



Roll No.

**PRESIDENCY UNIVERSITY
BENGALURU**

SCHOOL OF ENGINEERING

TEST 1

Sem & AY: Odd Sem. 2019-20

Course Code: PET 213

Course Name: PETROLEUM PRODUCTION ENGINEERING

Program: B.Tech. (PET) & V

Date: 27.09.2019

Time: 02:30PM to 03:30PM

Max Marks: 40

Weightage: 20%

Instructions:

- (i) All questions are compulsory.
- (ii) Assume the missing values (if any).

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries five marks. (5Qx2M=10M)

1. Define productivity index and specific productivity index. (C.O.NO. 1) [Knowledge]
2. Determine the effective stroke length for a SRP system with surface stroke length 60 inch and extension data as given- (C.O.NO. 2) [Knowledge]
Et = 3.2 inch
Ep = 10.25 inch
Er = 12.5 inch
3. During oil and gas production, sonic flow of fluid through the choke is preferred. Why? (C.O.NO.1) [Knowledge]
4. What are artificial lift techniques? Name any 3 artificial lift technique. (C.O.NO.2) [Knowledge]
5. Write the function of any 2 of the following SRP components -
a) Prime mover b) Gear reducer c) Walking beam and horsehead (C.O.NO.2) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries five marks. (4Qx5M=20M)

6. A well is producing from a reservoir with average reservoir pressure 2500 psig. The stabilized flow test data indicate wellbore flowing pressure to be 1950 psig and stabilized flow rate to be 450 stb/d. (C.O.NO1) [Application]
- a) Find the productivity index of the well. [2.5M]
 - b) Another well, in the same reservoir, is having productivity index of .35 stb/d/psi. The provided data is not sufficient for comparing the performance of 2 wells. State an appropriate reason for this. [2.5M]
7. A well is producing from a reservoir, at depth of 8000 ft, using a SRP pump system. The plunger area for the SRP system is 1.8 sq inch. The surface stroke length and pumping speed is 48 inch and 25 spm respectively. (C.O.NO2) [Application]
- a) Find the flow rate for the given system if effective stroke length is 45 inch. [3M]
 - b) What will be the actual flow rate if efficiency of the provided system is 80%? [2M]
8. A SRP pump considered as a type of positive displacement pump. Explain this statement using working mechanism of SRP pump. [5M]
- (C.O.NO.2) [Comprehension]
9. A well is producing from a saturated reservoir with average reservoir pressure 3000 psig. The stabilized wellbore flowing pressure was recorded to be 2400 psig for the stabilized flow rate of 450 stb/d. Using vogels method determine the following –
- a) $Q_{o\ max}$ [2.5M]
 - b) Flow rate at 2000 psig [2.5M]
- (C.O.NO.1) [Application]

Part C [Problem Solving Questions]

Answer the Question. Each Question carries ten marks. (1Qx10M=10M)

10. Zero draw down condition is defined as one in which the well bore flowing pressure is equal to reservoir pressure. Using standing's method for IPR determination, derive the productivity index equation for zero draw down condition. [10M]
- (C.O.NO.1) [Application]



SCHOOL OF ENGINEERING

Semester: V

Course Code: PET 213

Course Name: Petroleum Production Engg.

Date: 27/09/2019

Time: 02:30PM to 03:30PM

Max Marks: 40

Weightage: 20

Extract of question distribution

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C/A			A			
1	1	1	1+1	=	2							2
2	2	2	2	=	2							2
3	1	1	2	=	2							2
4	2	2	2	=	2							2
5	2	2	1+1	=	2							2
6	1	1				2.5+2.5	=	5				5
7	2	2				3+2	=	5				5
8	2	2				5	=	5				5
9	1	1				2.5+2.5	=	5				5
10	1	1							2.5+2.5	=	10	10
	Total Marks				10			20	5+5		10	40



SCHOOL OF ENGINEERING

SOLUTION

Semester: V

Course Code: PET 213

Course Name: Petroleum Production Engineering

Date: 27/09/2019

Time: 2:30 PM to 3:30 PM

Max Marks: 40

Weightage: 20

Part A

(5 x 2 = 10)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	<p>Productivity Index- It is a commonly used measure of the ability of the well to produce, mathematically defined as ratio of the total liquid flow rate to the pressure drawdown.</p> <p>Specific productivity Index- It is used to compare performance of two wells producing from same reservoir. It is mathematically defined as ratio of productivity index and reservoir thickness.</p>	1+1	3 min
2	$S_p = S + E_p - E_T - E_R$ $= 60 + 10.25 - 3.2 - 12.5$ $= 54.55 \text{ inch}$	2	3 min
3	During sonic flow of oil and gas through choke, the pressure upstream the choke is not affected by downstream pressure disturbance. This ensures a constant flow rate from the well. Thus during production of oil and gas sonic flow of fluid is preferred.	2	3 min
4	Production techniques used to maintain a constant low bottom hole flowing pressure. This helps to produce from a low energy reservoir or increase the production flow rate.	2	3 min
5	<p>Prime mover – It is required to produce the rotation motion. It can be an electric motor or a gas powered ic engine.</p> <p>Gear reducer – It works to reduce the rotation speed developed by the prime mover.</p> <p>Walking beam and horse head – These are required to convert rotation motion developed by prime mover into vertical motion.</p>	1+1	3 min

Part B

(4 x 5 = 20)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	<p>a) Productivity index = $Q / (Pr - P_{wf})$ = .818 stb/d/psi</p> <p>b) No, we cannot compare 2 well based on productivity index alone as it does not account for thickness of the reservoir. The</p>	2.5+2.5	5 min

	term that can be used to compare 2 well is known specific productivity index.		
2	a) $V = .1484 * A * S * N$ $= 300 \text{ bbl/d}$ b) $V = 300 * .8$ $= 240$	3+2	5 min
3	The working mechanism of a SRP pump includes- i. Bottom of upstroke-The travelling valve closes and standing valve opens. ii. Upstroke – The fluid enters into the pump from the well bore and the fluid present in the tubing is pumped to the surface. iii. Top of down stroke- The travelling valve opens and standing valve closes. iv. Down stroke – The fluid is transferred from lower part of pump to the upper part of pump. So a SRP is often considered to be similar to reciprocating pump because it also pumps a fixed volume of fluid in each cycle.	5	5-8 min
4	$\frac{Q_o}{(Q_o)_{max}} = 1 - 0.2 \left(\frac{p_{wf}}{\bar{p}_r} \right) - 0.8 \left(\frac{p_{wf}}{\bar{p}_r} \right)^2$ a) $Q_{omax} = 1372 \text{ stb/d}$ b) $Q = 695 \text{ stb/d}$	2.5 + 2.5	5-8 min

Part C

(1 x 10 = 10)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	Step 1- Vogels eq $\frac{Q_o}{(Q_o)_{max}} = 1 - 0.2 \left(\frac{p_{wf}}{\bar{p}_r} \right) - 0.8 \left(\frac{p_{wf}}{\bar{p}_r} \right)^2$ Step 2- Rearranging vogels eq $J = \frac{(Q_o)_{max}}{\bar{p}_r} \left[1 + 0.8 \left(\frac{p_{wf}}{\bar{p}_r} \right) \right]$ Step 3 - Using zero draw down $J_p = 1.8 \left[\frac{(Q_o)_{max}}{\bar{p}_r} \right]$	2.5+2.5+5	10 min



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**PRESIDENCY UNIVERSITY
BENGALURU**

SCHOOL OF ENGINEERING

TEST – 2

Sem & AY: Odd Sem 2019-20

Course Code: PET 213

Course Name: PETROLEUM PRODUCTION ENGINEERING

Program: B.Tech. (PET) & V

Date: 16.11.2019

Time: 2:30 PM to 3:30 PM

Max Marks: 40

Weightage: 20%

Instructions:

- (i) All questions are compulsory.
 - (ii) Assume the missing values (if any).
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Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries three marks. (5Qx3M=15M)

1. Differentiate between continuous and intermittent gas lift. (C.O.NO.3) [Knowledge]
2. Write the working mechanism of ESP pump. (C.O.NO.4) Knowledge]
3. A gas lift system nitrogen charged dome with pressure 650 psi. If the tubing pressure is 220 psi and bellow & valve area is 1.1 sq inch & 0.18 sq inch respectively. From the given data determine casing opening pressure (P_{co}). (C.O.NO.3) [Knowledge]
4. What are different type of installations used in gas lift wells. (C.O.NO.3) [Knowledge]
5. Write the function of any 2 of the following ESP components -
a) Motor b) Drain valve c) Protector (C.O.NO.4) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries five marks. (3Qx5M=15M)

6. A gas lift valve with bellow & valve area is 1.15 sq inch and 0.18 sq inch, is charged with nitrogen at pressure 470 psi @ 60 F. Assuming the tubing pressure is 300 psi Find the casing opening pressure if depth of valve is 2600 ft and temperature gradient is 0.02 F / ft.

(C.O.N.O.3) [Application]

7. It is desired to have small amount of gas present in oil for better flow characteristics in ESP system. Explain this statement.

(C.O.N.O.4) [Comprehension]

8. Why do we prefer larger valves for intermittent gas lift system?

(C.O.N.O.3) [Comprehension]

Part C [Problem Solving Questions]

Answer the Question. The Question carry ten marks.

(1Qx10M=10M)

9. A well is being produced using ESP system, from a reservoir at depth 11000 ft and at well bore flowing pressure 3100 psi. The pressure gradient generated due to reservoir fluid is 0.35 psi/ft. Assuming that well head pressure is 250 psi and friction pressure loss is 150 psi, determine-

a) Pump depth if suction pressure is 215 psi.

[3]

b) Total pump head required.

[7]

(C.O.N.O.4) [Application]



SCHOOL OF ENGINEERING

Semester: V

Course Code: PET 213

Course Name: Petroleum Production Engg.

Date: 16/11/2019

Time: 02:30PM to 03:30PM

Max Marks: 40

Weightage: 20

Extract of question distribution

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type	Thought provoking type	Problem Solving type		Total Marks
			[Marks allotted]	[Marks allotted]	[Marks allotted]		
			Bloom's Levels	Bloom's Levels			
			K	C/A	A		
1	3	3	3 → 2 3				3
2	4	4	3 = 2 3				3
3	3	3	3 = 2 3				3
4	3	3	3 = 2 3				3
5	4	4	1.5+ 1.5 = 2 3				3
6	3	3		5 = 5			5
7	4	4		5 = 5			5
8	3	3		5 = 5			5
9	4	4			3+7 = 10		10
	Total Marks			15	15	10	40



SCHOOL OF ENGINEERING

SOLUTION

Semester: V

Course Code: PET 213

Course Name: Petroleum Production Engineering

Date: 16/11/2019

Time: 2:30 PM to 3:30 PM

Max Marks: 40

Weightage: 20

Part A(Memory Recall Question)

(5Q x 3M = 15M)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	<ul style="list-style-type: none"> • Continuous gas lift system are used for high pressure reservoir as compared to intermittent gas lift system. • In continuous gas lift system, gas is continuously injected in the tubing oil while in intermittent gas lift system gas is injected in intervals. • Larger diameter ports are used for intermittent lift system as compared to intermittent gas lift system. • In continuous gas lift system, fluid density reduction is main reason for fluid production. In intermittent gas lift system, expansion of gas lift is primary driving force. 	3	3 min
2	As the fluid is produced from the reservoir and travels upward it passes along the motor and protector. While moving upward it helps to cool down the motor. As it continuous to travel upward, it reaches to gas separator/ inlet. The fluid enters into the tubing through the inlet/gas separator. From gas separator, fluid is passed to the pumping unit where some extra pressure is provided, by the centrifugal pump, to the fluid for production at desired flow rate.	3	3 min
3	$P_{vo} = \frac{1}{1-R} P_d + S_r - \frac{R}{1-R} P_r.$ <p style="text-align: center;">Pco = 734 psi</p>	3	3 min
4	Different types of gas lift installations are used in the industry depending on well conditions. They fall into three categories: (1) Open installation – Tubing is suspended in the well without a packer or standing valve. This kind of system are best suited for continuous gas lift.	3	3 min

	<p>(2) Semi-closed installation – Tubing is provided with packer to prevent flow of fluid in the annulus. This type of system can be used for both continuous gas lift and intermittent gas lift system.</p> <p>(3) Closed installation – This type of system has both packer and standing valve to prevent flow of fluid in the annulus and to protect the reservoir or reservoir fluid from effect of gas injection pressure. This type of system is best suited for intermittent gas lift system.</p>		
5	<p>a) Motor – It is required to produce the rotation motion to the esp pumping unit.</p> <p>b) Drain valve – It works to bleed off all the oil present in the tubing to prevent wet pull out of tubing.</p> <p>c) Protector – It acts as breathing arrangement for the motor. It works to prevent formation of high pressure or vacuum conditions in the motor.</p>	3	3 min

Part B (Thought Provoking Question)

(3Q x 5M = 15M)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	$P_d = (P_s * T_d) / (T_s)$ $= 517 \text{ psi}$ $P_{vo} = \frac{1}{1-R} P_d + S_t = \frac{R}{1-R} P_t$ $P_{co} = 557 \text{ psi}$	5	5-8 min
2	When free gas is present in the system it can cause impeller damage. But if the gas is present in dissolved form then it helps to reduce the viscosity of the oil and thus makes the flow of flow easier.	5	5 min
3	Major driving force for production using intermittent gas lift system is expansion of gas. To ensure that sufficient energy is provided to the fluid, large volume of gas is required to be injected as quickly as possible. So it is required to use larger valves.	5	5 min

Part C (Problem Solving Question)

(1Q x 10m = 10M)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
a)	$D_{pump} = D \cdot \frac{P_{wf} - P_{suction}}{0.433 \gamma_L}$ $= 2757 \text{ ft}$	3+7	10 min
b)			

	$H = h + h_r + h_t$ $h = 12000 - h' \quad (h' = 3100 / .35)$ $= 3142 \text{ ft}$ $h_r = p_r / .433 = 346 \text{ ft}$ $h_t = p_t / .433 = 577 \text{ ft}$ $H = 4065 \text{ ft}$		
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**PRESIDENCY UNIVERSITY
BENGALURU**

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019 - 20

Date: 23 December 2019

Course Code: PET 213

Time: 9:30 AM to 12:30 PM

Course Name: PETROLEUM PRODUCTION ENGINEERING

Max Marks: 80

Program & Sem: B.Tech (PET) & V

Weightage: 40%

Instructions:

- (i) Read the all questions carefully and answer accordingly.
- (ii) Question paper consists of 3 parts.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 5 marks.

(6Qx5M=30M)

1. Define productivity index and IPR. Mention different methods that can be used to determine IPR. (C.O.No.1) [Knowledge]
2. What are different types of artificial lift technique used in petroleum industry? Write about any four of these techniques. (C.O.No.2) [Knowledge]
3. A SRP surface unit is designated as M-243-D-289-146. Define the given SRP unit according to designation provided. (C.O.No.2) [Knowledge]
4. Discuss about different types of gas lift valve used in oil and gas industry. (C.O.No.3) [Knowledge]
5. Write the working principle of progressive cavity pump. (C.O.No.4) [Knowledge]
6. Define the following terms with respect to fluid flow in pipe line-
a) Liquid hold up b) Superficial velocity c) Actual velocity d) Slip velocity
(C.O.No.5) [Knowledge]

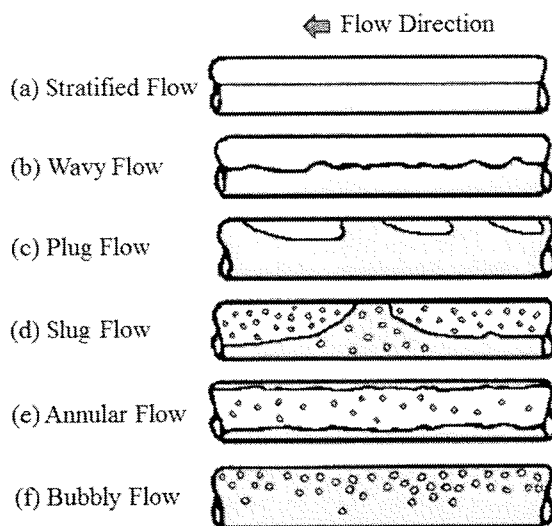
Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 10 marks.

(3Qx10M=30M)

7. A well, operated by ONGC in Gujarat field, is being produced using water injection. Due to mixing of incompatible reservoir and injection water, barite salt has deposited in the tubing. Being a production engineer suggest –
 - a) Which method will be better suited for scale removal – Mechanical method or Chemical method? Give an explanation for the given answer.

- b) Which method will be better suited for scale prevention – Chelants or Threshold inhibitors? Give an explanation for the given answer. (C.O.No.5) [Comprehension]
8. In deviated wells, it is preferred to use ESP instead of SRP. Justify this statement. Also suggest an artificial lift method that can be used for gassy wells with an appropriate reason. (C.O.No.2,C.O.No.4) [Comprehension]
9. Raghu joined a pipeline company as intern for industrial practice program offered by his college. During his internship he was asked to observe different type of pipe flow patterns occurring in different section of pipelines carrying moderate density crude oil. Different patterns observed by him are as shown in the figure below.



- a) Explain the reason for horizontal fluid interface in case of stratified flow.
- b) Arrange the following pattern according to increasing order of their gas flow velocity. (C.O NO.5) [Comprehension]

Part C [Problem Solving Questions]

Answer the Question. The Question carries 20 marks.

(1Qx20M=20M)

10. A well, with perforation at depth 4500 ft, is operated using gas lift system, with spring and charged nitrogen. The dome pressure is 700 psi and spring pressure is 350 psi. If the tubing pressure is 310 psi and bellow & valve area is 1.1 sq inch & 0.16 sq inch respectively. Determine-
- (C.O.No.3) [Application]
- Tubing effect & Tubing effect factor
 - Valve opening pressure (P_{co})
 - Valve closing Pressure (P_{cc})
 - Test rack opening pressure (P_{tro}) if temperature gradient is .02 F/ft



SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type	Thought provoking type	Problem Solving type [Marks allotted]	Total Marks
			[Marks allotted] Bloom's Levels	[Marks allotted] Bloom's Levels		
			K	C	C/A	
1	1	1	5			5
2	2	2	5			5
3	2	2	5			5
4	3	3	5			5
5	4	4	5			5
6	5	5	5			5
7	5	5		10		10
8	2,4	2,4		10		10
9	5	5		10		10
10	3	3			20	20
	Total Marks		30	30	20	80

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature:

Reviewer Commend:

Format of Answer Scheme



SCHOOL OF ENGINEERING

SOLUTION

Semester: Odd Sem. 2019-20

Course Code: PET 406

Course Name: Petroleum Production Engineering

Program & Sem: B.Tech (PET)-V Sem

Date: 23.12.2019

Time: 9:30 AM- 12:30 PM

Max Marks: 80

Weightage: 40%

Part A

(6Q x 5M = 30Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	<p>Productivity Index- It is a commonly used measure of the ability of the well to produce, mathematically defined as ratio of the total liquid flow rate to the pressure drawdown.</p> <p>Inflow Performance Relationship (IPR) of a well is the relation between the production rate and flowing bottom hole pressure. For oil wells, it is frequently assumed that fluid inflow rate is proportional to the difference between reservoir pressure and wellbore pressure. This assumption leads to a straight line relationship that can be derived from Darcy's law for steady state flow of an incompressible, single phase fluid and is called the Productivity Index (PI). However, this assumption is valid only above the bubble point pressure. Methods that can be used for determining IPR are -</p> <ul style="list-style-type: none"> • Vogel's Method • Wiggins' Method • Standing's Method • Fetkovich's Method • The Klins-Clark Method 	2 +2 +1	10 min
2	<p>Artificial lift is a method used to lower the producing bottomhole pressure (BHP) on the formation to obtain a higher production rate from the well. Different type of artificial lifts used in industry are-</p> <p>Hydraulic pumping systems - Hydraulic pumping systems transmit energy to the bottom of the well by means of pressurized power fluid that flows down in the wellbore tubular to a subsurface pump</p> <p>ESP - Electric Submersible Pumps (ESP) consist of a downhole pump (a series of <u>centrifugal pumps</u>), an <u>electrical motor</u> which transforms the electrical power into kinetic energy to turn the pump, a separator or protector to prevent produced fluids from entering the electrical motor, and an electric power cable that</p>	1 X 5	10 min

	<p>connects the motor to the surface control panel</p> <p>Gas Lift - <u>Gas lift</u> is another widely used artificial lift method. As the name denotes, gas is injected in the tubing to reduce the weight of the <u>hydrostatic column</u>, thus reducing the <u>back pressure</u> and allowing the reservoir pressure to push the mixture of produce fluids and gas up to the surface</p> <p>Rod pumps - Rod pumps are long slender cylinders with both fixed and moveable elements inside. The pump is designed to be inserted inside the tubing of a well and its main purpose is to gather fluids from beneath it and lift them to the surface</p>		
3	<p>M-243-D-289-146</p> <p>M – Master torque</p> <p>Torque – 243000 lbf-inch</p> <p>D – Double gear reducer</p> <p>Load – 28900 lb</p> <p>Stroke length – 146 inch</p>	1 X 5	8 min
4	<p>The downhole PC pump is a positive displacement pump that consists of two parts-Helical steel “rotor” and Stator” comprised of a steel tubular housing with a bonded elastomeric sleeve formed with a multiple internal helix matched suitably to the rotor configuration. The relative configuration of stator and rotor create cavity. The stator is typically run into the well on the bottom of the production tubing, while the rotor is connected to the bottom of the sucker rod string. Rotation of the rod string by means of a surface drive system causes the rotor to spin within the fixed stator, creating the pumping action necessary to produce fluids to surface.</p>	5	10 min
5	<p>Tubing pressure operated valve - If tubing pressure is exerted against the bellows causing gas flow regulation, this valve is referred to as a tubing-operated or fluid-operated valve.</p> <p>Casing pressure operated valve - If casing pressure is applied on the bellows, causing gas flow regulation, then we have a casing-operated or pressure-operated valve</p>	2.5 X 2	8 min
6	<p>a) Liquid holdup (HL) is defined as the fraction of an element of pipe which is occupied by liquid at same instant. $HL = \frac{\text{Volume of liquid in a pipe element}}{\text{volume of the pipe element}}$</p> <p>b) Superficial velocity (or superficial flow velocity), in engineering of multiphase flows and flows in porous media, is a hypothetical (artificial) flow velocity calculated as if the given phase or fluid were the only one flowing or present in a given cross sectional area</p> <p>c) Actual velocity, in engineering of multiphase flows and flows</p>	<p>1.5 X 2</p> <p>+</p> <p>1 X 2</p>	10 min

	<p>in porous media, is flow velocity calculated with respect to actual flow area occupied by the fluid.</p> <p>d) Slip velocity is the difference between the gas and liquid velocity for a multiphase flow system</p>		
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Part B

(3Q x 10M = 30 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
7	<p>a) Mechanical methods are better suited for the given condition as it is difficult to control and monitor the rate of reaction down hole. Due to difference in reaction environment between surface and well bore the reaction may not proceed as expected. So due to better control over mechanical methods these are preferred over the chemical methods.</p> <p>b) Scale precipitation can be avoided by chelating the scaling cation but using a threshold inhibitor is better choice. Use of chelants is costly because the reactions are “stoichiometric,”. Threshold inhibitors are chemicals that poison the growth of scale. These effectively inhibiting mineral scale growth at concentrations of 1,000 times less than a balanced stoichiometric ratio.</p>	5+5	20 min
8	<p>It is preferred to use ESP over SRP in deviated wells because of the rods that are required to connect the subsurface pump in SRP to surface pumping unit. The rod transmit the rotation motion for the surface unit to the SRP pump which then helps to pump the fluid. While in case of ESP no such rod connection are required and the power is provided using an electric cable. This electric cable powers the ESP pump that provides extra pressure required for pumping. So in deviated wells it is better to use ESP pump.</p> <p>In gassy wells it is preferred to use gas lift system as the presence of gas does not affect the production rate and lift performance instead it helps to further reduce the back pressure of the oil column. If the pumps are used in gassy wells then it can result in various problems such as gas locking, cavitation etc. which reduces the lift performance.</p>	10	20 min

9	<p>a) Most probable reason for horizontal interface in the pipe line section is that similar velocity profile of gas and liquid. As the velocity are similar then no momentum transfer will be occurring for gas to liquid or liquid to gas. This provides a dynamically stable condition thus providing a horizontal interface in the pipe line.</p> <p>b) Based on the increasing velocity of gas the flow pattern can be set as- Bubble flow-Plug flow-Stratified flow-Wavy flow-Slug flow-Mist flow</p>	5+5	15 min
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Part C

(1Q x 20M = 20Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
10	<p>a) $TEF = \frac{R}{1-R}$ = 0.169</p> <p>TE = $\frac{R}{1-R} P_t$ = 52.57 psi</p> <p>b) $P_{co} = \frac{1}{1-R} P_d + S_t - \frac{R}{1-R} P_t$ = 1116 psi</p> <p>c) $P_{cc} = P_d + (1-R) P_s$ = 999 psi</p> <p>d)</p> $P_{tro} = \frac{P_d \text{ at } 60^\circ\text{F}}{1-R} + S_t$ <p>= 1048 psi</p>	5 X 4	30 min

