Question #1

The EXPRESS model bellow describes a printed wiring assembly (PWA). A PWA (shown in Figure 1) consists of a printed wiring board (PWB) with electrical components (such as resistors, integrated circuits, capacitors, etc.) attached. A “component occurrence” is an instance of an electrical component placed at a specific location on the board. A part can be a PWA, a PWB or an electrical component.

Draw the EXPRESS-G diagram corresponding to the following EXPRESS model:

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SCHEMA printed_wiring_assembly;

TYPE length_measure = REAL;
END_TYPE;

TYPE plane_angle_measure = REAL;
END_TYPE;

TYPE id = STRING;
END_TYPE;

ENTITY location;
    rotation : OPTIONAL plane_angle_measure;
    coordinates : xy_coordinates;
END_ENTITY;

ENTITY xy_coordinates;
    x : length_measure;
    y : length_measure;
END_ENTITY;

ENTITY part
    ABSTRACT SUPERTYPE OF(ONEOF (pwb, pwa, electrical_component));
    part_number : id;
    description : STRING;
UNIQUE
    unique_part_number : part_number;
END_ENTITY;

ENTITY pwb
    SUBTYPE OF(part);
    outline : LIST [1:?] OF xy_coordinates;
END_ENTITY;
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ENTITY pwa
  SUBTYPE OF ( part );
    associated_pwb : pwb;
END_ENTITY;

ENTITY electrical_component
  ABSTRACT SUPERTYPE OF ( ONEOF( resistor, capacitor, integrated_circuit ) )
  SUBTYPE OF ( part );
    package_type : STRING;
END_ENTITY;

ENTITY resistor
  SUBTYPE OF ( electrical_component );
END_ENTITY;

ENTITY capacitor
  SUBTYPE OF ( electrical_component );
END_ENTITY;

ENTITY integrated_circuit
  SUBTYPE OF ( electrical_component );
END_ENTITY;

ENTITY component_occurrence;
  component : electrical_component;
  reference_designator : id;
  associated_location : location;
  of_pwa : pwa;
UNIQUE
  unique_reference_designator : reference_designator;
END_ENTITY;

END_SCHEMA;

Figure 1: A Printed Wiring Assembly
Create an EXPRESS-G diagram to model the linkage illustrated in Figure 2.

Figure 2: The Linkage

The linkage has two sleeves (sleeve1 and sleeve2). Each sleeve has a diameter (d_s), a thickness (t_s), and a width (w_s - not shown in the figure, measured in the direction perpendicular to the paper). The distance between the centers of the two sleeves is called L.

The feature that joins the two sleeves is called shaft. The shaft is an I-Beam, whose typical cross section is illustrated in Figure 3. Since the height of this beam is variable and therefore there are infinite possible sections along the beam, consider only a particular cross section (say, the smallest) which we will call critical section (indicated as A-A in Figure 2). You may want to group the section parameters of Figure 3 in an entity called I-Section.

Also, model the fact that the linkage is made of some material. We will assume that this material is a linear elastic material with a name, a Young’s Modulus and a Poisson’s ratio.

For this homework, don’t worry about DERIVED attributes (such as the area of the cross section); draw them as regular attributes.

Hint: I have indicated possible entities of the model in italics and possible attributes in bold. However, feel free to present any modeling options that make sense to you.
Given a pinball mechanism – pull, release, impact:

1. Name attributes of the pinball mechanism and the ball attributes (the components, the geometrical and physical char)
2. Name the pinball mechanism and ball operations (think about the states theses elements are during their activities)
3. Build state diagrams for the pinball mechanism and ball.