University of British Columbia
Faculty of Applied Science
Department of Mechanical Engineering

TEST #1, October 6, 2017

MECH 221

Suggested Time: 45 minutes **Allowed Time:** 50 minutes

Materials admitted: Pencil, eraser, straightedge, Mech 2 Approved Calculator (Sharp EL-510), one 3x5 inch sheet of paper for hand-written notes.

There are 2 Short Answer Questions and 1 Long Answer Problem on this test. All questions must be answered.

Provide **all** work and solutions **on this test**. Do not mark in the QR code area of the page – this may cause sorting issues, leading to your work for that page not being graded.

Orderly presentation of work is required for solutions to receive full credit. **Illegible work, or answers that do not include supporting calculations and explanations will NOT BE MARKED**.

FILL OUT THE SECTION BELOW. Do this during the examination time as additional time will not be allowed for this purpose.

NAME:____Section___________

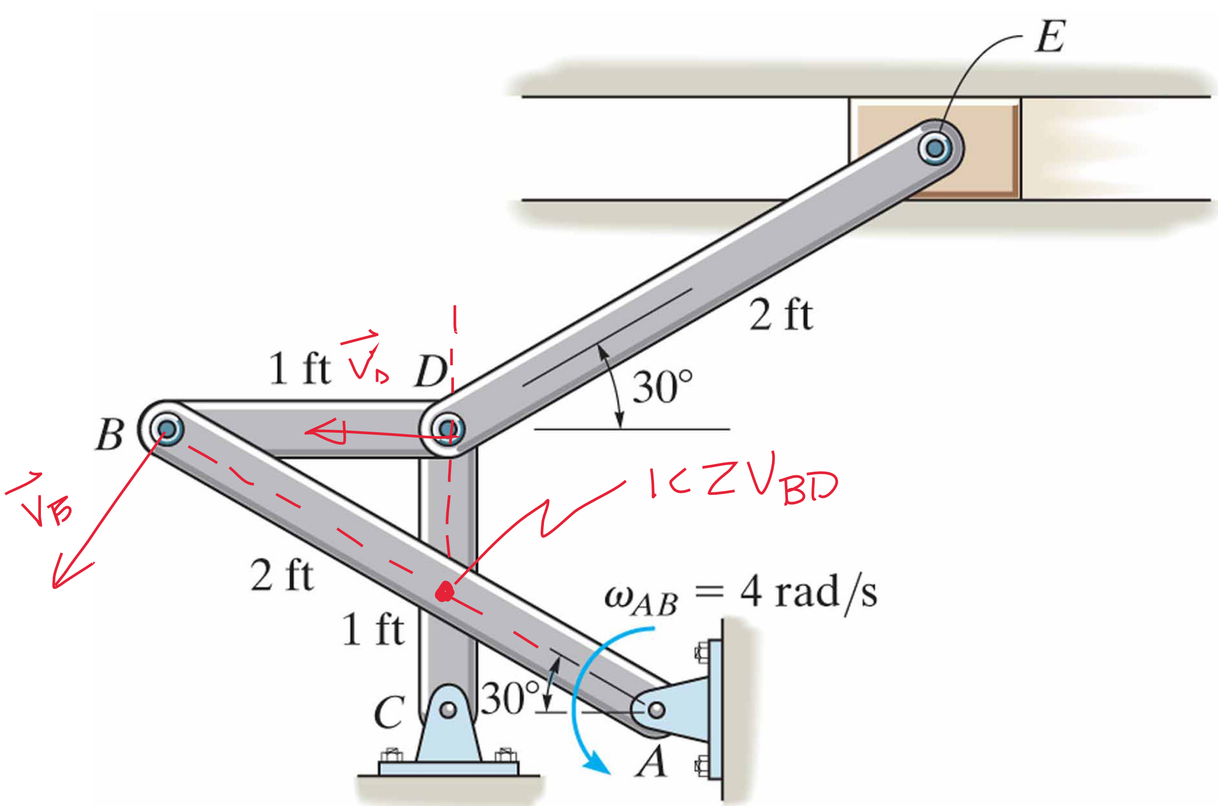
SIGNATURE:___________________________________

STUDENT NUMBER:___________________________

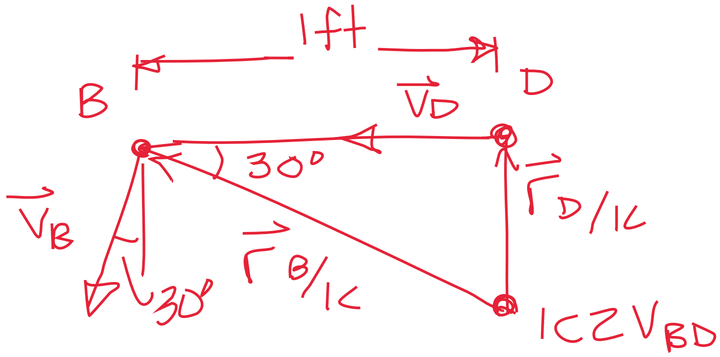
Question	Mark Received	Maximum Mark
SA 1		5
SA 2		5
Prob 1		25

Prob 1. [25 marks]

a) (5 marks) Draw the ICZV for link BD on the diagram below, clearly showing the direction of the velocities used to find it.



b) (10 marks) Find the angular velocity of link BD, $\overrightarrow{\omega_{BD}}$.



$$\tan 30 = \frac{|\vec{r}_{D/IC}|}{1\text{ft}}$$

$$|\vec{r}_{D/IC}| = \tan 30 \text{ ft}$$

$$\vec{r}_{B/IC} = (-1\hat{i} + \tan 30\hat{j})\text{ ft}$$

PURE ROTATION (w r t ICZV)

$$\vec{V}_B = \vec{\omega}_{BD} \times \vec{r}_{B/IC} \quad ①$$

$$|\vec{V}_B| = (\omega_{AB})(2\text{ft}) = 4\text{ rad/s}(2\text{ft}) = 8\text{ rad/s}$$

$$\vec{V}_B = -8\sin 30\hat{i} - 8\cos 30\hat{j} = \omega_{BC}\hat{k} \times (-1\hat{i} + \tan 30\hat{j})\text{ft}$$

$$= -\omega_{BC}\hat{j} - \omega_{BC}\tan 30\hat{i}$$

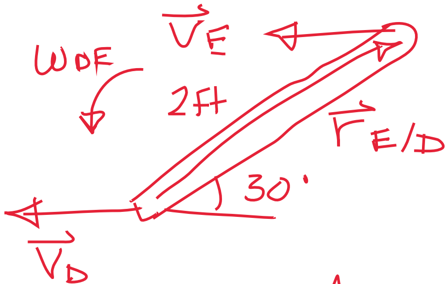
from $\hat{j}$: $\omega_{BC} = 8\cos 30$ rad/s

$$= 6.93 \text{ rad/s}$$

$$\boxed{\vec{\omega}_{BC} = 6.93\hat{k} \text{ rad/s}}$$

c) (10 marks) Show using Chasles' Theorem that the angular velocity of link DE at the instant shown equals zero ($\overrightarrow{\omega_{DE}} = 0$).

Chasles' Theorem $\quad \vec{V}_E = \vec{V}_D + \vec{V}_{E/D}$



E = rectilinear trans $(-\hat{i})$

D = pure rotation, $-\hat{i}$ direct

AT THIS INSTANT

$$-V_E\hat{i} = -V_D\hat{i} + \omega_{DE}\hat{k} \times (2\cos 30\hat{i} + 2\sin 30\hat{j})$$

$$-V_E\hat{i} = -V_D\hat{i} + 2\omega_{DE}\cos 30\hat{j} - 2\omega_{DE}\sin 30\hat{i}$$

$\hat{i}$: $\quad -V_E = -V_D - 2\omega_{DE}\sin 30$

$\hat{j}$: $\quad 0 = 2\omega_{DE}\cos 30 \Rightarrow \omega_{DE} = 0$

$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad \dot{=}\ \ V_E = V_D$