Government of Karnataka
Department of Technical Education
Board of Technical Examinations, Bangalore

<table>
<tr><td rowspan="2">  </td><td colspan="3">Course Title: Automotive Mechanics</td></tr>
<tr><td>Scheme (L:T:P) :
4:0:0</td><td>Automotive Mechanics:
52</td><td>Course Code:15AT61T</td></tr>
<tr><td></td><td>Type of Course:
Lectures, Self Study & Quiz</td><td>Credit :04</td><td>Core/ Elective:
Core</td></tr>
<tr><td colspan="2">CIE- 25 Marks</td><td colspan="2">SEE- 100 Marks</td></tr>
</table>

Prerequisites: Knowledge of Applied Science, Engineering mechanics, Mechanics of machines and Machine Design.

Course Objectives:

Apply mechanical engineering science to Analyse engine and vehicle performance.

Course Outcomes:

On successful completion of the course, the students will be able to attain CO:

Course Outcome		CL	Linked PO	Teaching Hrs
CO1	Compare the different dynamometers and analyze various IC engine performance parameters.	***U/A/An***	2,5,6	**10**
CO2	Determine the axial force, torque transmitted and dimensions of clutch plate.	***U/A/An***	2	**09**
CO3	Explain the Gear terminology & calculate different gear ratios for different engine speeds	***U/A/An***	2	**06**
CO4	Illustrate the steering system terminology and determine the various parameters of steering mechanism.	***U/A/An***	2	**10**
CO5	Analyse the different forces involved in braking process and calculate various braking parameters for different load, road, and drive conditions of vehicle.	***U/An***	2	**06**
CO6	Discuss the various resistances involved in vehicle propulsion and determine various vehicle performance parameters for different load, road and drive conditions of Vehicle.	***U/A/An***	2	**11**
		Total sessions		**52**

Legend: R; Remember, U: Understand A: Application An: Analyze.

COURSE-PO ATTAINMENT MATRIX

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Automotive Mechanics	-	**3**	-	-	**1**	**1**	-	-	-	-

Level 3- Highly Addressed, Level 2-Moderately Addressed, Level 1-Low Addressed.

Method is to relate the level of PO with the number of hours devoted to the COs which address the given PO.

If ≥40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 3

If 25 to 40% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 2

If 5 to 25% of classroom sessions addressing a particular PO, it is considered that PO is addressed at Level 1

If < 5% of classroom sessions addressing a particular PO, it is considered that PO is considered not-addressed.

COURSE CONTENT AND BLUE PRINT OF MARKS FOR SEE/

Unit No	Unit Name	Hour	Questions to be set for SEE/Marks			Marks Weightage	Weightage (%)
			R	U	A/An		
1	**Performance of IC Engines.**	**10**	**5**	**5**	**20**	**30**	**20**
2	**Clutch**	**07**	**0**	**5**	**10**	**15**	**11**
3	**Gearbox**	**06**	**5**	**5**	**10**	**20**	**14**
4	**Steering**	**07**	**0**	**5**	**10**	**15**	**11**
5	**Brakes**	**11**	**5**	**5**	**20**	**30**	**20**
6	**Vehicle Performence**	**11**	**5**	**10**	**20**	**35**	**24**
	Total	**52**	**20**	**35**	**90**	**145**	**100**

Legend: R; Remember, U: Understand A: Application

UNIT I: PERFORMENCE OF IC ENGINES. 10Hrs

Dynamometers-need-types, Prony Brake Dynamometer, Electrical Dynamometer.-hydraulic dynamometer-construction and working, **Engine performance-** determination of IP- BP- FP- MEP- IMEP-BMEP- Engine Torque - piston speed -Mechanical Efficiency-Thermal Efficiency- Indicated Thermal Efficiency- Brake Thermal Efficiency- Volumetric Efficiency,-Air Standard Efficiency- Relative efficiency –TFC-SFC- BSFC- ISFC- air fuel ratios ,determination of IP- Willan's Back Trace Method-Morse Test, heat balance sheet, Performance Curves - Problems.

UNIT II: CLUTCH 07 Hrs

Clutch: Introduction, Derivation on Torque Transmitted through Single and Multi plates Clutches – Uniform Intensity of Pressure- Uniform Rate of Wear Conditions, Problems on Uniform Rate of Wear Conditions.

UNIT III: GEARBOX 05 Hrs

Terminology of gear, gear train-speed ratio-gear ratio, output torque, module of gear tooth, centre distance of gear train shafts – Problems.

UNIT IV: STEERING 07 Hrs

Definitions: wheel base, wheel track, overall length, and front over hung, rear over hung, and turning circle radii, derive equation for correct steering, **Ackerman steering mechanism**-Derive equation by Analytical method - derive expression for turning circle radii – problems.

UNIT V: BRAKES 11 Hrs

Definitions: Stopping Distance-Braking Efficiency-Braking Torque-Leading Shoe and Trailing Shoe – Derive an Expression For Stopping Distance –Derive an Expression For weight transfer during braking- Derive Expressions for Braking of Vehicle Moving on Gradient, - Brakes Applied To Rear Wheels-Front Wheels and All Four Wheels- Equation for Braking Torque on Leading and Trailing Shoe – Mean Lining Pressure and Heat Generated – Problems.

UNIT VI: VEHICLE PERFORMANCE 11Hrs

Different resistances on vehicle movement- Equations of the resistances -Wind Resistance-Rolling Resistance & Grade Resistance , Equation for power required for propulsion, relation between engine revolution and vehicle speed, Traction & Tractive effort with mathematical expression , Concept of Surplus power-acceleration- Gradability and Drawbar pull with Mathematical expression – Definition of equivalent weight with mathematical expression, Expression of maximum acceleration , maximum Tractive effort for front wheel, Rear wheel and Four wheel drives – problems.

TEXT BOOKS

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1. Automotive Mechanics - Dr.N.K. Giri (Khanna Publishers)
2. Automobile design Problem - R.S. Agarwal
3. Machine design - R.S. Khurmi & J.K. Gupta (S.Chand Publications)

REFERENCES

1. Machine Design - Sharma & Agarwal
2. Machine design - R.S Kurmi
3. Machine design - Abdulah sharief

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SUGGESTED LIST OF STUDENT ACTIVITYS

Note: the following activities or similar activities for assessing CIE (IA) for 5 marks (Any one)

- Each student should do any one of the following type activities or similar activities related to the course and before take up, get it approved from concerned course coordinator and HOD.
- Each student should conduct different activity and no repetition is allowed.

1	List the Dynamometers, sketch and explain any one of them.
2	Collect the performance data of different 100cc engines analyze, grade the engines and submit the report.
3	Sketch the ideal Valve timing diagram and the actual, compare submit hand written report of 500 words.
4	Assignments related to subject.

Course Delivery

- The course will be delivered through lectures
- Motivate student to take case study on performance parameters, power transmission and to inculcate him for self and continuous learning.

MODEL OF RUBRICS /CRITERIA FOR ASSESSING STUDENT ACTIVITY

RUBRICS MODEL

Student Name :				Reg No:		
RUBRICS FOR ACTIVITY(5 Marks)						
	Unsatisfactory	**Developing**	**Satisfactory**	**Good**	**Exemplary**	**Student**
	1 Mark	**2 Mark**	**3 Mark**	**4 Mark**	**5 Mark**	
Collection of data	Does not collect any information relating to the topic	Collects very limited information; some relate to the topic	Collect much information; but very limited relate to the topic	Collects some basic information; most refer to the topic	Collects a great deal of information; all refer to the topic	Ex: 4
Fulfill team's roles & duties	Does not perform any duties assigned to the team role	Performs very little duties but unreliable.	Performs very little duties	Performs nearly all duties	Performs all duties of assigned team roles	5
Shares work equally	Always relies on others to do the work	Rarely does the assigned work; often needs reminding	Usually does the assigned work; rarely needs reminding	Normally does the assigned work	Always does the assigned work without having to be reminded.	3
Listen to other Team mates	Is always talking; never allows anyone else to speak	Usually does most of the talking; rarely allows others to speak	Talks good; but never show interest in listening others	Listens, but sometimes talk too much	Listens and speaks a fair amount	2
Average / Total =marks=(4+5+3+2)/4=14/4=3.5=4						

Note: This is only an example. Appropriate rubrics/criteria may be devised by the concerned faculty (Course Coordinator) for assessing the given activity.

Course Assessment and Evaluation Scheme:

Method	What		To whom	When/Where (Frequency in the course)	Max Marks	Evidence collected	Course outcomes
Direct Assessment	CIE (Continuous Internal Evaluation)	IA	Students	Three IA Tests; (Average of three Tests)	20	Blue books	1,2,3,4,5,6
				Activity	05	Activity report	1,2,3,4,5,6
	SEE (Semester End Examination)	End Exam		End of the course	100	Answer scripts at BTE	1,2,3,4,5,6
Indirect Assessment	Student Feedback on course		Students	Middle of the course		Feedback forms	1,2 &3Delivery of course
	End of Course Survey			End of the course		Questionnaires	1,2,3,4,5,6 Effectiveness of Delivery of instructions & Assessment Methods

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Note to IA verifier: ***The following documents to be verified by CIE verifier at the end of semester***

1. Blue books (20 marks)
2. Student suggested activities report for 5 marks and should be assessed as per RUBRICS given.
3. Student feedback on course regarding Effectiveness of Delivery of instructions & Assessment Methods.

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Note: Internal choice may be given in each CO at the same cognitive level (CL).

MODEL QUESTION PAPER (CIE)

Test/Date and Time	Semester/year	Course/Course Code	Max Marks
Ex: I test/6 th weak of sem 10-11 Am	VISEM	AUTOMOTIVE MECHANICS	20
	Year: 2016-17	Course code:15AT61T	

Name of Course coordinator : Units:1,2

Co: 1,2

Note: Answer all questions

Q No	Question	MARKS	CL	CO	PO
1.	A petrol engine consumes 0.263 kg of fuel per b.kwh. The mechanical efficiency of the engine is 78% and the compression ratio is 5.6:1. The heating value is 43890 kJ/kg calculate the brake thermal efficiency, the ideal air standard efficiency and also the efficiency ratio. OR A four cylinder petrol engine has an output of 51.5 kw bp at 2000rpm.A Morse test was carried out and brake torque readings were 176.3, 169.5, 166.8 and 173.6 N-m respectively. For normal running at this speed specific fuel consumption is 0.37kg/bkwh. The lower heating value of the fuel is 43900kJ/kg. Calculate the mechanical efficiency and the brake thermal efficiency of the engine.	10	A	1	2,5,6
2	A plate clutch has three discs on the driving shaft and two discs on the driven shaft, providing four pairs of contact surfaces. The outside diameter of the contact surfaces is 240 mm and inside diameter 120 mm. Take $\mu = 0.3$, find the total spring load pressing the plates together to transmit 23 kW power at 1575 revolution per minute. If there are 6 springs each of stiffness 13 kN/m each of the contact surfaces has worn away by 1.25 mm, find the maximum power that can be transmitted, assuming uniform wear. OR Maximum torque of a Ford V-8 engine of 81 mm bore 96 mm stroke is 245 N-m at 2000 r.p.m. Find the outside diameter of the clutch facing for a single plate dry clutch necessary to transmit this torque. Take mechanical efficiency as 85% and the inside diameter of facing as outside diameter. Assume a coefficient of friction of 0.3 and the allowable pressure on the facing as 245 kPa.	10	A	2	2

CIE ASSESSMENT FOR FINAL REVIEW

1	Average of three IA tests Marks	20marks
2	Activity	05mark
Total		25marks

MODEL QUESTION PAPER

VI- Semester Diploma Examination
Course Title: **Automotive Mechanics**

Time: **3 Hours**] [Max Marks**:** **100**

Note: Answer any **SIX from Part A** and any **SEVEN from Part B**

PART-A 6x5=30 marks

1. 3. A petrol engine working on Otto cycle has a clearance volume of 20% of the stroke volume. The engine consumes 8.17 liters of petrol per hour when developing 23.5 kW i.p. The specific gravity of petrol is 0.76 and its heating value is 43,900 kJ / kg. Determine the indicated thermal efficiency of the engine. Take γ=1.4 for air
2. Explain any one dynamometer with a neat sketch
3. Explain with equation the torque transmitted through the clutch.
4. List different terms involved in terminology of spur gear
5. Define: Speed ratio, Gear ratio and diametrical Pitch
6. Explain Ackerman steering mechanism.
7. List the requirements of braking
8. Explain the brake fade
9. Find the rpm of the engine when the vehicle is moving at 60 Kph in top gear. Take the rear axle reduction to be 4.2:1 and the diameter of the wheels as 500mm

PART-B 7x10=70 marks

1. The following readins were noted for a 4-cylinder, 4-stroke engine:
Diameter= 101 mm.
Stroke= 114 mm.
Speed= 1600 r.p.m.
Fuel consumption= 0.204 kg/min.
Heating value of fuel= 41800 kJ / kg
Difference in tension on either side of brake pulley= 378N
Brake circumference = 3.35m
Assume a mechanical efficiency =83%, calculate
I) Brake thermal efficiency II). Indicated thermal efficiency
III). Mean effective pressure of cylinder. IV). Petrol consumption per b.kWh.

2. An eight-cylinder automobile engine of 85.7 mm bore and stroke 82.5mm and with a compression ratio of 7:1 is tested on dynamometer which has an arm of 0.5335 m, long the dynamometer scale reading 400N and the speed of the engine 4000 r.p.m. During the ten minutes run the fuel consumption was 4.55 kg of gasoline the heating value of fuel was 45980kJ/kg. The quantity of air supplied was 5.44 kg/min at a pressure of $10x10^4$ Pa and at temperature of 293k.find the following
(a)BP developed
(b) The b.m.e.p. (c) the b.s.f.c.,
(d) The brake thermal efficiency,
(f) The volumetric efficiency, (g) the air consumption,
(g) The air-fuel ratio.

3. A plate clutch has three discs on the driving shaft and two discs on the driven shaft, providing four pairs of contact surfaces. The outside diameter of the contact surfaces is 240 mm and inside diameter 120 mm. Take μ = 0.3, find the total spring load pressing the plates together to transmit 23 kW power at 1575

revolution per minute. If there are 6 springs each of stiffness 13 kN/m each of the contact surfaces has worn away by 1.25 mm, find the maximum power that can be transmitted, assuming uniform wear.

4. In a constant mesh gearbox the clutch shaft pinion has 14 teeth and a lay shaft gear has 32 teeth. The number of teeth in the lay shaft gear wheels is 16, 19 and 21. The differential drive pinion has 14 teeth and crown pinion has 62 teeth. The road wheel diameter is 0.65 m. If the engine is running at a constant speed of 3200 rpm, find the various speeds of the vehicle in respective gears.

5. The distance *L* between the pivots of a car is 1.27 m. The knuckle arms are 0.165 m long. The angle between the knuckle arm and the longitudinal axis of the car in the straight ahead position is 20°. The track is 1.42 m and *L* is 45% of the wheelbase. Find the radius of the path near side front wheel for correct steering to the right.

6. In a shoe-brake with leading and trailing shoes, the total actuating force of 471 N acts at a distance of 0.15 m from the pivot of the shoes which is 0.075 rn from the axis of the drum of radius 0.09 m? The shoes have symmetrical lining with coefficient of friction 0.45. If the effective radius of the friction force is 0.1 m, calculate the total braking torque, when

(a) The actuating mechanism gives equal forces to the shoes; (b) when the actuating mechanism gives the shoes equal displacement

7. A bus weighing 124587 N is to be kept at a constant speed of 32 km/hr when going down a 3 km long slope (tan $\Theta = 0.1$). Suggest if the brakes should be used in this operation. If there are brakes on all four wheels and if the weight is shared equally by the wheels, calculate the heat dissipated at each brake when the brakes are used to control and limit the speed to 32 km/hr.

8. For a motor vehicle, the rolling resistance is given by, 13.6 + 0.6965 V and the air resistance by the expression 0.0827 V^2 the resistance being in N and V the speed in km/hr. If the transmission efficiency is 88%, calculate the b.kw required for a top speed of 128 km/hr assuming that the engine torque at 48 km/hr in top gear is 25% more than that at 128 km/hr and that the vehicle inertia corresponds to a weight of 17805N; calculate the acceleration in m/s^2 at 48 km/hr.

9. A car of weight 13341.6 N is to be provided with an engine. The gear ratio is 3.8: 1, the wheels are 0.61 m diameter and a transmission efficiency of 92% may be assumed. The rolling resistance on good macadam road is 13 N per 1000 N of weight and air resistance is equal to 0.06023 V^2, where V is the forward speed in km per hour. The total inertia of the car may be assumed to be equivalent to a weight of 17795.3 N. The car has to have a maximum acceleration of 0.76 m/s^2 at 56 km/hr. Calculate(i) the engine speed at 56 km/hr ;(ii) the engine power which is needed at the above speed ;(iii) the load which the car can pull on level in a trailer if the trailer weighs 4448.8 N at 54 km/hr.

10. a) List and explain the resistances offered against the movement of vehicle.

b) Deduce the relationship between engine revolutions and vehicle speed

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MODEL QUESTION BANK

CO1: Compare the different dynamometers and analyze various IC engine performance parameters.

1. Explain the procedure of computing of heat balance sheet.
2. Explain Prony brake dynamometer.
3. List the different efficiencies of the power plant.
4. Define indicated power, brake power, and engine friction loss.

UNDERSTANDING

1. Explain the following terms.
   a) Theatrical Volume b) Swept Volume c) Relative Efficiency
2. Explain the calculation of IP of multi cylinder engine.
3. Differentiate between the actual and theoretical valve timing diagrams
4. Explain IMEP, BMEP and mechanical efficiency with respect to engine pressures
   6. Explain ISFC, BSFC and mechanical efficiency with respect to engine fuel consumption.

APPLICATION

1. A four-cylinder petrol engine has an output of 51.5 kW bp at 2000 r.p.rn. A Morse test was carried out and the brake torque readings were: 176.3, 169.5, 166.8 and 173.6 N-m respectively. For normal running at this speed specific fuel consumption is 0.37 kg / kWh. The L.H.V. of the fuel is 43900 kJ I kg. Calculate the mechanical efficiency and the brake thermal efficiency of the engine.

2. The following were noted for a 4-cylinder, 4-stroke engine:
Diameter= 101 mm.
Stroke= 114 mm.
Speed= 1600 r.p.m.
Fuel consumption= 0.204 kg/min.
Heating value of fuel= 41800 kJ / kg
Difference in tension on either side of brake pulley= 378N
Brake circumference = 3.35m
Assume a mechanical efficiency =83%, calculate
I) Brake thermal efficiency, II). Indicated thermal efficiency
III) Mean effective pressure of cylinder, IV) Petrol consumption per b.kWh.

3. A petrol engine working on Otto cycle has a clearance volume of 20% of the stroke volume. This engine consumes 8.17 liters of petrol per hour when developing 23.5 kW i.p. The specific gravity of petrol is 0.76 and its heating value is 43,900 kJ I kg. Determine the indicated thermal efficiency of the engine.
Take γ=1.4 for air

4. An eight-cylinder automobile engine of 85.7 mm bore and stroke 82.5mm and with a compression ratio of 7:1 is tested on dynamometer which has an arm of 0.5335 m. long the dynamometer scale reading 400N and the sped of the engine 4000 r.p.m during the ten minutes run the fuel consumption was 4.55 kg.of gasoline the heating value of fuel was 45980kJkg. The quantity of air supplied was 5.44 kg/min at a pressure of $10x10^4$ Pa and at temperature of 293k.find the following
(a)BP developed
(b) The b.m.e.p. (c) the b.s.f.c.,
(d) The brake thermal efficiency,
(f) The volumetric efficiency, (g) the air consumption ,
(g) The air-fuel ratio.
Difference in tension on either side of the brake pulley = 378 N
Brake circumference= 3.35 m.
Assume a mechanical efficiency = 83%
Calculate:

(a) Brake thermal Efficiency
(б) Indicated Thermal Efficiency
(c) Mean Effective Pressure of Cylinder
(d) Petrol Consumption per b.kWh.

5. A four-cylinder petrol engine has an output of 51.5 kW bp at 2000 r.p.rn. A Morse test was carried out and the brake torque readings were: 176.3, 169.5, 166.8 and 173.6 N-m respectively. For normal running at this speed specific fuel consumption is 0.37 kg /b.kWh. The L.H.V. of the fuel is 43900 KJ / kg. Calculate the mechanical efficiency and the brake thermal efficiency of the engine.

6. In a trial on 4-cylinder, 4-stroke, petrol engine of 101.6 mm bore, and 127 mm stroke, the net dynamometer load was 183 N at a radius of 508 mm when the speed was 2500 rpm. At this speed and throttle opening the engine required 4.6 kW to motor it with ignition switched off

(i) Calculate the mechanical efficiency and the indicated mean effective pressure.

(ii) During a 3 minute run at this speed and power, the engine used 0.598 kg of petrol of heating value 45310 kJ / kg and 22.68 kg of cooling water with a temperature rise of 55.5 K.

Draw a heat balance chart of the test in kJ / min.

7. A petrol engine uses 0.263 kg of fuel per b. kW hour. The mechanical efficiency of the engine is 78% and the compression ratio 5.6 : 1. If the heating value of the fuel is 43890kJ/kg, calculate the brake thermal efficiency, the indicated thermal efficiency, the ideal air standard efficiency and also the efficiency ratio.

8. Trial in a 6 cylinder, 4-stroke petrol engine of 127 mm bore and 152.4 mm stroke, the net dynamometer load was 200 N at a radius of 762 mm when the speed was 3000 rpm. At this speed and throttle opening the engine required 7.5 kW to motor it with the ignition switch off. Calculate the mechanical efficiency and the indicated mean effective pressure.
If the fuel flow is 0,8175 kg/min of heating value 45310 kJ/kg and water flow is 13.64 litre/min with a rise of temperature of 55 K, draw the heat balance sheet in kJ/min.

9. Following particulars refer to a four-stroke petrol engine working on otto four stroke cycle principles
Cylinder diameter = 76.2mm
Stroke =88.8mm
Clearance volume =81.0ml
Indicated power developed =20.6kw
Petrol consumption =5kg/hr
Heating value of petrol = 41800 kJ/kg
Calculate:

(a) Actual Thermal Efficiency
(b) Air Standard Efficiency.
(c) Relative Efficiency

Assume C_p for air as 1.0and C_v as 0 .71

10. In a test with a four-cylinder, four-stroke petrol engine, the following results were obtained for a particular setting and speed. B.P. with all cylinders working 23.55 kW, B.P. with No. 1 cylinder cut out 15.89 kW, B.P. with No. 2 cylinder cut out 16.41 kW, B.P. with No. 3 cylinder cut out 16.56 kW and B.P. with No. 4 cylinder cut out 16.92 kW Estimate the I.P. of the engine and its mechanical efficiency.

11. (a) Draw the performance curves for the following characteristics
Of an automotive petrol engine. Variation of BP. F.P, I.P, torque, B.M.E.P, mechanical efficiency and fuel consumption against speed in r.p.m.

(b) The Morse test of a petrol engine provided the following results: B.P. with all cylinders working = 73.6 kW B.P.
With No. 1 cylinder cutout = 50.4 kW B.P,
With No. 2 cylinder cutout = 50.8 kW B.P.
With No. 3 cylinder cutout = 52.3 kW B.P.

With No. 4 cylinder cutout = 52.6 kW
Calculate the F.P., LP. And mechanical efficiency of the engine.

12. While testing a four-cylinder automobile petrol engine of bore 85 mm and stroke 92.2 mm at 3000 r.p.m. on a test stand. The following data were obtained:
Indicated mean effective pressure = 96.14 x 10^4 N/m^2 Fuel consumption = 1.36 kg
Engine torque developed = 135.6 N-m
Duration of test = 5 min.

If the heating value of fuel used 44270 kJ/kg, calculate,
(a) Indicated power of the engine
(b) Brake power
(c) Mechanical efficiency
(d) Overall thermal efficiency of the engine.

13. A petrol engine working on otto cycle has a clearance volume of 20% of stroke volume. The engine consumes 8.17 liters of petrol per hour when developing 23.5 kw. The specific gravity of petrol is 0.76 and its heating value is 43900 kN/kg. Determine the indicated thermal efficiency of the engine. Take *y* =1.4 for air. (5)

14. In a test on a four cylinder, four stroke petrol engine, the following results were observed for a particular setting ad speed,

BP with all cylinders working 23.5 kw,
BP with no 1 cylinder cut-off 15.89 kw,
BP with no 2 cylinder cut-off 16.41 kw,
BP with no 3 cylinder cut-off 16.56 kw,
BP with no 4 cylinder cut-off 16.92 kw,
Calculate the IP and its mechanical efficiency.

15. In Morse test of a petrol engine the following results were obtained.

BP with all cylinders working 73.6 kw,
BP with no 1 cylinder cut-off 50.4 kw,
BP with no 2 cylinder cut-off 50.6 kw,
BP with no 3 cylinder cut-off 52.3 kw,
BP with no 4 cylinder cut-off 52.6 kw,
Calculate FP, IP and mechanical efficiency of the engine.(5)

16. The following data were noted for a four cylinder 4 stroke engine,

Diameter=101mm, stroke=114mm, speed=1600rpm, fuel consumption=0.204kg/min, heating value of fuel =41800kj/kg, difference in tension on either side of brake pulley=378N, brake circumference=3.35m, Assume mechanical efficiency=83%, calculate brake thermal efficiency indicated thermal efficiency, mean effective pressure of cylinder, petrol consumption per brake kwhr.

17. While testing a four cylinder petrol engine of bore 101.6mm and stroke 127mm . the net dynamometer load was 183N at a radius of 508mm, when the speed was 2500 rpm. At this speed and throttle opening the engine required 4.6 kw to motor it with ignition switch off. Calculate mechanical efficiency and indicated mean effective pressure during a 3 minute run at this speed and power. The engine used 0.598 kg of petrol of heating value 45310 kj/kg and 22.68 kg of cooling water with a temperature raise of 55.5^0k draw heat balance sheet.

18. A four cylinder petrol engine has an output of 51.5 Kw BP at 2000 rpm. A Morse test was carried out and the braking torque readings were 176.3, 169.5, 166.8 and 173.6 Nm respectively. Calculate the mechanical efficiency of the engine.

CO2 Determine the **axial** force, torque transmitted and dimensions of clutch plate.

REMEMBERING

1. List the materials of clutch friction surface.
2. Write the coefficient of friction of clutch materials
3. List the requirements of clutch
4. List the causes of clutch slip

UNDERSTANDING

1. Explain the with the equation torque transmission through the clutch.
2. Explain the with the equation torque transmission through the clutch in uniform wear conditions.
3. Explain the torque transmission through the clutch in uniform pressure conditions.

APPLICATION

1. An automobile is fitted with a single plate clutch to transmit 22.1 kW, at 2100 r.p.m. The total axial load on the clutch plate is 1422.5 N. The outside diameter of the friction surface is 250 mm. Both sides of the plate are effective and the μ (coefficient of friction) between the contact surfaces is 0.35. Assuming uniform rate of wear condition, calculate the inner diameter of friction surface.

   The rotating parts attached to the driven parts of the clutch are initially at rest having M.I. of 20.7N-m^2. Assuming the acceleration of the machine is uniform; calculate the time lapse before the engine attains full speed of 2100 r.p.m. if the clutch is suddenly engaged.

2. A plate clutch has three discs on the driving shaft and two discs on the driving shaft, providing four pairs of contact surfaces. The outside diameter of the contact surfaces is 240 mm and inside diameter 120 mm. Assuming uniform pressure and μ = 0.3, find the total spring load pressing the plates together to transmit 23 k W power at 1575 revolution per minute.

   If there are 6 springs each of stiffness 13 kN/m each of the contact surfaces has worn away by 1.25 mm, find the maximum power that can be transmitted, assuming uniform wear.

3. Maximum torque of a Ford V-8 engine of 81 mm bore 96 mm stroke is 245 N-m at 2000 r.p.m. Find the outside diameter of the clutch facing for a single plate dry clutch necessary to transmit this torque. Take mechanical efficiency as 85% and the inside diameter of facing as | outside diameter. Assume a coefficient of friction of 0.3 and the allowable pressure on the facing as 245 kPa.
4. A multi-plate clutch is required to transmit 33 kW at 1000 r.p.m. There are nine discs with the outer casing and eight with the moving shaft. The outer radius is 1.5 times the inner. Permissible intensity of pressure is 789.7 kPa when coefficient of friction is 0.15; determine the dimensions of the friction surfaces, assuming the rate of wear to be uniform.
5. Design the friction plate of a single plate automobile clutch, which has to transmit 92 b. kW at 3500 r.p.m. The lining material has a coefficient of friction 0.25. The radial width of the lining is not to exceed 30 mm. Assume the axial pressure for the Ferodo lining of 69 kPa.
6. A single plate clutch is to have a maximum capacity of 56 kW at 1800 r.p.m. The clutch facing has a coefficient of friction of 0.4 and permissible pressure of 207 kPa supposed uniform. The clutch is engaged through 12 springs. Determine the diameters of the clutch facing, if the inner diameter is 0.7 times the outer. Find also the spring force of each spring when the clutch is engaged. **A** friction plate is of the single plate type and both sides of the plate are effective. The inside diameter of the friction

surfaces is 177.8 mm and the outside diameter is 254 mm and the coefficient of friction clutch lining is 0.25. What is the least axial load required so that the clutch may transmit 25.8 kW at 2000 r.p.m. ?

7. A single plate dry disc clutch having both the faces effective is required to transmit 36.8 kW at crank shaft speed at 3000 r.p.m. Total pressure exerted by the spring is 3561 N and the coefficient of friction between disc and metal is 0.3. Find the size of friction lining required if the inner radius of lining is 0.75 of the outer radius.
8. A single plate dry disc clutch having both sides of the plate effective is to be designed for a car engine rated at 13.3 kW and giving a maximum torque of 122 N-m. The coefficient of friction is 0.35, the axial pressure is not to exceed 82.9 kPa and the external radius of the friction surface is 1.25 times the internal radius. Find the dimensions of the friction lining and the total axial pressure that must be exerted by the spring.
9. The clutch of a motor car has to transmit 73.6 kW at 3600 r.p.m. It is of a single plate type, both sides being effective. Friction material yields a coefficient of 0.25 and the axial pressure is limited to 83 kPa of plate area. If the internal diameter of the plate is to be 75% of the external diameter, determine the main dimensions of the clutch plate.
10. Derive the formula for calculating the torque transmitted by a single plate clutch. Calculate the power transmitted by a single plate clutch of 254 mm (mean diameter), having six springs exerting a force of 446.4 N each and the friction fabric having a coefficient of friction of 0.35.
11. The clutch member having 1375N of axial load which is exerted on the clutch plate, which is having an outer diameter of 0.25m and the inner diameter of 0.154m. The coefficient of friction of the liner is 0.35. Find the torque transmitted by the friction of single plate clutch. Assume uniform rate of wear. (5)
12. A single plate clutch of a vehicle has to transmit 23 Kw of BP at 2100 rpm. The total axial load is 1425N and the clutch plate is having an outside diameter of 0.25 m and the coefficient of friction is 0.35. Assuming the rate of wear as uniform calculate the inner diameter of the clutch liner. (5)
13. A automobile power unit gives a maximum torque of 13.56 Nm. The clutch is of a single plate dry disc type, having effective clutch lining of both sides of the plate disc. The coefficient of friction is 0.3 and the maximum axial pressure is 8.29×10^4 Pa and external radius of the frictional surface is 1.25 times the internal radius. Calculate the dimension of the clutch plate and the total axial pressure that must be exerted by the clutch spring. (10)
14. A motor car engine develops 15 Kw at 2100 rpm. Find the suitable size of the clutch plate having friction lining riveted on both sides to transmit the power under the following conditions.

- The intensity of pressure on surface should not exceed 7.18×10^4 Pa.
- Slip torque and losses due to wear is 35% of given torque
- Coefficient of friction is limited to 0.3
- Outside diameter of the plate is two times the inside diameter

CO3: Explain the Gear terminology & calculate different gear ratios for different engine speeds

REMEMBRING

1. List different terms involved in terminology of spur gear
2. List the types of gears used in automobile gear boxes.

UNDERSTANDING

1. Define: Speed ratio, Gear ratio and diametrical Pitch
2. Define: Pitch circle, Face, and angle of tooth.

APPLICATION

1. Evolve a design for spur gears to be used in an ordinary gear box that gives the following speed ratios: 1.0, 1.43, 2.29 and 3.91.The diametrical pitch of all the wheels is to be 3.25 mm. The smallest pinion in the system is to have a minimum of 15 teeth.
2. A four speed gear box is to have the following gear ratios, 1.0, 1.5, 2.48 and 3.93. The centre distance between the lay shaft and the main shaft is 73.12 mm and the smallest pinion is to have at least 12 teeth with a diametrical pitch of 3.25 mm. Find the number of teeth of the various wheels. Find the exact gear ratios.
3. A gear box with three speeds forward and one reverse is to provide the speed reduction as follows: top 5.1: 1 intermediate 8.8: 1, low 16.5: 1, reverse 19.8: 1 with a constant reduction 5.5: 1 at the rear axle. Assuming that the smallest pinion has not less than 15 teeth and speed of the lay shaft half that of main driving shaft, find the suitable number of teeth of different wheels
4. In a constant mesh gearbox the clutch shaft pinion has 14 teeth and a lay shaft gear has 32 teeth. The number of teeth in the lay shaft gear wheels is 16, 19 and 21. The differential drive pinion has 14 teeth and crown pinion has 62 teeth. The road wheel dia is 0.65 m. If the engine is running at a constant speed of 3200 rpm, find the various speeds of the vehicle in respective gears. (10)
5. The maximum rpm of the engine is 4300. Find the maximum speed of the vehicle in KPH in top, III, II, I st gear. The teeth on constant mesh gears are 18 and 42. The corresponding number of teeth on the lay shaft gear wheels is 16, 24 and 28 for I, II, and III gears respectively. The driving pinion has 15 teeth and the crown wheel has 48 teeth. Dia of the road wheel is 0.75 m. (10)
6. Find the rpm of the engine when the vehicle is moving at 60 Kph in top gear. Take the rear axle reduction to be 4.2:1 and the dia of the wheels as 500mm.
7. From the following data, calculate the gear ratios and no. of teeth on driving pinion.
   I st gear speed 25 kmph, II gear speed 39 kmph, III gear speed 58kmph , Top gear speed 80 kmph. Max. Engine rpm is 3200, dia of the wheels is 61 cm, teeth on crown wheel is 62 (10)

8. The engine of an automobile runs at a constant speed of 3200 rpm. Its rear axle ratio is 4.42:1 and its effective wheel dia not to exceed 0.65 m. It is adopted with a four speed of gear ratio 1.0, 1.5, 2.48, 3.93:1. The centre distance from the lay shaft and main shaft is 73.12mm and the smallest pinion is to have at least 15 teeth, with a diametrical pitch of 3.25mm. find the total number of teeth on various gear wheels , exact gear ratio and vehicle speed in different ratio.

CO4 Illustrate the steering system terminology and determine the various parameters of steering mechanism.

REMBERING

1. Define: wheel base and wheel track
2. Define: overall length, front over hung, rear over hung
3. Define: instantaneous centre and turning circle radius

UNDERSTANDING

1. Explain Ackerman steering mechanism.
2. Derive equation for correct steering.
3. Derive expression for turning circle radii.

APPLICATION

1. A track has pivot pins 1.37 m apart, the length of each track arm is 0.18 m and the track rod is behind front axle and 1.27 m long. Determine the wheel base which will give true rolling for all wheels when the car is turning so that the inner wheel stub axle is 60° to the centre line of the car. A geometrical construction may be used.
2. A motor car has a wheel-base of 2.743 m and pivot centre of 1.065 m. The front and rear wheel track is 1.217 m. Calculate the correct angle of outside lock and turning circle radius of the outer front and inner rear wheels when the angle of inside lock is 40°.

3. A car has pivot pins 1.14 m apart, the length of each track arm is 0.1525 m and the track rod behind the axle is 1.04 m long. Determine the wheelbase for true rolling of all wheels when the inner wheel stub axle is at 55° to the centre line of the car.
4. A car having a wheelbase of 2.44 m and pivot centre of 1.12 m has a track of 1.22 m between centers of tire tread. If the angle of lock is 30° and the width of tire 0.114 m, determine the minimum radius of outer turning circle.
5. The distance *L* between the pivots of a car is 1.27 m. The knuckle arms are 0.165 m long. The angle between the knuckle arm and the longitudinal axis of the car in the straight ahead position is 20°. The track is 1.42 m and *L* is 45% of the wheelbase. Find the radius of the path near side front wheel for correct steering to the right.

CO5. Analyse the different forces involved in braking process and calculate various braking parameters for different load, road, and drive conditions of vehicle.

REMBERING

1. Define stopping distance and brake fade.
1. Define Leading shoe and trailing shoe.
2. List the requirements braking

UNDERSTANDING

1. Explain the brake balance
2. Explain the brake fade
3. Explain the brake torque.

Analyze

1. Derive the equitation's for Theory of Internal Shoe Brake.
2. Derive the equitation's for Effect of Expanding Mechanism of shoe on total braking torque.

APPLICATIONS

1. A truck of gross vehicle weight 88996 N has brakes on all four wheels and is brought to rest from 64 km/hr in 27.45 m, assuming uniform distribution of braking forces, calculate the mean lining pressure in N/m^2 from the following data
   Effective wheel diameter = 0.7875 m
   Brake drum diameter = 0.38 m
   Width of lining = 0.0635 m
   Lining coefficient = 0.3
   Total angle of contact per drum = 200°.

2. In a test to determine the coefficient of adhesion of a certain road surface a test car with all four wheels having brakes was run upto speed and braked, so that the brakes just locked. The following result were recorded :
   Speed from which braking Stopping distance was done

km/hr	m
32	6.7
48.2	15.24
64.3	27.43
80.9	42.67
96.55	62.48

   Calculate the coefficient of adhesion of the road.

A bus weighing 124587 N is to be kept at a constant speed of 32 km/hr when going down a 3 km long slope (tan 0 = 0.1). Suggest if the brakes should be used in this operation. If there are brakes on all four wheels and if the weight is shared equally by the wheels, calculate the heat dissipated at each brake when the brakes are used to control and limit the speed to 32 km/hr.)

3. A motor vehicle of weight 15568.5 N with brakes on all four wheels is slowed uniformly from 96 km/hr to 48 km/hr in a distance of 305 m while running down an incline of 1 in 12. Assume uniform distribution of braking forces, calculate the mean lining pressure in N/m~ from the following data:
   Effective wheel diameter = 0.76 m
   Brake drum diameter = 0.36 m
   Brake lining width = 0.04 m
   Lining contact angle in each drum = 240°
   Coefficient of friction =0.4.
   Calculate the amount of heat generated at each wheel during braking operation. (Assume symmetrical lining, fixed cam and ratio of the effective radius of frictional force and radius of shoes as one).
4. A motor car has a wheel base of 2.64 m the height of it e.g. above the ground is 0.61 m ami ic is 1.12 in in front of the rear axle. If the car is travelling at 40 km/hr on a level track, determine the minimum distance in which the car may be stopped, when
   (a) The rear wheels are braked,
   (b) The front wheels are braked,
   (c) All wheels are braked.
   The coefficient of friction between tyre and road may be taken as 0.6. Prove any formula if assumed.
5. An automobile brake of the internal expanding type has a leading and a trailing shoe which work inside a brake drum of 0.38 m diameter. The brake shoes are pinned together at the bottom 0.15 m away from the brake drum centre. The free ends of the two shoes are forced apart each with a force of 311.5 N which may be considered as acting at a distance of 0.3 m from the fixed pin. Assuming the normal pressure on the brake shoe to act at right angles to the line joining the pin centre with the brake drum centre and the point of application of the resultant frictional force to act at a distance of 0.22 rn from the brake drum centre, determine the braking torque provided by the leading and the trailing shoe. Take the coefficient of friction between shoe and drum as 0.4
6. A motor car weighs 13341.5 N and has a wheel base of 2.65 m. The e.g. is 1.27 m behind the front axle and 0.76 m above the ground level. Maximum braking on all four wheels on level ground will bring the vehicle uniformly to rest from a speed of 64 km / hr in a distance of 25.9 m. Calculate the value of an adhesion between the tire and the road. Under the same road condition, the vehicle descends a hill of gradient 1 in 20 and is braked on the front wheels only. Determine the load distributed between the front and rear wheels and the distance required to bring the car to rest.
7. A passenger car of all up-weight 14322.6 N is fitted with four brakes and slowed uniformly from 86.5 km /hr to 48 km / hr n a distance of 152.5 m while running down an incline of 1 in 15. Calculate the amount of heat generated in kJ during this operation and mention the methods employed to transfer this heat to the atmosphere. If the front wheels share 55% of the braking forces, calculate the mean lining pressure in N/m^2 on the front wheel brakes from the following data :
   Brake lining width - 0.05 m
   Effective wheel dia. = 0.686 m
   Brake drum dia. = 0.318 rn
   Lining area of the drum=.0321m^2
   Coefficient of friction between drum and lining= .35
   What is the lining contact of each drum?

   7. In a shoe-brake with leading and trailing shoes, the total actuating force of 471 N acts at a distance of 0.15 m from the pivot of the shoes which is 0.075 rn from the axis of the drum of radius 0.09 m? The shoes have symmetrical lining with coefficient of friction 0.45. If the effective radius of the friction force is 0.1 m, calculate the total braking torque, when
   (a) The actuating mechanism gives equal forces to the shoes ;
   (b) When the actuating mechanism gives the shoes equal displacement.
1. A truck weighing 78480 N has its e.g. 1.2 m in front of the rear axle, 1.8 rn behind the front axle and 1.35 m above the gr ound level. The front wheel brakes are having only leading shoes whereas the

rear wheel brakes have conventional leading and trailing shoes. Final actuating forces are applied to all the shoes which are symmetrically placed:

Having brake drums diameter = 0.25 m
Distance of shoe pivots from the drum axes = 0.1 m
Distance of line of action of the actuating force from the drum axes - 0.1 m
Effective radius for the resultant frictional force =0.16 m
Coefficient of friction =0.4
Diameter of road wheels = 0.92 m
Coefficient of adhesion for the road = 0.5
Calculate, (a) the magnitude of actuating force on each shoe, and
(b) The maximum deceleration possible without any skidding of the wheels.

CO6. Discuss the various resistances involved in vehicle propulsion and determine various vehicle performance parameters for different load, road and drive conditions of Vehicle.

REMEMBERING

1. List the resistances offered against the movement of vehicle.
2. Define air resistance, Rolling resistance and grade resistance.
3. Define gradability and Draw bar pull

UNDERSTANDING

1. Differentiate between Traction and Tractive Effort.
2. Deduce the relationship between engine revolutions and vehicle speed.
3. Deduce the equation of Power for Propulsion
4. Explain the road performance curves.

ANALYZE

1. Derive an expression for calculation of maximum acceleration, Maximum tractive effort and reactions for different drive
2. Derive the expressions for stability of vehicle on slope.

APPLICATION

1. A racing car weighs 14224.5 N including the four road wheels, each of which has an effective diameter of 0.66 m, radius of gyration of 0.275 m and weight 267.3 N. The engine develops 221 kW at 5000 r.p.m. The parts rotating at engine speed weigh 890 N with radius of gyration of 0.107 m. the transmission efficiency is 90% and the total load and air resistance at this engine speed in top gear of 4.2: 1 is 1324.5 N. Calculate the acceleration in km per hr per sec under these conditions. (R.U. 1964 S, A.M.I.E. India Nov. 1968)

2. A motor car weighing 13341.6 N and has an engine developing 40.5 bkW at 4000 r.p.m. The transmission system has an efficiency of 90% in top gear and 85% in second gear. The top gear ratio is 1 : 1 and the second gear ratio 1.64 : 1, when running on level with wide open throttle, the car reaches 112 km/hr at 4000 r.p.m. and at the same engine speed in second gear it will just climb a hill of 1 in 12. If the resistance to motion on level is given by the formulae H - A + BV^2, where R is in N and V in km/hr. Calculate A and B. Compute the maximum speed with which the car can climb a grade of 1 in 20 in top gear. What is the corresponding engine speed ? Assume that engine power is proportional to engine speed in the above range. (R.U. 1964 AT

3. A car of all up weight 14224.5 N is fitted with an engine developing 31 bkW at 2000 r.p.m. The top gear ratio is 4.5: 1 with an effective wheel diameter of 0.66 m and transmission efficiency of 88% at 2000 r.p.m. The rolling resistance is 14 N per 1000 N of weight and the air resistance is equivalent to 0.0775

V^2, N where Vis forward speed in km/hr. The total inertia of the car including that of engine, transmission and road wheel may be assumed to be equivalent to that of a weight of 17805 N. Calculate,

(a) The forward speed at 2000 r.p.m. ;
(б) The power available for hill-climbing or acceleration at this speed ;
(c) The maximum acceleration possible at this speed.
'.27. Two cars, similar in all respects, excepting that one has rear wheels drive and the other front wheel drive, are used on a test track. If the engine power does not limit the ability to climb grades, state which car can ascend the steeper grade. If the weight of each car is 14239 N with 50% on each axle, the wheel base is 2.666 m, the C.G. above the ground is 0.5334 m and if the coefficient of friction of the track is 0.6, what is the difference in grades which either car can ascend if engine power is not the limitation? (% grade = tan 0 x 100).

4. For a motor vehicle, the rolling resistance is given by, 13.6 + 0.6965 V and the air resistance by the expression 0.0827 V^2 the resistance being in N and V the speed in km/hr. If the transmission efficiency is 88%, calculate the bkW required for a top speed of 128 km/hr. Assuming that the engine torque at 48 km/hr in top gear is 25% more than that at 128 km/hr and that the vehicle inertia corresponds to a weight of 17805 X, calculate the acceleration in m/s^2 at 48 km/hr.

5. A car of weight 13341.6 N is to be provided with an engine. The gear ratio is 3.8 : 1, the wheels are 0.61 m diameter and a transmission efficiency of 92% may be assumed. The rolling resistance on good macadam road is 13 N per 1000 N of weight and air resistance is equal to 0.06023 V^2, where V is the forward speed in km per hour. The total inertia of the car may be assumed to be equivalent to a weight of 17795.3 N. The car has to have a maximum acceleration of 0.76 m/s^2 at 56 km/hr. Calculate(i) the engine speed at 56 km/hr ;(ii) the engine power which is needed at the above speed ;(iii) the load which the car can pull on level in a trailer if the trailer weighs 4448.8 N at 54 km/hr.

6. A car weighing 12017.3 N and having a frontal area of 2.23 m^2 has to climb a hill, OR fifth gear with a maximum gradient 0.35 to 1 at 12.8 km/hr. The car has a rear axle ratio of 5:1 and wheel radius of 0.355 m. the engine of the car develops a max, torque of 133 N-m. Calculate the first gear ratio for the gear box of the car. Neglect wind resistance and take rolling resistance as 17.85 N per 1000 N weight. Assume transmission efficiency of 80%.

7. A motor vehicle of total weight 13341.6 N has road wheels of effective diameter 0.635 m. The engine can develop a max torque of 189.82 N-m and the transmission efficiency is 80%. The moment of inertia of road wheels and axles is 66.22 N-m^2 and that of the engine and flywheel is 5.89 N-m . Calculate the gear ratio required to give a maximum acceleration of 0.455 m/s up a slope of 1 in 10 with a road resistance of 311.46 N under maximum torque condition.

8. A motor car weighs 11212.8 N und the engine develops 41 bkW at 4500 rpm. The combined air and rolling resistance is given by the formula R - 40.82 + 0.0515 V^2, where R is in N and V in km/hr. The performance characteristics are such that it will reach 120.5 km per hour at 4500 r.p.m. and full throttle when engine is running in still air and at the same speed in second gear it will just climb a gradient of 1 in 10. The top and the second gear ratios are 5: 1 and 8: 1 respectively.

i) Calculate the efficiency of transmission on top and second gear. (ii) Calculate the engine power required for second gear with same efficiency of transmission as in the earlier case when climbing up the gradient of 1 in 20 at 48 km/hr.

9. What is meant by the term tractive resistance? A car weighing 14950 N is travelling up a hill of slope 1 in 25 at a speed of 35.35 km/hr. The road resistance is 11.5 N per 1000 N and there is a head wind of 12.8 km/hr. If the projected area of the car is 1.67 m^2, calculate the total power employed in propelling the car.

10. A Swiss diesel locomotive used for hauling freight has an engine bp. of 1251 kW at 3500 r.p.m. It has an adhesive weight of 1036623 N. It hauls a trailing load up a gradient of 1 in 83 at 20 km/hr. The wind resistance of the locomotive is 0.00125 V" N per 1000 N and the train resistance of the freight wagon is

1.815 + 0.083 V + 0.001545 V~ N/1000 N, where Vis the speed in km/hr. Calculate the trailing load under the above conditions

11. A lorry carrying a load of 39868 N including its own weight, is travelling up a gradient of 1 in 20 at a speed of 32 km/hr. The road resistance 23 N per 1000 N. There is a head wind blowing at 16 km/hr. Determine the power required to propel the vehicle under these conditions if the projected area is 2.8 m^2. Take the value of constant K for wind resistance as 0.03708 and the efficiency of transmission 0.85.

If the lorry is then to accelerate to attain a speed of 48 km/hr in 20 sec, find the extra power required

12. The b.p. of a vehicle is 94.2 kW at 3300 r.p.m. The total tractive resistance on low gear including gradient resistance 5395.5 N and that in the top gear is 1697 N. The diameter of the wheels is 0.9144 m and the efficiency of transmission is 75% on low gear and 85% in top gear. Calculate the gear ratio for a three speed gear box. Make a diagrammatic sketch of the arrangement

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