ME-309 Mechanics of machines
HW (1) – Solutions

Abbreviations:

> **RVJ** ≡ Revolute Joint (Type J_1; i.e. $f = 1$)
> **PSJ** ≡ Prismatic Joint (Type J_1; i.e. $f = 1$)
> **RCJ** ≡ Rolling Contact Joint (Type J_1; i.e. $f = 1$)
> **SCJ** ≡ Sliding Contact Joint (Type J_2; i.e. $f = 2$)

Problem 1.9

Determine the mobility and the number of idle degrees of freedom of each of the planar linkages shown below. Show the equations used and identify the input and output links assumed when determining your answers.
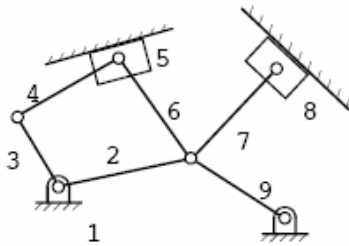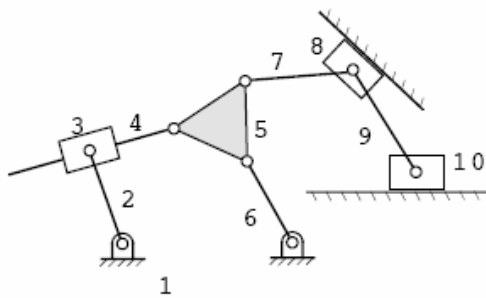
$n = 9$

$j = 12$

$$M = 3(n - j - 1) + \sum_{i=1}^{j} f_i$$

$$= 3(9 - 12 - 1) + 12 = -12 + 12 = 0$$

Mobility $= 0$

Idle DOF $= 0$

(a)
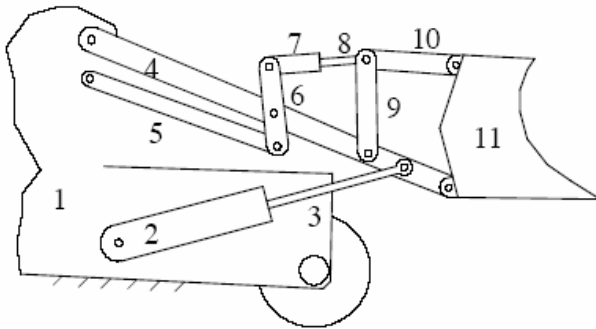
$n = 10$

$j = 12$

$$M = 3(n - j - 1) + \sum_{i=1}^{j} f_i$$

$$= 3(10 - 12 - 1) + 12 = -9 + 12 = 3$$

Mobility $= 3$

Idle DOF $= 0$

(c)

Problem 1.12

Determine the mobility of each of the planar linkages shown below. Show the equations used to determine your answers.
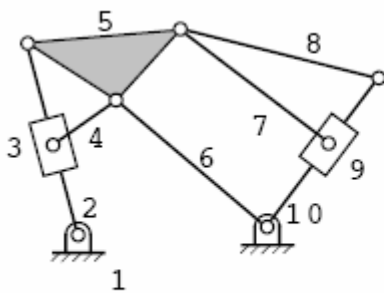

(b)

$n = 11$

$j = 14$

$\sum_{i=1}^{j} f_i = 14 \times 1 = 14$

$$M = 3(n - j - 1) + \sum_{i=1}^{j} f_i$$

$$= 3(11 - 14 - 1) + 14 = -12 + 14 = 2$$

Mobility $= 2$

Problem 1.15

Determine the mobility and the number of idle degrees of freedom of each of the planar linkages shown below. Show the equations used to determine your answers.
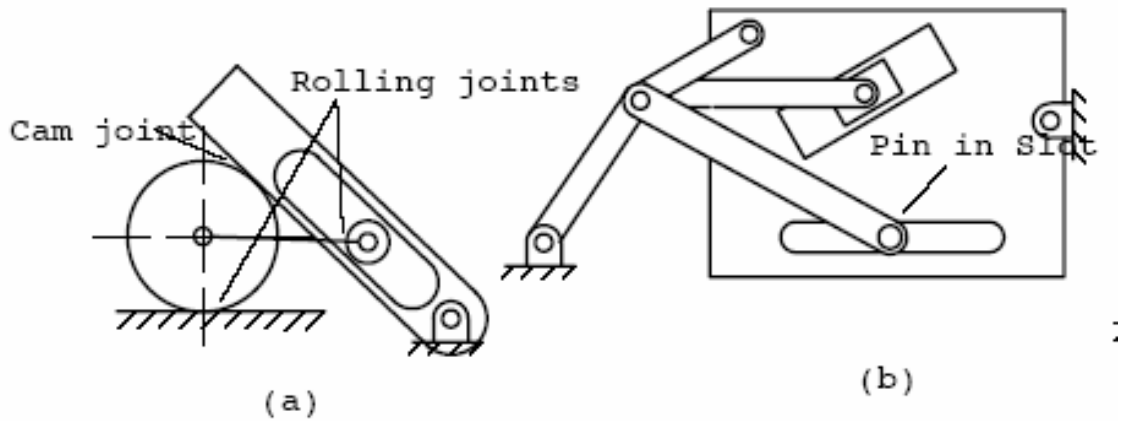

(c)

$n = 10$

$j = 13$

$$M = 3(n - j - 1) + \sum_{i=1}^{j} f_i$$

$$= 3(10 - 13 - 1) + 13 = -12 + 13 = 1$$

Mobility $= 1$

Idle DOF $= 0$

Determine the mobility and the number of idle degrees of freedom associated with each mechanism. Show the equations used and identify any assumptions made when determining your answers.

(a)

(b)

a)
$$n = 5$$
$$j = 6 \Rightarrow (3\,RVJ + 2\,RCJ + 1\,SCJ)$$

$$M = 3(n - j - 1) + \sum_{i=1}^{j} f_i$$

$$= 3(5 - 6 - 1) + (3 + 2 + 2) = 1$$

$$Mobility = 1$$

b)
$$n = 7$$
$$j = 9 \Rightarrow (7\,RVJ + 1\,PSJ + 1\,SCJ)$$

$$M = 3(n - j - 1) + \sum_{i=1}^{j} f_i$$

$$= 3(7 - 9 - 1) + (7 + 1 + 2) = 1$$

$$Mobility = 1$$

Determine the mobility and the number of idle degrees of freedom for each of the mechanisms shown. Show the equations used and identify any assumptions made when determining your answers.

(a)
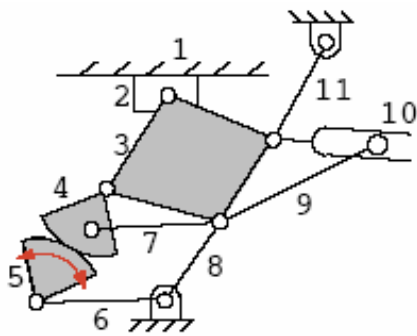
$$n = 11$$
$$j = 15$$
$$M = 3(n - j - 1) + \sum_{i=1}^{j} f_i$$
$$= 3(11 - 15 - 1) + 17 = -15 + 17 = 2$$

Mobility = 2

Idle DOF = 1