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| **Name:**<br>**Enrolment No:** | |

**UPES**
**End Semester Examination, May 2023**

**Course: Enhanced Oil Recovery** | **Semester: VIII**
**Program: B. Tech. APE UP** | **Time : 03 hrs.**
**Course Code: PEAU 4010P** | **Max. Marks: 100**
**Nos. of page(s) : 3**

**Instructions: All question are compulsory.**

a. Answers must carry the supporting material such as equations and diagrams
b. Abbreviations used in the questions are standard and have their usual meaning
c. Make appropriate assumptions where data is not supplied

**SECTION A**
**(5Qx4M=20Marks)**

| S. No. | Statement of question | Marks | CO |
|---|---|---|---|
| Q 1 | Illustrate benefits of Enhanced Oil Recovery processes. Write down the selecting criteria of different types of EOR methods. | **4** | **CO1** |
| Q 2 | Define Infill recovery, capillary number, viscous fingering and sweep efficiency ratio with suitable figures & equations. | **4** | **CO1** |
| Q 3 | Illustrate the different methods to estimate oil and gas reserves. Define exponential decline curve analysis in detail with suitable figure and equations. | **4** | **CO2** |
| Q 4 | List the different factors effecting the water flooding process. Write down the advantages of water flooding process. | **4** | **CO2** |
| Q 5 | Illustrate the favourable characteristic for polymer flooding method. List out the two names of commercial polymer. | **4** | **CO2** |

**SECTION B**
**(4Qx10M= 40 Marks)**

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| Q 6 | (a) Explain principle of Material Balance Equation and calculate the reservoir volume occupied by released gas [MBE], if Cumulative oil production for our example reservoir was $14.73 \times 10^6$ STB at the time when reservoir pressure was 900 psig. At the same time, cumulative production of solution gas was $4.05 \times 10^9$ SCF.<br>**Data given:**<br>$N = 90.46 \times 10^6$ [STB]<br>Rsi at 1225 psig = 230 [SCF/STB]<br>Rs at 900 psig = 169 [SCF/STB] | **10 (5+5)** | **CO2** |

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| | Bg at 900 psig = 0.002905 [RB/SCF]<br>(b) Discuss general terminology- apparent viscosity, relative viscosity, resistance factor (RF), residual resistance factor (RRF) and Screen factor related EOR polymer screening in detail. | | |
| Q 7 | (a) Describe well spacing. Define different rules of well spacing. Illustrate the different types of well pattern with suitable figures.<br><br>(b) Calculate the oil recovery for given data set.<br>Oil saturation at the start of the project $S_O = 0.70$<br>Effective Rock Porosity $\phi = 0.32$<br>Pattern Sweep Efficiency $E_P = 0.55$<br>Vertical Sweep Efficiency $E_I = 0.35$<br>Displacement Efficiency in Zone I $E_{du} = 0.43$<br>Oil Consumed $S_{Ocons} = 0.065$ | **10 (5+5)** | **CO3** |
| Q 8 | (a) Explain microbial products illustrate the need and major applications area of MEOR method. Write down the two Indian patents of MEOR.<br>(b) Describe recent advances in EOR. Illustrate the applications of Enzyme EOR & Nanotechnology in EOR.<br><br>**OR**<br>(a) Discuss Huff and Puff microbial method. List out the types of microbes cultured in laboratory. Write down the two Indian patents of MEOR.<br>(b) Explain different types of miscible recovery method. Describe most suitable N2 flooding method for deep reservoirs. | **10 (5+5)** | **CO4** |
| Q 9 | Explain types of simulators in various EOR methods in detail. Describe the Pre and post processor files of Builder in CMG Black oil simulator. Write down the name of commercial simulators for different EOR recovery processes.<br>**OR**<br>Discuss GRID section in Eclipse 100 software. List out the name of commercial simulators for chemical and thermal EOR recovery processes as well as<br>(I) Set 10 cells to have length of 500 feet using **DX** keyword and<br>(II) Define a box as follows:<br>X direction - cell 1 to cell 5<br>Y direction - cell 1 to cell 5<br>Z direction - cell 1 to cell 1 (top layer only)<br><br>Set the depth below sea level of the tops of each cell in the box to 8,000 feet using the **BOX**, **TOPS** and **ENDBOX** keywords. | **10** | **CO6** |

| SECTION-C<br>(2Qx20M=40 Marks) | | | |
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| Q 10 | (a) Discuss coning of water and/or gas in oil well. Illustrate the types of cone formation. Describe Sobocinski-Cornelius correlation for predicting water breakthrough time based on lab and modeling results.<br><br>(b) Calculate the water breakthrough using the Sobocinski-Cornelius method for a vertical well producing at 250 STB/day. The related well and reservoir data are given below:<br><br>Oil rate, $Q_o$ = 250 STB/day<br>Oil column thickness, h = 50 ft<br>Perforated interval, $h_p$ = 15 ft<br>Water density, $\rho_w$ = 63.76 lb/ft$^3$<br>Oil density, $\rho_o$ = 47.5 lb/ft$^3$<br>Oil viscosity, $\mu_o$ = 0.73 cp<br>Oil formation volume factor, $B_o$ = 1.1 bbl/STB<br>Vertical permeability, $k_v$ = 9 mD<br>Horizontal permeability, $k_h$ = 93 mD<br>Porosity, = 13% and M = 3 | **20<br>(10+10)** | **CO2** |
| Q 11 | (a) Discuss $CO_2$ Flooding method and its limitations. Describe $CO_2$ flooding method with case study of Indian or Foreign oil field.<br><br>(b) Calculate the $CO_2$ static wellhead pressure $P_w$, when the static bottom hole pressure is the miscibility pressure of 2114 $p_{sia}$. The following additional information is available:<br><br>Bottom Hole Temperature $T_R$ = 170° F (76° C)<br>Surface Temperature $T_S$ = 70° F (21° C)<br>$CO_2$ specific gravity SG=1.529 (air=1)<br>$CO_2$ deviation factor Z = 0.56 is assumed to be practically Constant between reservoir pressure and temperature range<br>Reservoir depth D = 4264 ft. (1300 m)<br><br>**OR**<br><br>(a) Discuss thermal EOR method. Describe applications and limitation of steam flood process with case study of successful implementation in any Indian or Foreign oil field.<br><br>(b) Calculate the oil consumed after 5 years of in situ combustion developed as a primary recovery method. The oil reservoir (SG=0.950) has 157 x 10$^6$ bbl OOIP reserve, and the combustion process is sustained by the injection of 700 x 10$^3$ ft$^3$ air/day through each of the 12 injection wells. | **20<br>(10+10)** | **CO5** |