University of Stavanger

English text.

FACULTY OF SCIENCE AND TECHNOLOGY

SUBJECT: MPE 340 Reservoir simulation, introduction **DATE: December 19, 2008**

TIME: 4 hours

AID: No printed or written means allowed. Definite basic calculator allowed.

THE EXAM CONSISTS OF 5 PROBLEMS ON 2 PAGES

REMARKS: You may answer in English or Norwegian. All problem parts are given equal weight.

Problem 1

a) Write the Black Oil model assumptions.
Describe the composition of phases in terms of components for Black Oil fluids.

b) Write the general Black Oil mass balance differential equations.
Expand the water flow term, i.e. write the flow term using partial derivatives.

c) Make the additional assumption that gas can dissolve in water. Write the differential mass balance equations for this case.

Problem 2

a) Assume no gravity and zero capillary pressure. What are the standard Buckley-Leverett assumptions needed to derive the standard Buckley-Leverett equation?

b) Derive the standard Buckley-Leverett equation starting with the special case of the general Black Oil equations obtained using the Buckley-Leverett assumptions.

c) What is determined when the Buckley-Leverett equation is solved? What model input parameters will effect the solution?

Problem 3

a) Make a list of relative permeability saturation end points used in end point scaling of relative permeabilities.

b) Outline the scaling procedure for k_{rg} and k_{rog}.

Problem 4

a) What model input parameters are needed for computing the initial state of a reservoir?

b) Outline the initialization procedure.

Problem 5

Given the differential equation

$$u_x = -u_t, \quad x \in [0,1], \quad t \geq 0 .$$

Boundary conditions:

- u(0,t) = 0 and u(1,t) = 1 for all t
- u(x,0) = 2x for $0 < x \leq ½$, u(x,0) = 1 for $½ < x < 1$.

Subdivide the interval [0,1] into 5 computational points with equal spacing Δx. The first point is the left boundary point x = 0 and the fifth point is the right boundary point x = 1.
Subdivide the time axis into time points with equal time step length $\Delta t = 1/16$.
High index n is used to denote time step, t^0 denotes time t = 0, t^1 denotes time t = 1/16, etc.
Standard explicit difference approximation is given by

$$\frac{u_{i-1}^n - u_i^n}{\Delta x} = \frac{u_i^{n+1} - u_i^n}{\Delta t} .$$

a) Use the explicit formula to compute the solution at time $t^2 = 1/8$.

b) What is the difference in stability properties between implicit and explicit solution methods? What is the maximal time step length that can be used for the computations in a)?