BITS, PILANI-DUBAI CAMPUS, ACADEMIC CITY, DUBAI
SECOND SEMESTER 2012-2013

ME C441 AUTOMOTIVE VEHICLES

COMPREHENSIVE EXAMINATION

DATE: 05-06-13

DURATION: 3 Hrs. **MAXIMUM MARKS: 40** **WEIGHTAGE: 40%**

Answer all the questions

---

1. With a layout explain the working of a pneumatic braking system. Draw the cross sectional view of brake valve and explain its working. **4**

2. a. Draw the P-θ diagram for a CI engine indicating the various stages of combustion. Indicate also the injection timing, delay period and injection duration in it. Explain how knocking takes place in CI engine.
   b. With a neat sketch explain the pre-combustion chamber and a used in CI engines. List out their merits and demerits compared to the Direct Injection chambers. **5**

3. a. Explain the different types of leaf springs used in automobiles with simple sketches.
   b. Differentiate clearly the functions of a spring and a shock absorber. Explain the construction and working of a telescopic shock absorber with the help of a neat diagram. **6**

4. With a neat diagram explain the construction and working of a hydromatic transmission system. Explain how different gear ratios are obtained in it. **5**

5. A motor car weighs 13341.5 N and has a wheel base of 2.65m. The center of gravity of the vehicle is 1.27m behind the front axle and 0.76m above the ground level. Maximum braking on all four wheels on level ground will bring the vehicle uniformly to rest from a speed of 64km/hr in a distance of 25.9m. Calculate the value of adhesion between the tyre and the road. Under the same road condition the vehicle descends from a slope of 1 in 20 and is braked on the front wheels only. Determine the load distributed between the front axle and the rear wheels and the distance required to bring the car to rest. **5**

6. Determine the size of the fuel orifice to give a 13.5:1 air-fuel ratio, if the venturi throat has a 3 cm diameter and the pressure drop in the venturi is 6.5 cm Hg. The air temperature and pressure at carburetor entrance are 1 bar and 27 °C respectively. The fuel orifice is at the same level as that of the float chamber. Take density of gasoline as 740-kg/m^3 and discharge coefficient as unity. Assume atmospheric pressure to be 76 cm of Hg and consider the compressibility of air. **5**

7. A test on a single cylinder 4 stroke oil engine having bore of 180 mm and stroke of 360 mm gave the following results. Speed = 350 rpm, brake torque = 390 N-m, IMEP = 7.2 bar, oil consumption = 3.5 kg/h, coolant flow = 270 kg/h, cooling water temperature rise = 36°C, air-fuel ratio by weight = 25, exhaust gas temperature = 500°C, room temperature = 21°C. The fuel has a calorific value 45200 kJ/kg and taking specific heat of the exhaust gases as 1.0035 kJ/kg-K and specific heat of water as 4.18kJ/kg-K, calculate Indicated thermal efficiency and Draw up a heat balance sheet in kW basis. **5**

8. A car of total mass of 1200 kg is traveling in a level road in top gear while the engine is running at 5000rpm.Crown wheel to pinion ratio is 4.3, radius of the wheel tyre is 0.3m and frontal area of the car is 2.2 m^2. Taking the coefficient of the rolling friction as 0.12 N/kg and wind resistance 0.05 N/m^2-(km/h)^2 determine the power developed by the engine to propel the car. **5**

IV yr. Mech. Engg

ME C441 AUTOMOTIVE VEHICLES

Comprehensive Exam 05-6-13 Scheme of valuation

(1) LAY out of the pneumatic System – 1½
Brake Valve Sketch – 1½
Explanation – 1

(2) PO diagram for CI combustion – 1½
Ignition – 1.
pre combustion Chamber – 1
Merits & Demerits – 1½
5

(3) Different Springs and the Explanation ½ – 3.
Spring & Shock absorber diff – 1.
Telescopic Shock absorber – 2
6

(4) Hydromatic transmission – 2½
Sketch.
Explanation for worm and diff gears – 2½
5

(5) Given $h = 0.76m$.
$b = 2.65$
$l = 2.65 - 1.27$.

$$f = \frac{v^2}{2s} = \left(\frac{64}{3.6}\right)^2 \Big/ 2 \times 25.9$$

$$f = 6.1 m/sec^2.$$

$$\mu = \frac{f}{g} = \frac{6.1}{9.81} = 0.622.$$

During skope and front wheels are braked.

$$\frac{b}{s} = \frac{\cancel{h}\cos\theta}{b - \mu h} - \sin\theta$$

$$f = 3.37 m/sec^2$$

Stopping distance = $S = \frac{V^2}{2b}$

$S = 46.9\ m$

$R_f = \frac{l \cos\theta}{b - \mu h} \times W$

$R_f = 8447.6\ kg$

$R_R = W - R_f$

$R_R = 4893.9\ kg$

---

(5) $\dot{m}_f = C_f \times A_f \times \sqrt{2 g H \rho_f}$

$\dot{m}_a = \frac{A_2 p_1}{R\sqrt{T_1}} \sqrt{2 C_p \left[\left(\frac{p_2}{p_1}\right)^{\frac{2}{\gamma}} - \left(\frac{p_2}{p_1}\right)^{\frac{\gamma+1}{\gamma}}\right]}$

$\Delta p = \frac{101.325}{76} \times 6.5$

$\Delta p = 5.67\ kN/m^2$

$p_2 = 91.33$ "

$\dot{m}_a = 0.056\ kg/sec$

$d_f = 1.59\ mm$

---

(7) a) $\eta_{IH} = \frac{IP}{FC \times CV} =$

$IP = P_{mn} \cdot LA \cdot N_c$

$= 19.24\ kw$

$\eta_{IH} = 43.5\%$

$Q = 43.54\ kw$

b) Heat Balance

i) $Q_1 = BP = \frac{2\pi NT}{60 \times 10^3} = 14.3\ kw$

$\frac{Q_1}{Q} \times 100 = 32.52\%$

ii) $FP = 4.95\ kw$

$\%$ of $Q_5 = 11.3\%$

iii) Q_3 = Heat in coolant

$\dot{m}_w C_{pw} (\Delta T)_w$

$Q_3 = 11.3\ kw$

$\%$ of $Q_1 = 25.7\%$

iv) Heat in exhaust

$\dot{m}_g C_{pg} (\Delta T)_g$

$Q_4 = 12.15\ kw$

$\%$ of $Q_4 = 27.7\%$

$Q_5 = 2.87\ kw$ $\%$ 1.26 kw

BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
SECOND SEMESTER 2012-2013
ME C441 AUTOMOTIVE VEHICLES

TEST 2 (open book) *

DATE: 05-05-13

DURATION: 50 MINUTES MAXIMUM MARKS: 20 WEIGHTAGE: 20%

*Only prescribed textbook and hand written notes are allowed

---

1. What is the use of swinging shackle, center bolt and rebound clips in leaf springs used in conventional suspension system. **3**

2. What do you mean by ignition timing? How it is changed with respect to the engine speed? **2**

3. What is octane number and klimep with respect to SI combustion? How they are related in arriving at the performance number for determining the knocking tendency of the engine. **3**

4. The air fuel ratio of a diesel engine is 30:1. If the compression ratio is 19:1 and the temperature & the pressure at the beginning of the compression are 300k and 100kPa.Find at what percentage of stroke is the combustion completed. Assume the combustion begins at the top dead center and takes place at constant pressure. Take calorific value of the fuel is 42000kJ/kg, R=0.287 kJ/kg-K and Cv= 0.709+0.000028*T kJ/kg-K. (T is in K), the index of compression n=1.3. **4**

5. In a trial on a SI engine at full speed and fully open throttle the ignition timing was 40°BTDC and the ignition delay ended 8°BTDC. Estimate the optimum spark timing for maximum power a. under full throttle conditions when the engine is operated at the half the maximum speed b. when the engine is operated at the half the maximum speed and the throttle is one third open. Assume that the combustion period should finish 15°ATDC for maximum power and the effect of two third closing the throttle at constant speed is to increase the delay period by 20% of the value at the full throttle. **4**

6. Show that the efficiency of the Diesel cycle is lower than that of the Otto cycle for the same compression ratio. Comment why the higher efficiency of the Otto cycle compared to the Diesel cycle for the same compression ratio is only of academic interest and no practical importance. **2**

7. How does the air fuel ratio affects the peak pressure and peak temperature based on the fuel air cycle analysis. **2**

****

ME C 441 Automotive Vehicles

Test (2) Open Book

Scheme of Evaluation

05-5-13

(1) Use of Swinging shackle, centre bolt and rebound clips.

$3 \times 1 = 3$ marks.

(2) Ignition timing — 1

Relation to the engine speed — 1

(3) Octane number — 1 Knock — 1 Performance No — 1

(4) ~~$T_1 = 30$~~ $A/F = 30$ $\eta_c = 19$

$T_1 = 300$ K $p_1 = 1$ bar

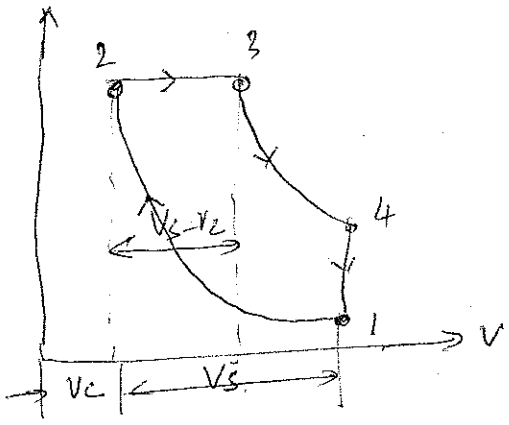
CV = 42000 kJ/kg

Sp heat = $C_v = 0.709 + 0.000028 \times T$

$R = 0.287$ $n = 1.3$

$T_2 = T_1 \eta_c^{n-1} = 300 \times 19^{0.3}$

$\boxed{T_2 = 725.7 \text{ K}}$



~~$Q = m C_p dT$~~

$Q = m \int_2^3 C_p \, dT$

$m = 1 + \frac{1}{30}$

$m = \frac{31}{30}$

$C_p = C_v + R$

$= 0.996 + 0.000028 T$

$Q = \frac{31}{30} \int_{T_2}^{T_3} (0.996 + 0.000028 T) \, dT$

$\boxed{T_3 = 2035.16 \text{ K}}$

$V_3 = \frac{T_3}{T_2} \times V_2 = \frac{2035.16}{725.7} V_2 = 2.8$

$\boxed{V_3 = 2.8 V_2}$

To find $\frac{V_3 - V_2}{V_s} = V_c \left[\frac{\frac{V_3}{V_c} - 1}{V_s}\right] \times 10$

$\eta_c = \frac{V_s + V_c}{V_c} = 1 + \frac{V_s}{V_c}$

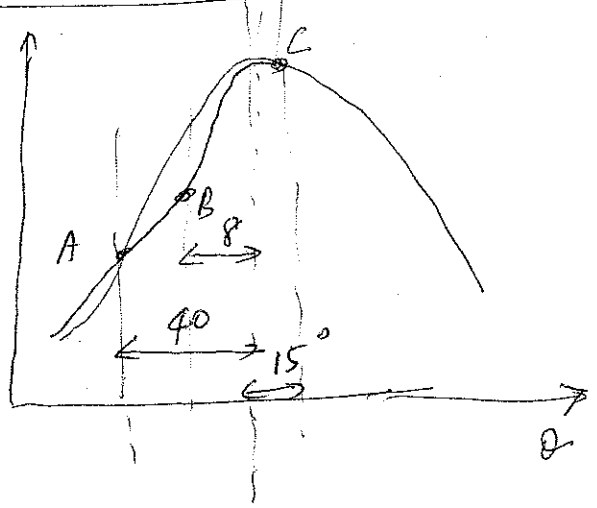
$\frac{V_s}{V_c} = \eta_c - 1$

$\equiv \frac{\frac{V_3}{V_2} - 1}{\frac{V_s}{V_c}(\eta_c - 1)}$

$= \frac{(2.8-1) \times 100}{18} = \boxed{10\%}$

(5) Delay period = $40 - 8 = 32 = AB$

Combustion period = $BC = 8 + 15 = 23$



$AB = 32$

a) full throttle half speed.

delay will be reduced to $= \frac{32}{2} = 16$

$\boxed{AB = 16}$

Hence the spark timing should be.

$= 8 + 16 = \boxed{24^\circ \text{ BTDC}}$

b) half the speed and throttle one third open.

The delay period will be increased by 20%.

Hence $= 16 + 0.2 \times 16 = 19.2^\circ$

Delay period $AB = 19.2^\circ$ BTDC

Ignition timing should be $= 19.2 + 8 = 27.2^\circ$ BTDC.

(6) $\eta_{otto} = 1 - \frac{1}{\eta_c^{\gamma-1}}$ $\eta_{Diesel} = 1 - \frac{1}{\eta_c^{\gamma-1}} \left\{\frac{1}{\gamma}\left[\frac{\rho^\gamma - 1}{\rho - 1}\right]\right\}$

for same η_c the term $\{\}$ is greater than 1, hence $\eta_{Diesel} < \eta_{otto}$

But the practical diesel engines run at a very high compression ratio

Hence this is only of academic interest.

(7) P_{max} vs F/A ratio, T_{max} vs F/A ratio $\quad 2 \times 1 = 2$ marks

BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
SECOND SEMESTER 2012-2013
ME C441 AUTOMOTIVE VEHICLES

TEST 1

DATE: 18-03-12

DURATION: 50 MINUTES MAXIMUM MARKS: 25 WEIGHTAGE: 25%

---

1. Explain Tractive effort and Total resistance of an automobile. With the help of tractive effort and Total resistance curve explain the necessity of gear box of an automobile. **4**

2. A car of total mass of 2tons is traveling at a uniform speed in an inclined road with a slope of 60deg in second gear (gear ratio = 3.5) while the engine is running at 6000rpm. Crown wheel to pinion ratio in the differential is 4. Radius of the wheel tyre is 0.4 m and the frontal area of the car is 3 m^2. Taking the coefficient of rolling friction as 0.2 N/kg and co efficient of wind resistance as 0.06 N/m^2-$(km/hour)^2$ determine the power developed by engine to propel the car. The coefficient of rolling friction between the tyre and road may be taken as 0.6. **6**

3. An epicyclic gear train has a sun wheel of 30teeth and two planet gears of 50teeth each. The planet gears mesh with the internal teeth of a fixed annulus having 120teeth. The driven shaft is connected to the arm which carries the planet wheels. The driving shaft carrying the sun wheels transmits 4kW at 300rpm.Determine the speed of the driven shaft and the torque transmitted by it considering an overall transmission efficiency of 95%. **3.5**

4. Explain the working of a constant mesh type gear box with a simple sketch. What do you mean by double-declutching? Explain how and why it is done? **5**

5. Explain the working of a centrifugal clutch with a simple sketch. **3**

6. A vehicle engine develops 8kW at 2100 rpm. Find the suitable size of a clutch plate having frictional lining riveted on both sides to transmit the power under the following conditions. a. Intensity of pressure not to exceed 49kPa, b. slip torque and losses due to wear and other causes are 30% of the engine torque. c. Coefficient of friction on contact surfaces is 0.445 and d. inside diameter of the frictional plate is half the outside diameter. **3.5**

****

IV yr. Mechanical Engg

Test 1 — ME C441 Automotive Vehicles — Date 18-3-12

① Tractive effort & Total resistance explanation — (14)
Graph — (12)
Necessity — (1)

② $m = 2000$ kg, $\eta_2 = 4$, $C_a = 0.06\ N/m^2 - (km/hr)^2$
$\theta = 60$, $r_w = 0.4$, $C_r = 0.6$
θ $\eta_1 = 3.5$, $A_f = 3m^2$
$N_e = 6000$ rpm, $C_r = 0.2\ N/kg$

TE = Total resistance = $R_g + R_s + R_a$.

$R_a = C_a A_f V^2$ V = Vehicle speed → $\frac{\pi D N_W}{60} \times 3.6$ km/hr

$R_a = 0.06 \times 3 \times 64.63^2 = 751.8$ N

$= \frac{\pi \times 0.8 \times \left(\frac{6000}{3.5 \times 4}\right) \times 3.6}{60}$ $N_W = 428.6$

$V = 64.63$ km/hr

$R_g = W \sin\theta = 2000 \times 9.81 \times \sin 60$

$R_g = 16{,}991.4$ N

$R_r = CrW = 0.2 \times 2000 \times$ ~~78~~

$R_r =$ ~~1 x 12 N~~ / 400

TE = ~~Tw~~ T_W

$T_W = \frac{18143.2}{29515.2} \times 0.4\ r_W$ (12)

$T_W =$ ~~11806.1 N-m~~ / 7257.28

~~R = 29515.2 N~~

R = 18143.2

Power at the wheels = Power at the engines

$P_E = \frac{2\pi N T_W}{60 \times 10^3}$

$= \frac{2 \times \pi \times 428.6 \times 11806.1}{60 \times 10^3}$ 7257.28

~~$P_E = 529.86$ kW~~

$P_E = 325.73$ kW

③ (12)

③ Given

$T_A = 30$

$T_D = 120$

$T_B = 50$

Speed of Sun = 300 rpm

$G_{11} = 1 + \frac{T_D}{T_A}$

$= 1 + \frac{120}{30}$

$G_{11} = 5$

Speed of arm $= \frac{300}{5} = 60$ rpm.

Power transmitted = 3.8 kW

Torque transmitted by it =

(1) (1/2)

$3.8 = \frac{2 \times \pi \times 60 \times T}{60 \times 10^3}$

$T = 604.8$ N-m → (1)

---

④ Constant mesh type gear box :- Sketch + Explanation — (3)

Double declutching — (2)

---

⑤ $P = 8$ kW

$N = 2100$ rpm

$\bar{p} = 49$ kN/m²

Slip torque = 30%

$\mu = 0.445$

$\rightarrow p r_1 = C$

$r_1 = \frac{r_2}{2}$

$P = \frac{2\pi N T}{60 \times 10^3}$

$8 = \frac{2 \times \pi \times 2100 \times T}{60 \times 10^3}$

$T = 36.38$ N-m.

Taking into account the losses

$T = 1.3 \times 36.38 = 47.29$ N-m. → (1/2)

$T = 2\pi \mu C (r_2^2 - r_1^2)$

$47.29 = 2 \times \pi \times 0.445 \times 49 \times 10^3 \times r_1 \left[4r_1^2 - r_1^2\right]$

$3r_1^3 = 3.452 \times 10^{-4}$

$r_1 = 0.049$ m.

$r_1 = 49$ mm

$r_2 = 98$ mm

→ (2)

BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
SECOND SEMESTER 2012-2013
05-03-13

ME UC441 AUTOMOTIVE MECHANICS

QUIZ 1

DURATION: 20 MINUTES MAXIMUM MARKS: 8 WEIGHTAGE: 8%

---

1. Explain the different types brake shoe arrangements in the drum brakes?

2. What are different types of brake rotors used in the disc braking system? What are the considerations based on which the type of brake rotors are chosen?

3. How the ABS system used in automobile is classified and explain the different types of ABS systems?

4. What is tandem master cylinder in hydraulic brakes and what are the advantages of it?

5. A motor car has a wheel base of 3m, the height of its CG above the ground level is 0.7m and it is 1.25m front of the rear axle. If the car is climbing up at the speed of 40km/hr on a slope of 30deg, determine the minimum distance the car may be stopped when all the wheels are braked. The coefficient of friction between the tyre and road may be taken as 0.5. Also determine the braking force applied to the front wheels alone.

6. Explain the functions of an automobile clutch and how they are classified?

7. A plate clutch has four discs on the driving shaft and three discs on the driven shaft. The outside diameter of the contact surfaces are 240mm and inside diameter is 120mm. Assuming uniform pressure and μ=0.3 find out the spring load which is pressing the plates together to transmit 30kW of power at 1800rpm.

BITS, PILANI-DUBAI, ACADEMIC CITY, DUBAI
SECOND SEMESTER 2012-2013
05-03-13
ME UC441 AUTOMOTIVE MECHANICS

QUIZ 1

DURATION: 20 MINUTES MAXIMUM MARKS: 8 WEIGHTAGE: 8%

---

1. Explain the different types brake shoe arrangements in the drum brakes?

a) Leading & trailing shoe –

b) Twin leading shoe –

c) Duo - Servo –

2. What are different types of brake rotors used in the disc braking system? What are the considerations based on which the type of brake rotors are chosen?

a) Solid rotors –
b) Slotted rotor
c) Curved Vane rotor

With cross drilled
(or) without.

They are chosen based on the strength and heat transfer capabilities.

3. How the ABS system used in automobile is classified and explain the different types of ABS systems?

A) Four channel four sensor ABS
b) Three channel Three Sensor ABS
c) One channel One sensor ABS.

4. What is tandem master cylinder in hydraulic brakes and what are the advantages of it?

Tandem master cylinder has two outlets one for rear wheels and one for front wheels. Even if one circuit leaks the other circuit will be active ensuring some braking.

$m = 1500\,kg$

5. A motor car has a wheel base of 3m, the height of its CG above the ground level is 0.7m and it is 1.25m front of the rear axle. If the car is climbing up at the speed of 40km/hr on a slope of 30deg, determine the minimum distance the car may be stopped when all the wheels are braked. The coefficient of friction between the tyre and road may be taken as 0.5. Also determine the braking force applied to the front wheels alone.

When all the wheels are braked

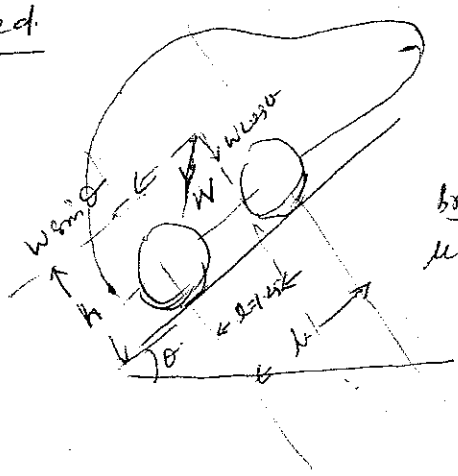
$$\frac{f}{g} = \mu\cos\theta + \sin\theta$$

$$\frac{f}{9.81} = 0.5\cos 30 + \sin 30$$

$$f = 9.153\ m/sec^2$$

$$S = \frac{u^2}{2f} = \frac{\left(\frac{40}{3.6}\right)^2}{2\times 9.153}$$

$S = 6.74\ m$



Given

$b = 3\ m \quad h = 0.7\ m$

$a = 1.25\ m$

$\mu = 0.5$

$\theta = 30°$

Braking force

μR_F –

$$R_F = \frac{W\cos\theta}{b}\left[a + \mu h\right]$$

$$= \frac{1500\times\cos 30}{3}\left[1.25 + 0.5\times 0.7\right]$$

$R_F = 692.82\ kg$

$\mu R_F = 346.4\ kg$

6. Explain the functions of an automobile clutch and how they are classified?

a) Connecting and disconnecting the engine with the rest of the transmission for smooth starting of the vehicle and gear change.

clutches

- friction
  - single plate
  - multi plate
  - centrifuge
  - semi centrifuge
- fluid coupled fluid.

7. A plate clutch has four discs on the driving shaft and three discs on the driven shaft. The outside diameter of the contact surfaces are 240mm and inside diameter is 120mm. Assuming uniform pressure and μ=0.3 find out the spring load which is pressing the plates together to transmit 30kW of power at 1800rpm.

$n_A = 4 \quad r_2 = 120 = 0.12\ m \quad \mu = 0.3 \quad n = 4+3-1 = 6$

$n_B = 3 \quad r_1 = 60 = 0.06\ m$

$$P = 30\ KW = \frac{2\pi\times 1800\times T}{60\times 10^3}$$

$T = 159.15\ N-m$

$$T = \frac{2}{3}\times\mu W\left[\frac{r_2^3 - r_1^3}{r_2^2 - r_1^2}\right]$$

$$T = \frac{2}{3}\times 0.3\times W\left[\frac{0.12^3 - 0.06^3}{0.12^2 - 0.06^2}\right] = 159.15$$

$W = 947.32\ N$