

Name:
SAP ID:



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, July 2020

Course: Well Stimulation
Program: B.Tech (APE upstream)
Course Code: PEAU3007
No. of Pages: 12

Semester: 6th
Time: 03 hrs.
Max. Marks: 100

Instructions:

1. Neat diagrams must be drawn wherever necessary
2. Use a non-programmable calculator
3. In MCQs, only one option is correct

Note:

1. Read the instruction carefully before attempting.
2. This question paper has two section, Section A and Section B.
3. There are total of seven questions in this question paper. One in **Section A** and six in **Section B**
4. **Section A** consist of multiple choice based questions and has the total weightage of 60%.
5. **Section A** will be conducted online on BB Collaborate platform
6. **Section B** consist of long answer based questions and has the total weightage of 40%.
7. The maximum time allocated to **Section A** is two Hrs.
8. **Section B** to be submitted within 24 hrs from the scheduled time (*exceptional provision due extraordinary circumstance due to COVID-19 and due to internet connectivity issues in the far-flung areas*).
9. No submission of **Section B** shall be entertained after 24 Hrs.
10. **Section B** should be attempted after **Section A**
11. **The section B** should be attempted in blank white sheets (hand written) with all the details like programme, semester, course name, course code, name of the student, Sapid at the top (as in the format) and signature at the bottom (right hand side bottom corner)

SECTION A (Attempt all the questions)
(60 × 1 marks)

Q1. Attempt following multiple choice questions: - (CO3)

i. In cationic surfactants, cations will normally:

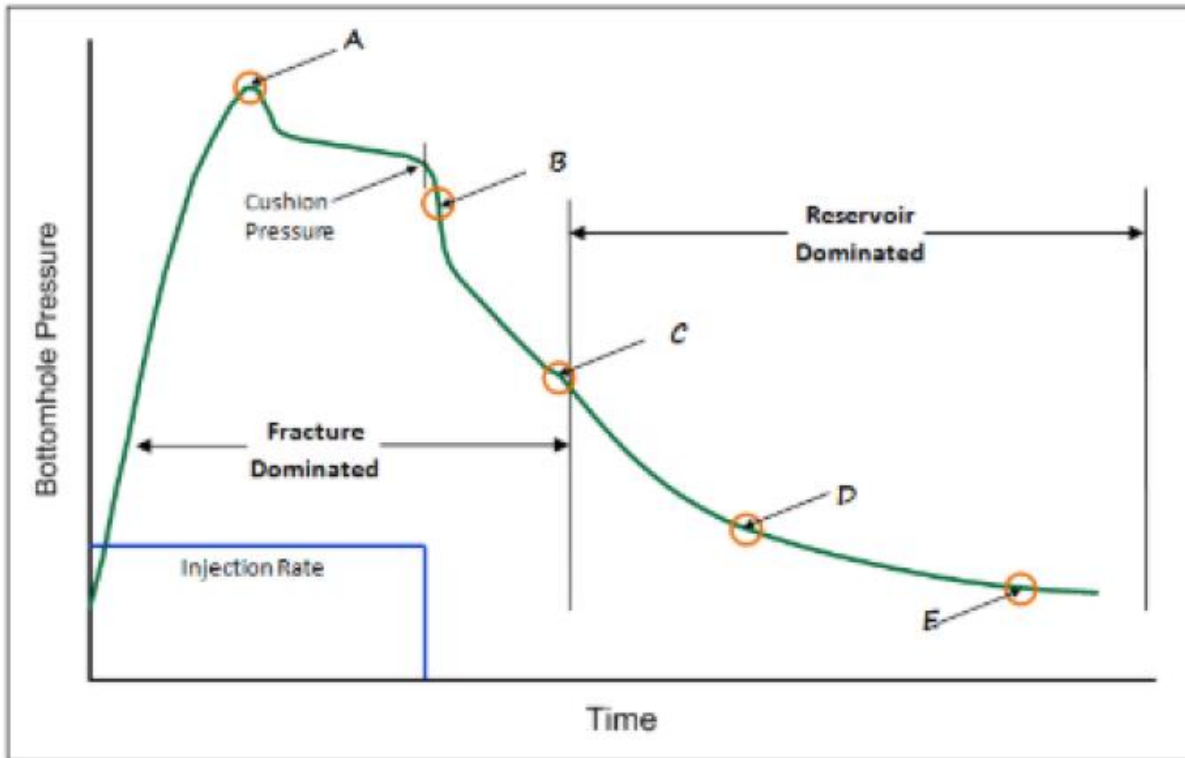
- a) Emulsify water in oil b) Disperse clays or fines in oil c) Flocculate clays in water d) All of the above

ii. Which of the following acid is not used in well stimulation

- a) Formic acid
 - b) Acetic
 - c) Sulfamic acid
 - d) Sulphuric acid
- iii. The consequences of chemical incompatibility of chemicals used in acidization will be
- a) Formation damage
 - b) Formation fracture
 - c) Tremendous increase in pressure
 - d) All of the above
- iv. While pumping acid in to the formation during acidization , acid can penetrate inside the formation up to the length of
- a) 4 ft.
 - b) 20 ft.
 - c) 100 ft.
 - d) Up to the drainage radius of the reservoir
- v. Which of the following acid is suitable for the treatment of carbonate reservoir
- a) Hydrofluoric acid
 - b) Hydrochloric acid
 - c) Formic acid
 - d) Mud acid
- vi. Ethylene diamine tetra acetic acid is a chemical used in oil industry
- a) As a Chelating agents to prevent the precipitation of damaging compounds.
 - b) As a chelating agents for stimulation treatments
 - c) To treat or remove scale in reservoir drilling fluids.
 - d) All of the above
- vii. Mud acid is used for acid job in
- a) Sand stone reservoirs
 - b) Carbonate reservoir
 - c) Both sand stone and carbonate reservoirs
 - d) None of the above
- viii. Maximum concentration of hydrochloric acid used in acidization is
- a) 5 %
 - b) 10%
 - c) 15%
 - d) 40%
- ix. Find the statement that is not correct. The acidization in a well bore is done
- a) To dissolve and/or disperse materials near the wellbore that impair well production
 - b) To create new, unimpaired flow channels between the wellbore and formation.

- c) To increase the permeability of the formation
- d) None of the above

x. In the figure below the point of formation breakdown pressure is is



Typical pressure behaviour of mini frac tests

- a) point A
- b) point B
- c) point C
- d) point D

xi. The three stresses acting on a rock at a depth of 3500 ft. are σ_v , σ_{Hmax} and σ_{Hmin} . Given the order of stresses are $\sigma_v > \sigma_{Hmax} > \sigma_{Hmin}$. The fracture direction will be

- a) normal to the σ_{Hmin}
- b) normal to the σ_v
- c) normal to the σ_{Hmax}
- d) None of the above

xii. The standard techniques of conveying perforating guns include

- a) Tubing Conveyed Perforation
- b) Through Tubing Perforation
- c) Through casing perforation
- d) Above all

- xiii. It is a type of formation in which acid can be used to create linear fracture systems by itching hydraulically created fractures. Identify the formation type.
- a) limestone
 - b) shale
 - c) sandstone
 - d) Coal
- xiv. Which of the following well stimulation technique is performed below the fracture pressure of the formation?
- a) Matrix acidizing
 - b) Fracture acidizing
 - c) Hydraulic fracturing
 - d) None
- xv. Which of the following does not comes under design consideration of hydraulic fracturing job?
- a) fracture geometry
 - b) selection of fracturing fluid and proppant
 - c) fracture density
 - d) fracture conductivity
- xvi. Fracture geometry created by hydraulic fracturing depends upon
- a) Fracturing flood types
 - b) volumes of flood pumped
 - c) Formation characteristics
 - d) Above all
- xvii. Which of the following is not a reason of hydraulic fracturing?
- a) To extend a conductive path deep into a formation and thus increase productivity / injectivity beyond the natural level.
 - b) To bypass near-wellbore damage and return a well to its 'natural' productivity/ injectivity.
 - c) To produce hydrocarbons from tight formations.
 - d) None
- xviii. Which of the following is INCORRECT about packer?
1. Always supports full weight of the tubing.
 2. Provides seal between surface valve and flow line.
 3. Prevent downhole movement of casing strings.
- a) 2 Only
 - b) 1 & 2 only
 - c) 1, 2 & 3 all
 - d) 2 & 3 only
- xix. For an effective hydraulically-fractured well, the skin factor would GENERALLY be
- a) Negative
 - b) Positive
 - c) Zero

d) Indeterminate

- xx. _____ is opening of new channels in the rock for oil and gas to flow through easily.
Well stimulation
Well glancing
Formation evaluation
Well cleaning
- xxi. The term _____ is generally used when referring to remedial operations where the well is killed, the Christmas tree is removed and a blowout preventer is installed.
a) Well intervention b) workover c) well cleaning d) well stimulation
- xxii. _____ is installed at the lower end of the tubing. Its purpose is to guide wireline tools into the tubing and prevent them being stuck.
a) Blast joint b) landing nipple c) wireline entry gauge d) sleeve
- xxiii. _____ is abrasive, it can damage downhole tubulars and associated equipment, and it can damage the production pipework and equipment on surface.
a) proppant b) sand c) mud acid d) none of the above
- xxiv. Function of swab valve present on a christmas tree is
a) To enable kill fluid to be pumped down the well b) To allow the well to flow c) To allow access for well intervention and workover operations d) To isolate the well
- xxv. _____ is the simplest form of well intervention, as it does not involve putting hardware into the well itself.
a) Pumping b) wireline c) coiled tubing unit d) snubbing
- xxvi. _____ is very often used for N₂ injection for well activation, especially for deviated wellbores.
a) Pumping b) wireline c) coiled tubing unit d) snubbing
- xxvii. _____ is used for more heavy-duty remedial operations such as fishing stuck tools.
a) slickline b) braided wireline c) electric wireline d) None of the above
- xxviii. _____ is a primary barrier in a coiled tubing unit and is designed to provide a pressure seal around a coiled tubing unit when it is being run into or pulled out of a live well.
a) BOP stack b) stripper c) lubricator d) downhole safety valve
- xxix. _____ is a downhole tool that is located and set to isolate the lower part of the wellbore. It may be permanent or retrievable, enabling the lower wellbore to be permanently sealed from production or temporarily isolated from a treatment conducted on an upper zone.

a) Flow couplings b) bridge plug c) liner d) sliding sleeve

xxx. Which among the following is a typical remedy for very high viscous crude oil (>200 cP) causing serious flowing and pumping problems.

- a) Thermal stimulation (e.g. Steam injection)
- b) Installation of bottom hole heater
- c) Mixing with lighter crude
- d) All of the above

xxxii. Which of the following statements is true about water coning

- 1. Vertical upward movement of water in a producing formation due to large pressure drawdown
 - 2. May be severe in low vertical permeability reservoirs
 - 3. Once established, may become relatively stable due to the increased relative permeability to water
- a) 1 only b) 1 and 3 only c) 1,2 and 3 d) 2 and 3 only

xxxiii. Perforations are normally performed in _____ condition

- a) overbalanced b) underbalanced c) both a and b d) none of the above

xxxiiii. Consider following two statements.

- 1. The characteristic that makes shales most troublesome to drillers is its water sensitivity, due in part to its clay content and the ionic composition of the clay.
- 2. For this reason, oil-base drilling fluids are the mud of choice to drill the most water-sensitive shales.

- a) Both 1 and 2 are incorrect b) Only 1 is correct c) Only 2 is correct d) Both 1 and 2 are correct

xxxv. Which log is run to correlate the perforation location depth with the initial log run on the well?

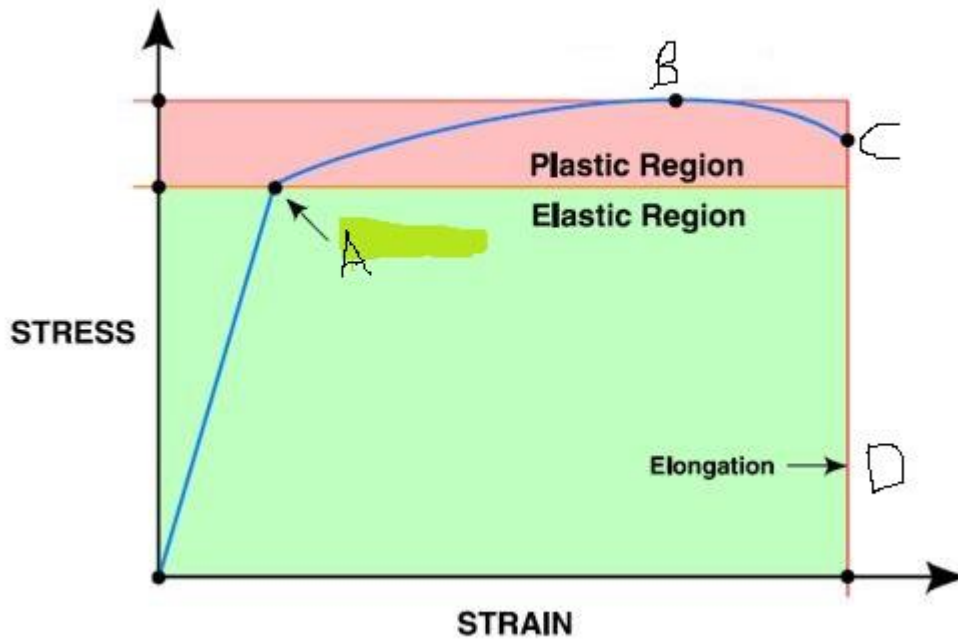
- a) Calliper log b) gamma ray log c) gamma ray & CCL log d) Casing collar correlator log

xxxvi. CCL tool comprises a _____ device that senses the increase in metal mass at casing or tubing collars.

- a) electric b) photonic c) magnetic d) nano-coated

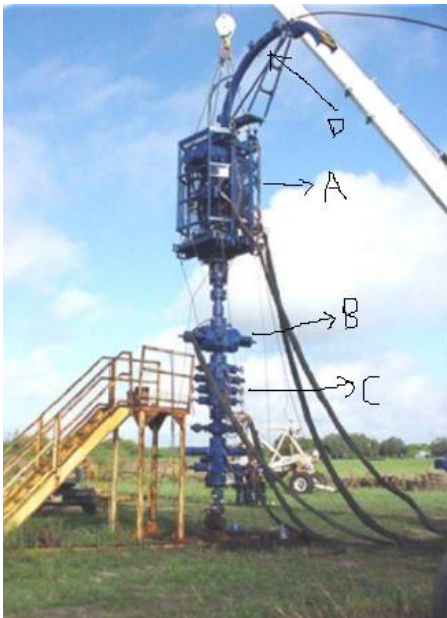
xxxvii. In the figure below the point of breaking strength is

Stress / Strain Diagram for CT pipe



- a) Point A b) Point B c) Point C d) Point D

xxxvii. In the figure below stripper is represented as



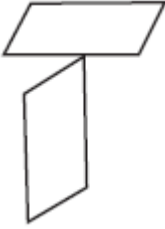
- a) Point A b) Point B c) Point C d) Point D

xxxviii. The final performance of the shape charge is largely dictated by the _____
a) main explosive charge b) outer case c) primer cord d) liner

xxxix. Clay type having maximum tendency of migration is
a) Smectite b) Kaolinite c) Chlorite d) none of the above

xl. Fines can include different materials such as clays (phyllosilicates smaller than ___ microns) and silts (silicates or aluminosilicates with sizes ranging from _____ microns)
a) 8 and 8 to 64 b) 16 and 16 to 256 c) 4 and 4 to 64 d) 5 and 5 to 125

xli. As shown in the figure, the edge to face association of clay particles is known as



- a) flocculation
- b) deflocculation
- c) dispersion
- d) aggregation

xlii. The value of fracture flow capacity of a finite fracture is 10,000 mD-ft. Calculate the dimensionless fracture conductivity, if formation permeability is 0.2 mD. and fracture half-length is 100 ft.

- a) 200
- b) 400
- c) 300
- d) 500

xliii. A hydraulic fracturing job has to be performed on a 14,400 ft. deep sandstone reservoir. The injection rate of fracturing fluid is 14 bpm of 40-lb/1000 gal zirconate- crosslinked fluid, and the density is 60 lb/ft³. Calculate the wellhead treating pressure (in psi) if the expected fracture breakdown pressure is 9200 psi and frictional pressure drop is 2000 psi.

- a) 5900
- b) 5200
- c) 17200
- d) 6200

xliv. The pore pressure and fracture gradient of petroleum formation at a depth of 4,000 ft. are 9 ppg and 0.75 psi/ft. respectively. The overburden pressure gradient is 0.9 psi/ft. If the pore pressure declines to 8 ppg after a few years of production, calculate the reduced fracture pressure of the formation in psi?

- a) 3926
- b) 2926
- c) 4926

d) 5926

xliv. A sandstone with a porosity of 22 % containing 15 vol.% calcite (CaCO_3) is to be acidized with HF/HCl mixture solution. A preflush of 16 wt.% HCl solution is to be injected ahead of the mixture to dissolve the carbonate minerals and establish a low pH environment. If the HCl preflush is to remove all carbonates in a region within 1.5 ft beyond a 0.328-ft radius wellbore before the HF/HCl stage enters the formation, what minimum preflush volume is required in terms of gallon per foot of pay zone?

Following data is given:

Molecular weight of calcite = 100.1 lb/mol

Molecular weight of HCl = 36.5 lb/mol

Density of calcite = 169 lb/ft³

Specific gravity of HCl = 1.07

- a) 70
- b) 80
- c) 111
- d) 90

xlvi. The sample reaction between hydrochloric acid (HCl) and Calcite (CaCO_3) is given as
 $2\text{HCl} + \text{CaCO}_3 \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2$

For the reaction between 100% HCl and Calcite calculate gravimetric dissolving power of acid.

Assume molecular weight of calcite = 100.1 gm/mole and molecular weight of HCl = 36.5 g/mole.

- a) 0.37
- b) 1.37
- c) 0.083
- d) 2.37

xlvii. A fracture's area evolves according to a Power Law model with exponent 2/3 (KGD model; opening time distribution factor is = 1.478). The leakoff coefficient is 0.001 ft/min^{0.5} and the pumping time is 40 min. Calculate the width lost because of leakoff in millimeter.

- a) 8.7
- b) 7.7
- c) 6.7
- d) 5.7

xlviii. Out of the following, which pressure is the highest in a flowing well

- a) Well head tubing pressure
- b) Flowing bottom hole pressure
- c) Static bottom hole pressure
- d) None of the above

xlix. Assume that a 100-ft sandstone formation is 8000 ft. deep. The formation density is 172.8 lb/ft³, the poroelastic constant is 0.82 and the Poisson ratio is 0.25. Calculate the absolute vertical stress gradient in psi/ft.

- a) 2.2

- b) 1.2
- c) 3.2
- d) 4

l. A sandstone at a depth of 5000 ft has a Poisson's ratio of 0.25 and a poroelastic constant of 0.71. The average density of the overburden formation is 170 lb/ft³. The pore pressure gradient in the sandstone is 0.35 psi/ft. Assuming a tectonic stress of 1500 psi and a tensile strength of the sandstone of 1,000 psi. Calculate the maximum horizontal stress (psi) at a depth of 5000 ft.

- a) 7296
- b) 5296
- c) 6296
- d) 4296

li. A production well of TVD 3000 ft. having oil with density 7 ppg is shut - in for routine workover job. The shut - in pressure at the surface is 400 psi. The density of mud required to kill the well will be _____ ppg.

- a) 9.5
- b) 15.5
- c) 14
- d) 12

lii. Calculate the skin factor resulting from the invasion of the drilling fluid to a radius of 2.5 ft. The permeability of the skin zone is estimated at 0.30 m² as compared with the unaffected formation permeability of 0.60 m². The wellbore radius is 0.25 ft.

- a) Log 10
- b) Ln 10
- c) Log 1
- d) Ln 1

liii. An oil well has been stimulated and effective well bore radius is reported to be twice of well bore radius. If the drainage radius is 700 ft. and well bore radius is 0.5 ft.; calculate the absolute value of skin after stimulation.

- a) 0.69
- b) -0.69
- c) 0.5
- d) -0.5

liv. To forcibly pump fluids into a formation, usually formation fluids that have entered the wellbore during a well control event is called

- a) Pumping
- b) Bullhead
- c) Snubbing
- d) Stripping

- iv. Clay type having maximum tendency of swelling when in contact with water is
a) Smectite b) Kaolinite c) Chlorite d) Illite
- lvi. A workover job was performed in a well with steel pipe in which the packer is set at a depth of 10,000 ft. Following data are given:

Surface temperature= 140° F
Bottom hole temperature= 410° F
Thermal expansion Co-efficient of steel = 7.5×10^{-6} (°F⁻¹)
After the workover job was completed, BHT reduced to 400 °F, whereas the surface temperature remained same. Calculate the change in length of the pipe (in feet) after the workover job.
a) 9
b) 12
c) 1
d) 0.75
- lvii. Which flow pattern is expected if the entire zone of interest is perforated?
a) Radial
b) Linear
c) Spherical
d) Both a & b are possible
- lviii. Tortuosity is
a) A measure of deviation from a straight line.
b) Used by drillers to describe wellbore trajectory,
c) Used by reservoir engineering to describe reservoir Characteristic
d) Both a & b
- lix. Undersized tubing will result in
a) Higher wellhead pressure than optimum
b) Higher bottom-hole pressure than optimum
c) Lower bottom-hole pressure than optimum
d) Need more information
- lx. Which of the following can be used as shaped charge explosive for perforation operation.
a) Octogen
b) Picrylaminodinitropyridine
c) Trinitrotoluene (TNT)
d) All of the above

SECTION B (4 x 10 = 40 marks)

Q 2	Draw and explain in detail surface read out of pressure variation during hydraulic fracturing job on a pressure vs. time plot	10	CO3
Q 3	Discuss the stages involved in acidization of sandstone reservoir.	10	CO1
Q 4	Define scale. Discuss the mechanism of scale formation and their detection and removal techniques.	10	CO2
Q 5	a. Elaborate about acid additives used during the acidization process. b. State the primary and secondary barriers during drilling, production and well intervention operations.	10	CO5