Document No : UniKL MFI_SD_AC41
Revision No: 02
Effective Date: 01 December 2008

CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION
JANUARY 2014 SESSION

SUBJECT CODE	:	**FVB21403**
SUBJECT TITLE	:	**INTERNAL COMBUSTION ENGINE**
LEVEL	:	**BACHELOR**
TIME / DURATION	:	2.5 Hours **9.00 am - 11.30 am**
DATE	:	29 MAY 2014

INSTRUCTIONS TO CANDIDATES

1. **Please read the instructions given in the question paper CAREFULLY.**
2. **This question paper is printed on both sides of the paper.**
3. **Please write your answers on the answer booklet provided.**
4. **Answer should be written in blue or black ink except for sketching, graphic and illustration.**
5. **Answer all questions in English.**

THERE ARE 4 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

INSTRUCTION: There are SIX (6) questions. Answer FOUR (4) questions only.

(Total: 100 marks)

Please use the answer booklet provided

Question 1 (25 marks)

(a) The distinctive feature of civilization today, one that makes it different from all others is the wide use of mechanical power. While transforming energy from one form to another, the conversion plays an important role.
Explain the internal combustion engine.

(5 marks)

(b) In the field of working cycles of internal combustion engine, differentiation is made between four-stroke and two-stroke processes.
Explain the four-stroke and two-stroke process.

(10 marks)

(c) According to the cycle of operation, explain how to classify the heat addition to the internal combustion engine.

(10 marks)

Question 2 (25 marks)

(a) An engine operates on Otto cycle between pressure 1 bar and 30 bar. The ratio of pressure at constant volume is 4. The temperature at the end of compression is 200 ^{0}C and the law of compression and expansion is $PV^{1.3}$=constant. If the engine now operates on Carnot cycle for the same range of temperature, solve the efficiency of the cycle.

(10 marks)

(b) An internal combustion engine works on Diesel cycle with a compression ratio of 8 and expansion ratio of 5. Solve the air standard efficiency. Assume γ=1.41.

(15 marks)

Question 3 (25 marks)

(a) Distinguish clearly between 'OCTANE NUMBER' and 'CETANE NUMBER'.

(5 marks)

(b) A gasoline fuel is generated by blending 5 % by weight of butane-1, 80 % triptane, and 15 % isodecane.

Determine:

(i) Research Octane Number (RON).

(5 marks)

(ii) Motor Octane Number (MON).

(5 marks)

(iii) Anti Knock Index (AKI).

(5 marks)

(iv) Performance Number (PN).

(5 marks)

(You can use the data from the table below to answer the question)

TABLE PROPERTIES OF FUELS

Fuel		Molecular Weight	Heating Value HHV (kJ/kg)	Heating Value LHV (kJ/kg)	Stoichiometric $(AF)_s$	Stoichiometric $(FA)_s$	Octane Number MON	Octane Number RON	Heat of Vaporization (kJ/kg)	Cetane Number
gasoline	C_8H_{15}	111	47300	43000	14.6	0.068	80–91	92–99	307	
light diesel	$C_{12.2}H_{22.2}$	170	44800	42500	14.5	0.069			270	40–55
heavy diesel	$C_{14.6}H_{24.8}$	200	43800	41400	14.5	0.069			230	35–50
isooctane	C_8H_{18}	114	47810	44300	15.1	0.066	100	100	290	
methanol	CH_3OH	32	22540	20050	6.5	0.155	92	106	1147	
ethanol	C_2H_5OH	46	29710	26950	9.0	0.111	89	107	873	
methane	CH_4	16	55260	49770	17.2	0.058	120	120	509	
propane	C_3H_8	44	50180	46190	15.7	0.064	97	112	426	
nitromethane	CH_3NO_2	61	12000	10920	1.7	0.588			623	
heptane	C_7H_{16}	100	48070	44560	15.2	0.066	0	0	316	
cetane	$C_{16}H_{34}$	226	47280	43980	15.0	0.066			292	100
heptamethylnonane	$C_{12}H_{34}$	178			15.9	0.063				15
α-methylnaphthalene	$C_{11}H_{10}$	142			13.1	0.076				0
carbon monoxide	CO	28	10100	10100	2.5	0.405				
coal (carbon)	C	12	33800	33800	11.5	0.087				
butene-1	C_4H_8	56	48210	45040	14.8	0.068	80	99	390	
triptane	C_7H_{16}	100	47950	44440	15.2	0.066	101	112	288	
isodecane	$C_{10}H_{22}$	142	47590	44220	15.1	0.066	92	113		
toluene	C_7H_8	92	42500	40600	13.5	0.074	109	120	412	
hydrogen	H_2	2	141800	120000	34.5	0.029		90		

Question 4 (25 marks)

(a) The difference between Indicated Power (IP) and Brake Power (BP) is known as total friction loss.

Explain:

(i) Direct Frictional Losses.

(3 marks)

(ii) Pumping Loss.

(3 marks)

(iii) Blow by Losses.

(3 marks)

(iv) Valve Throttling Losses.

(3 marks)

(v) Combustion Chamber Pump Loss

(3 marks)

(vi) Power loss to drive the Auxiliaries

(3 marks)

(b) Theoretically, the frictional force equal to zero at TDC and BTC. Give the reason.

(3 marks)

(c) The wear on the cylinder walls are not the same along the length of the cylinder. Give the reason.

(4 marks)

Question 5 (25 marks)

(a) In a test of a four cylinder, four-stroke petrol engine of 75 mm bore and 100 mm stroke, the following result were obtained at full throttle at a constant speed and with a fixed setting of the fuel supply of 0.082 kg/min.

Bp with all cylinders working = 15.24 kW
Bp with cylinder number 1 cut-off = 10.45 kW
Bp with cylinder number 2 cut-off = 10.38 kW
Bp with cylinder number 3 cut-off = 10.23 kW
Bp with cylinder number 4 cut-off = 10.45 kW

Estimate the indicated power of the engine under these conditions.

(15 marks)

(b) A four cylinder, four stroke spark ignition engine has a bore of 80 mm and stroke of 80 mm. The compression ratio is 8.

Calculate:

(i) The capacity of the engine. (3 marks)

(ii) The clearance volume. (3 marks)

(iii) Justify the type of engine. (4 marks)

Question 6 (25 marks)

(a) Explain the way a vehicle must overcome to stay in motion for the tractive force in term of:

(i) Aerodynamic drag. (5 marks)

(ii) Rolling resistance. (5 marks)

(iii) Inertial force. (5 marks)

(b) **Figure 1** shows a graph of brake power against engine speed for a petrol engine.

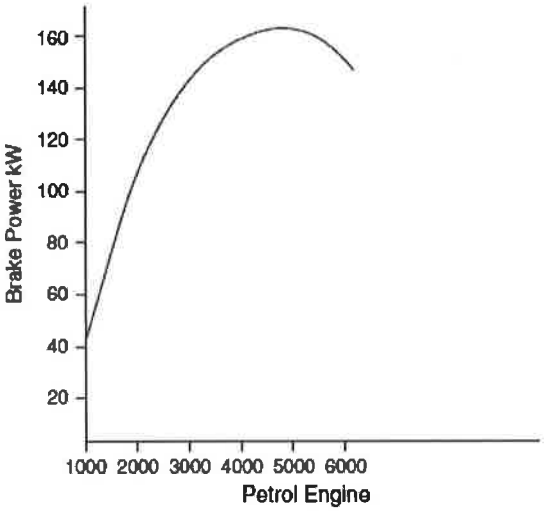

Figure 1

Based on the **Figure** shown:

(i) Justify the reason for the graph does not start at zero.

(5 marks)

(ii) Describe the reason why the power does not increase in direct proportion to the engine speed.

(5 marks)

END OF QUESTIONS