Unit 10 - Week 8

Assignment 8

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-09-25, 23:59 IST.

Paragraph for Question Nos. 1 to 10

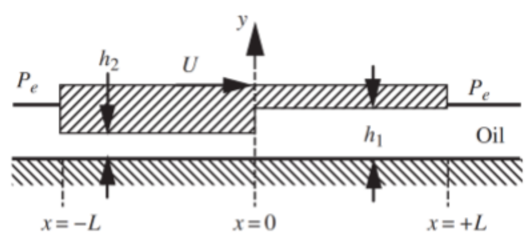
A bearing pad of total length $2L$ moves to the right at constant speed U above a thin film of oil with dynamic viscosity μ and density ρ. There is a step change in the gap thickness (from h_1 to h_2) below the bearing as shown in the figure which can be expressed mathematically as

$$h(x,t=0) = \begin{cases} h_2 & \text{for } -L \le x < 0 \\ h_1 & \text{for } 0 < x \le L \end{cases}$$

The length L is large compared to h_1. The pad is instantaneously aligned above the coordinate system fixed to the lower (flat) stationary surface at time $t = 0$ as shown. The pressure in the oil ahead and behind the bearing is P_e. For your analysis you may assume $\frac{\rho U h_1^2}{\mu L} << 1$ and the non-dimensional *bearing number* defined as

$$\Lambda = \frac{\mu U L}{P_e h^2}$$

to be of the order of unity. Neglect the variation of pressure in the oil film due to gravity.



1) Which among the following is the MOST GENERAL differential form of the x-component of linear momentum equation in the absence of any body forces? *1 point*

(A) $\rho \frac{\partial u}{\partial t} = -\frac{\partial p}{\partial x} + \mu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right)$

(B) $\rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) = \mu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right)$

(C) $\rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) = -\frac{\partial p}{\partial x} + \mu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right)$

(D) $0 = -\frac{\partial p}{\partial x} + \mu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right)$

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0
Accepted Answers:
C

2) Which among the following relations is/are correct for the flow in the gap below the bearing under the assumptions: $h_1 << L$, $\frac{\rho U h_1^2}{\mu L} << 1$ and $\frac{\mu U L}{P_e h^2} \sim 1$? *1 point*

(A) $\rho\left|u\frac{\partial u}{\partial x}\right| << \mu\left|\frac{\partial^2 u}{\partial y^2}\right|$

(B) $\left|\frac{\partial^2 u}{\partial x^2}\right| << \left|\frac{\partial^2 u}{\partial y^2}\right|$

(C) $\left|u\frac{\partial u}{\partial x}\right| << \left|v\frac{\partial u}{\partial y}\right|$

(D) $\left|\frac{\partial p}{\partial x}\right| << \mu\left|\frac{\partial^2 u}{\partial y^2}\right|$

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0
Accepted Answers:
A
B

3) Which among the following is the MOST SIMPLIFIED form of the x-component of linear momentum equation governing this flow field under these assumptions? *1 point*

(A) $\rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) = -\frac{\partial p}{\partial x} + \mu\frac{\partial^2 u}{\partial y^2}$

(B) $\rho\left(u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) = \mu\frac{\partial^2 u}{\partial y^2}$

(C) $0 = -\frac{\partial p}{\partial x} + \mu\frac{\partial^2 u}{\partial y^2}$

(D) $0 = \mu\frac{\partial^2 u}{\partial y^2}$

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0
Accepted Answers:
C

4) Which among the following relations is/are correct for the flow in the gap below the bearing under the assumptions? *1 point*

(A) $u << v$

(B) $\mu\left|\frac{\partial^2 v}{\partial y^2}\right| << \left|\frac{\partial p}{\partial y}\right|$

(C) $\left|\frac{\partial^2 v}{\partial y^2}\right| << \left|\frac{\partial^2 v}{\partial x^2}\right|$

(D) $\rho\left|v\frac{\partial v}{\partial y}\right| << \mu\left|\frac{\partial^2 v}{\partial y^2}\right|$

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0
Accepted Answers:
B
D

5) Which among the following is the MOST SIMPLIFIED form of the y-component of linear momentum equation governing this flow field under these assumptions? *1 point*

(A) $\rho\left(\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}\right) = -\frac{\partial p}{\partial y} + \mu\frac{\partial^2 v}{\partial y^2}$

(B) $\rho\left(u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y}\right) = \mu\frac{\partial^2 v}{\partial y^2}$

(C) $0 = -\frac{\partial p}{\partial y} + \mu\frac{\partial^2 y}{\partial y^2}$

(D) $0 = -\frac{\partial p}{\partial y}$

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0
Accepted Answers:
D

6) Which among the following are the correct boundary conditions to be satisfied by the horizontal component of velocity, u? *1 point*

(A) At $y = 0$, $u = U$

(B) At $y = h(x,t)$, $u = 0$

(C) At $y = 0$, $u = 0$

(D) At $y = h(x,t)$, $u = U$

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0
Accepted Answers:
C
D

7) Which among the following is the correct expression for the horizontal component of velocity, u in the gap below the bearing? *1 point*

(A) $u(x,y) = -\frac{1}{2\mu}\frac{\partial p}{\partial x}y\,(h-y) + U\frac{y}{h}$

(B) $u(x,y) = -\frac{1}{2\mu}\frac{\partial p}{\partial x}y\,(h-y)$

(C) $u(x,y) = U\frac{y}{h}$

(D) $u(x,y) = -\frac{1}{2\mu}\frac{\partial p}{\partial x}h^2\sin\left(\frac{\pi y}{h}\right) + U\frac{y}{h}$

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0
Accepted Answers:
A

8) Which among the following equations is an outcome of the continuity equation? *1 point*

(A) $\frac{\partial h}{\partial t} + \left(\frac{\partial}{\partial x}\int_0^{h(x,t)} v\,\mathrm{d}y\right) = 0$

(B) $\frac{\partial h}{\partial t} + \left(\frac{\partial}{\partial y}\int_{-L}^{L} v\,\mathrm{d}x\right) = 0$

(C) $\frac{\partial h}{\partial t} + \left(\frac{\partial}{\partial x}\int_0^{h(x,t)} u\,\mathrm{d}y\right) = 0$

(D) $\frac{\partial h}{\partial t} + \left(\frac{\partial}{\partial y}\int_{-L}^{L} u\,\mathrm{d}x\right) = 0$

- A
- B
- C
- D

No, the answer is incorrect.
Score: 0
Accepted Answers:
C

9) Which among the following is an expression for the pressure at $x = 0$ i.e. at the step? *1 point*

(A) $\frac{6\mu U L\,(h_1 - h_2)}{h_1^3 + h_2^3}$

(B) $\frac{3\mu U L\,(h_1 - h_2)}{h_1^3 + h_2^3}$

(C) $\frac{2\mu U L\,(h_1 - h_2)}{h_1^3 + h_2^3}$

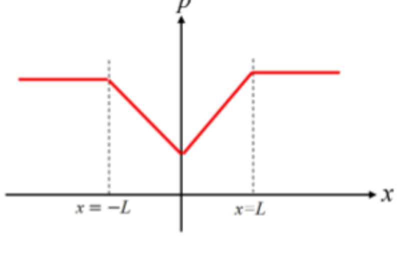
(D) $\frac{\mu U L\,(h_1 - h_2)}{h_1^3 + h_2^3}$

- A
- B
- C
- D

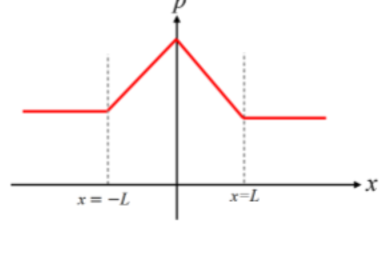
No, the answer is incorrect.
Score: 0
Accepted Answers:
A

10) Which among the following plots qualitatively represents the variation of pressure along the length of the bearing? *1 point*

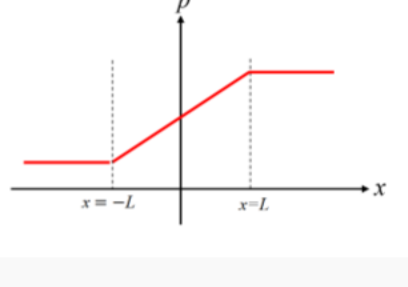
(A)



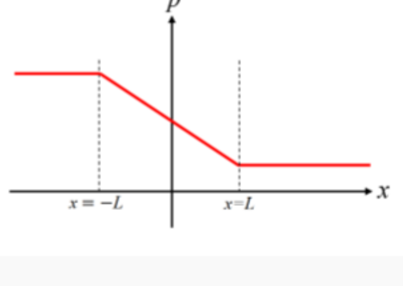
(B)



(C)



(D)



- A
- B
- C
- D

No, the answer is incorrect.
Score: 0
Accepted Answers:
B