Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UPES

End Semester Examination, May 2023

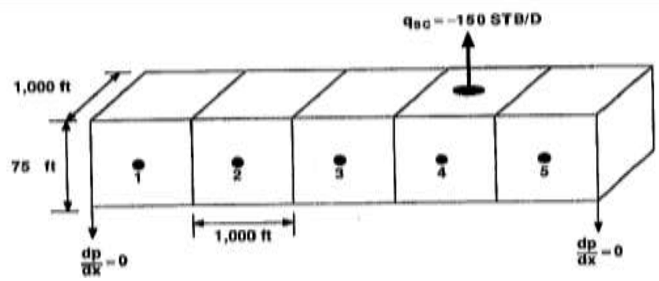
Course: Computational Dynamics of Unconventional Reservoirs **Semester: VIII**
Program: B.Tech Applied Petroleum Engineering+Upstream **Time : 03 hrs.**
Course Code: PEAU 4023P **Max. Marks: 100**

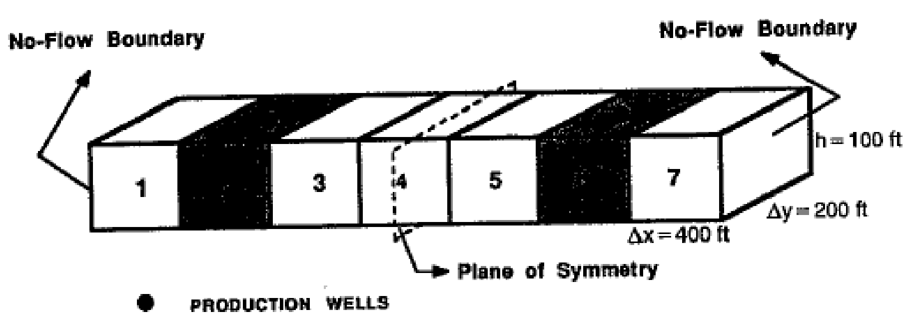
Instructions:
All Questions are Mandatory.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Explain the applications of CFD?	**4M**	**CO1**
Q 2	State the differences between a mathematical, a numerical and a computer model?	**4M**	**CO2**
Q 3	Differentiate between structured and unstructured grids?	**4M**	**CO3**
Q 4	Define stability in numerical solution of fluid in flow governing equations?	**4M**	**CO3**
Q 5	Report the different ways a reservoir can be modeled? Explain.	**4M**	**CO4**

SECTION B
(4Qx10M= 40 Marks)

Q 1	(i) Derive the mass conservation equation for a single phase flow through a 1D reservoir? (ii) Discuss cell centered formulation in Finite Difference Techniques.	**5M + 5M**	**CO2**
Q 2	For the 1D, block – centered grid shown in below figure. Determine the pressure distribution during the first year of production using the implicit backward difference formulation. The initial reservoir pressure is 6000 psia. The rock and fluid properties for this problem are Δx = 1000 ft, Δy = 1000 ft, Δz = 75 ft, $B_l = 1\ {RB}/_{STB}$, $c_l = 3.5 * 10^{-6}\ psi^{-1}, k_x = 15\ md, \Phi = 0.18, \mu_l = 10\ cp, and\ B_l^o = 1\ {RB}/_{STB}$. Use time step sizes of Δt = 15 days. Assume B_l acts as a constant within the pressure range of interest. 	**10M**	**CO3**

Q 3	Investigate the stability of the central finite difference approximation to the diffusivity equation. $$\frac{p_{i+1}^{n} - 2p_{i}^{n} + p_{i-1}^{n}}{(\Delta x)^2} = \frac{1}{D}\frac{p_{i}^{n+1} - p_{i}^{n-1}}{2\Delta t}$$ Where D = a positive constant.	**10M**	**CO3**
Q 4	A 2D, slightly compressible fluid transport equation is gives as $\frac{\partial}{\partial x}\left(\beta_c \frac{A_x k_x}{\mu_l B_l}\frac{\partial p}{\partial x}\right)\Delta x + \frac{\partial}{\partial y}\left(\beta_c \frac{A_y k_y}{\mu_l B_l}\frac{\partial p}{\partial y}\right)\Delta y + q_{lsc} = \frac{V_b \Phi\, C_l}{\alpha_c\, B_l^o}\frac{\partial p}{\partial t}$ 1. Derive the forward – difference approximation to this equation. 2. Derive the backward difference approximation to this equation.	**10M**	**CO4**
	SECTION-C **(2Qx20M=40 Marks)**		
Q 1	Consider a 1D reservoir, where unsteady – state, single phase oil flow is taking place. The equation is represented as $$\frac{\partial}{\partial x}\left(\beta_c \frac{A_x k_x}{\mu_l B_l}\frac{\partial p}{\partial x}\right)\Delta x + q_{lsc} = \frac{V_b \Phi\, C_l}{\alpha_c\, B_l^o}\frac{\partial p}{\partial t}$$ The reservoir has the homogeneous property distributions of Φ = 25% and $k_x = 165\ md$. The below figure shows the uniform dimensions of the finite grid blocks. The boundary conditions at the extreme ends are specified as no-flow boundary conditions and the wells in grid blocks 2 and 6 produce at a rate of 2,500 $^{STB}/_{D}$. Each grid block as an initial specified pressure of 3,800 psia. Obtain the system of equations whose solution give the pressure distribution in the reservoir at the end of 15 days. Use a time step of 15 days to generate the system of equations. Use the implicit, backward difference scheme to generate the finite difference equations. Also note that $B_l = 1\ ^{RB}/_{STB}, c_l = 4.5 *\ 10^{-6}\ psi^{-1}, \mu_l = 0.9\ cp, and\ B_l^o = 1\ ^{RB}/_{STB}$.  	**20M**	**CO4**
Q 2	Consider steady, fully developed laminar fluid flow through triangular duct in Z-direction. Solve the nonlinear partial differential equation representing the flow through triangular duct considering uniform grid spacing. Assuming no flow on the wall of the duct with the constant as -1300. The nonlinear partial differential equation representing the flow behavior is $$\frac{\partial^2 w}{\partial x^2} + \frac{\partial^2 w}{\partial y^2} = C$$	**20M**	**CO2**