	500		7		$10P_m$		35

S/N	t, mm	$\sigma_{c,h}$, N/mm²	C	t_h, mm	n_s	$\sigma_{t,s}$, N/mm²	d_c, mm	d_n, mm	D_p, mm	Pitch, mm
Cyl. 1		40	0.1			62				
Cyl. 2		40	0.1		6	62				
Cyl. 3		40	0.1		6	62				

Allowance for Reboring Table

D (mm)	75	100	150	200	250	300	350	400	450	500
A (mm)	1.5	2.4	4.0	6.3	8.0	9.5	11.0	12.5	12.5	12.5

Design formulae

$$\eta_{mech} = \frac{BP}{IP}; IP = \frac{p_m lAn}{60}; L_c = 1.15l; t = \frac{P \times D}{2\sigma_c} + A$$

$$t_h = D \times \sqrt{\frac{C \times P}{\sigma_c}}; d_C = \sqrt{\frac{D^2 \times P}{n_s \sigma_t}}; n_s = (0.01D + 4) to (0.02D + 4)$$

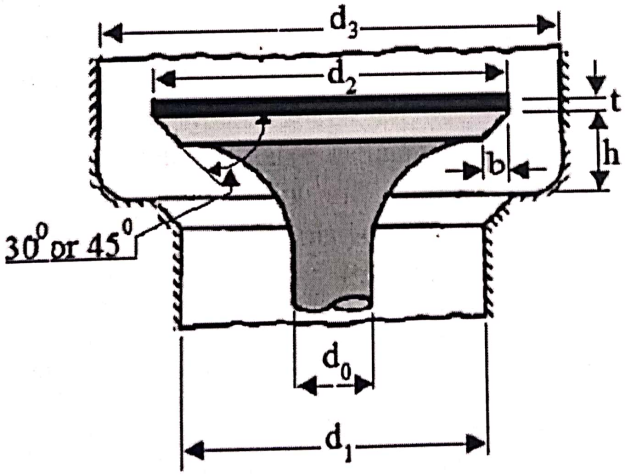
$$d_c = 0.8d_n \; D_p = D + 3d_n; \; 19\sqrt{d_n} \leq pitch \leq 28.5\sqrt{d_n}$$

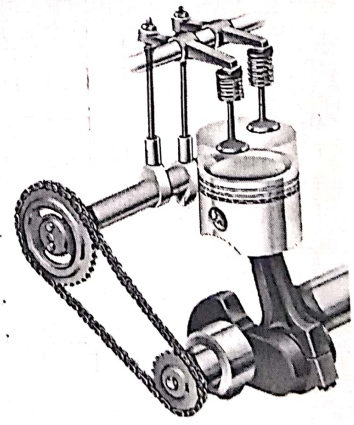
Question 2 (Engine Valve Design)

An automobile assembly plant in Kaduna State, Nigeria is required to assemble a Peugeot 406 vehicle within a month. Three cast iron engine valve mechanisms of different specifications: Max. gas pressure, P; cylinder bore diameter, D; gas velocity, V; mean piston speed, S_m; allowable stress, σ; valve seat angle, α_v, were purchased to fast track the assembling processes and it is required to select a valve mechanism that will perform best in service in terms of valve lift and valve dimensions. Copy and complete the **parametric specification table** below and determine which valve mechanisms you will recommend among the three and why? **[12 Marks]**

Parametric Specification Table

S/N	P_{max}, N/mm²	D, mm	V, m/min	S_m, m/min	σ, N/mm²	α_v (°)	d_0, mm	d_1, mm	d_2, mm	d_3, mm	b, mm	t, mm	h, mm
Valve 1	5	80	1500	300	42	30							
Valve 2	5		1500	300	42	45							12
Valve 3	5		1500	300	42	45							10.5





Design formulae

$$d_0 = \frac{d_1}{8} + 4mm$$

$$d_1 = d_{port} = D\sqrt{\frac{S_m}{V}}$$

$$t = k_1 d_1 \sqrt{\frac{P_{max}}{\sigma}}, k_1 = 0.54 \text{ for cast iron and } 0.42 \text{ for carbon steel or HGS}$$

$$b = \frac{t}{\tan \alpha_v} \text{ or } 0.1d_1 + 4\ mm$$

$$d_2 = d_1 + 2b$$

$$d_3 = \sqrt{{d_1}^2 + {d_2}^2}$$

$$h = \frac{0.25 d_1}{\cos \alpha_v} = \frac{d_1}{4 \cos \alpha_v}$$

Question 3 (Automotive Steering System Design)

Design an automotive steering system in terms of the gear ratio, torque ratio and percentage efficiency of the steering mechanism in a steering box which requires N turns of the steering wheel to move the drop arm through 30^0 from its central position to full lock in one direction. Assume the driver to exert a force F at the rim wheel diameter D and the torque transmitted to the drop arm is T_t. **[12 Marks]**

Design formulae

$$Gear\ ratio = \frac{360 \times No.\ of\ turns\ of\ the\ steering\ wheel}{No.of\ degree\ turned\ by\ drop\ arm}$$

$$T_t = F.d.G_s \eta_s$$

Parametric Specification Table

S/N	T_t, Nm	F, N	d, m	No. of wheel Turns, N	No. of degree turned by drop arm (^{0})	T_s, Nm	T_r	G_r	η, (%)
Steering 1	150	60	0.8	1.6	30				
Steering 2	150	25	0.8	1.6	30				
Steering 3	150	10	0.8	1.6	30				
Steering 4	150	25	0.4	1.6	30				
Steering 5	150	60	0.4	1.6	30				

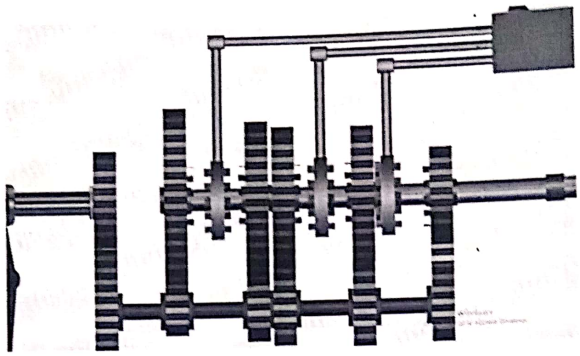
Copy and complete the **parametric specification table** above and determine which steering mechanisms you will recommend among the five and why?

Question 4 (Automotive Transmission System Design)

Sketch a section through a sliding type gear box with four forward and reverse speeds and explain clearly how the different speed ratios will be obtained in the following cases:

i. Gear ratio on the top gear = 1:1
ii. Gear ratio on the third gear = 1.38: 1
iii. Gear ratio on the second gear = 2.24:1
iv. Gear ratio on the first gear = 3.8:1
v. Gear ratio on the reverse gear = 3.8:1

Assume counter shaft or layout shaft speed is half of the engine speed and the smallest gear is not to have less than 15 teeth. **[12 Marks]**



SECTION B (Answer any two questions from this section)

Question 5 (Introduction to Automobile)

a. What differentiate a 'live axle' from a 'dead axle'? **[2 Marks]**
b. Describe the flow of power from the engine to the rear wheels **[2 Marks]**
c. Explain the two methods of body and chassis construction. **[3 Marks]**
d. What are the engine positions in Automobile? **[1 ½ Marks]**
e. The **SAE** has standardized **five grades of cast iron**, of which four are recommended for cylinder blocks and cylinder heads. Copy and complete the table of classification below.

S/N	*1*	*2*	*3*	*4*
Grade No.		*120*		
Specification	*Cylinder blocks*		*Truck and tractor*	

[2 ½ Marks]

f. The cylinder wall is subjected to gas pressure and the piston side thrust. What are the stresses produced as a result of the gas pressure? **[1 Mark]**

Question 6 (Automotive Engine Systems)

a. Explain the three causes of cylinder wear in Automobiles **[4 Marks]**
b. Distinguish between separate and integral cylinder head. **[1 ½ Marks]**
c. What are the valve productions processes? **[2 Marks]**
d. What are the categories of engine valves? **[1 ½ Marks]**
e. What are the components of valve mechanisms? **[3 Marks]**
f. What is the importance of valve rotator in Automobile? **[1 Mark]**

Question 7 (Automotive Steering and Transmission Systems)

a) What is the major function of the front axles in Automobile? **[2 Marks]**
b) List any four causes of stiff steering? **[2 Marks]**
c) What are the components of an Automobile steering system? **[2 Marks]**
d) What are the components of an automotive transmission systems? **[2 Marks]**
e) What are the two functions of a drive train in vehicles? **[2 Marks]**
f) Differentiate between manual and automatic transmission systems? **[2 Marks]**