PETROLEUM REFINERY ENGINEERING
(CHEN 4132)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) Which property of crude oil and petroleum products determine their volatility?
(a) API gavity (b) Reid Vapor Pressure
(c) Smoke Point (d) Aniline Point

(ii) RON measurement is carried out in an engine running at
(a) 600 rpm (b) 900 rpm
(c) 800 rpm (d) 400 rpm

(iii) Aniline point test of an oil qualitatively indicates the _____ content of oil
(a) Paraffin (b) Olefin
(c) Aromatic (d) Naphthene

(iv) The residence time in the riser of the FCC is around
(a) 30 min (b) 2-5 s
(c) 30-40 s (d) 15 min

(v) The equipment which separates the catalyst dust from the oil vapour in an FCC is called
(a) Bag filter (b) Reactor
(c) Electrostatic precipitator (d) Cyclone separator

(vi) The principal catalyst for Alkylation is
(a) Alumina (b) Zeolite
(c) HCl (d) HF

(vii) Which undesirable reaction occurs during the Isomerization process?
(a) Cyclisation (b) Hydrocracking
(c) Hydrogenation (d) Dehydrogenation

(viii) The main constituents of polymer gasoline are
(a) Aromatics (b) Naphthenes
(c) Iso-paraffins and iso-olefins (d) n- paraffins

(ix) For solvent extraction, the solvent used is
(a) Xylene (b) NMP
(c) Ethyl alcohol (d) Toluene

(x) Hydrogen produced from fossil fuels with CCUS use is called
(a) Green hydrogen (b) Blue Hydrogen
(c) Grey Hydrogen (d) Turquoise Hydrogen

Fill in the blanks with the correct word

(xi) Among paraffins, naphthenes and aromatics, _____ have the lowest Octane number.

(xii) The vacuum in a VDU is achieved by a _____.

(xiii) _____ joints are used for preventing Hydrogen leakage in hydrocrackers.

(xiv) For producing needle coke, the residence time has to be _____ hours.

(xv) Presence of aromatics in LOBS causes _____.

Group - B

2. (a) A crude oil sample is subjected to distillation at 1 atm and subsequently at 40 mm Hg. At 1 atm, a fraction of the sample which boils at 265°C has a specific gravity of 0.84 (measured at 15°C). At 40 mm Hg, a fraction of the sample which boils at 280°C has a specific gravity of 0.96. Determine the nature of the crude oil.
[(CO1)(Apply/IOCQ)]

(b) Why RON is used for measuring the knocking characteristics of gasoline during driving in cities? *[(CO1,3)(Analyse/IOCQ)]*

(c) Which compounds should be primarily present in diesel for good ignition?
[(CO1)(Understand/LOCQ)]

6 + 3 + 3 = 12

3. (a) A Gasoline mixture is formed by mixing different types of compounds as provided in the following table. Determine the requirement of n-butane to make this gasoline with Reid vapour pressure (RVP) of 10. The RVP and molecular weight of n-butane are 52 and 48 respectively.

Base stock	LSR Gasoline	Reformate	Alkylate	FCC gasoline
BPD	4000	6000	3000	8000
Lb/hr	39320	69900	30690	87520
MW	86	115	104	108
Mol/hr	457	617	295	810
Mol%	21	28.4	13.4	37.2
RVP,psi	11.1	2.8	4.6	4.4
PVP, psi	2.32	0.80	0.62	1.64

[(CO1)(Apply/IOCQ)]

(b) Distinguish between electrical desalting unit and stabilization process of crude oil. *[(CO2,3)(Analyse/IOCQ)]*

(c) Explain the vacuum distillation column with the help of neat sketch. List various products obtained from VDU unit. *[(CO2)(Understand/IOCQ)]*

5 + 2 + 5 = 12

Group - C

4. (a) A soaker visbreaker reduces the fuel cost for a furnace compared with the coil visbreaker. Justify. *[(CO4)(Evaluate/HOCQ)]*
   (b) Why is the feed to the delayed coker unit introduced directly to the bottom of the main fractionator? *[(CO4)(Analyse/IOCQ)]*
   (c) What are the objectives of delayed coking? *[(CO4)(Remember/LOCQ)]*

4 + 4 + 4 = 12

5. (a) What is smoke point? Which component is responsible for lowering the smoke point? Briefly explain the dearomatisation of kerosene with a help of neat flow sheet. *[(CO2,4)(Understand/IOCQ)]*
   (b) What are the additives added in petrol to improve its fuel qualities? *[(CO2)(Remember/LOCQ)]*

(2 + 1 + 6) + 3 = 12

Group - D

6. (a) In a two stage hydrocracker, amine scrubbing is used for the recycle gas from the first stage but not for that from the second stage. Why? *[(CO3,4)(Analyse/IOCQ)]*
   (b) If the pressure let-down valve before the low pressure separator in a 2-stage hydrocracker malfunctions, what will be the potential problems? *[(CO4)(Evaluate/HOCQ)]*
   (c) What type of control strategy will you choose as an engineer to control the temperature in a hydrocracker bed? Justify your choice. *[(CO4)(Evaluate/HOCQ)]*

4 + 4 + 4 = 12

7. (a) Why the feed to the alkylation unit needs to be dehydrated? *[(CO4)(Analyse/IOCQ)]*
   (b) An engineer selects the Isobutane/Olefin ratio for an alkylation unit to be 1.8. Is her/his selection practical? Justify. *[(CO4)(Evaluate/HOCQ)]*
   (c) Between HF and H_2SO_4, which one is more suitable as an alkylation catalyst and why? *[(CO2,4)(Analyse/IOCQ)]*

4 + 4 + 4 = 12

Group - E

8. (a) What are the properties of LOBS that are improved by dewaxing? *[(CO2,4)(Analyse/IOCQ)]*
   (b) How is propane deasphalting carried out? *[(CO2,4)(Understand/LOCQ)]*
   (c) Why do we need to remove aromatics for the production of LOBS? *[(CO2,4)(Analyse/IOCQ)]*

4 + 4 + 4 = 12

9. (a) What are the driving factors behind the push for refinery-petrochemical integration? *[(CO3,4)(Analyse/IOCQ)]*

(b) A recent trend of Indian refineries is to set up green hydrogen plants in each refinery. Discuss the reasons. *[(CO3,4)(Analyse/IOCQ)]*

6 + 6 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	14.58	68.75	16.67