Robot System Design (RME40003)

Robot Assembly Project – (25%)

Due Date: 11 September 2020

Students (group of 2) are required to design a manufacturing cell based on a single robot for the assembly of one of the products described in Section 2A and 2B.

Section 1: Project Details

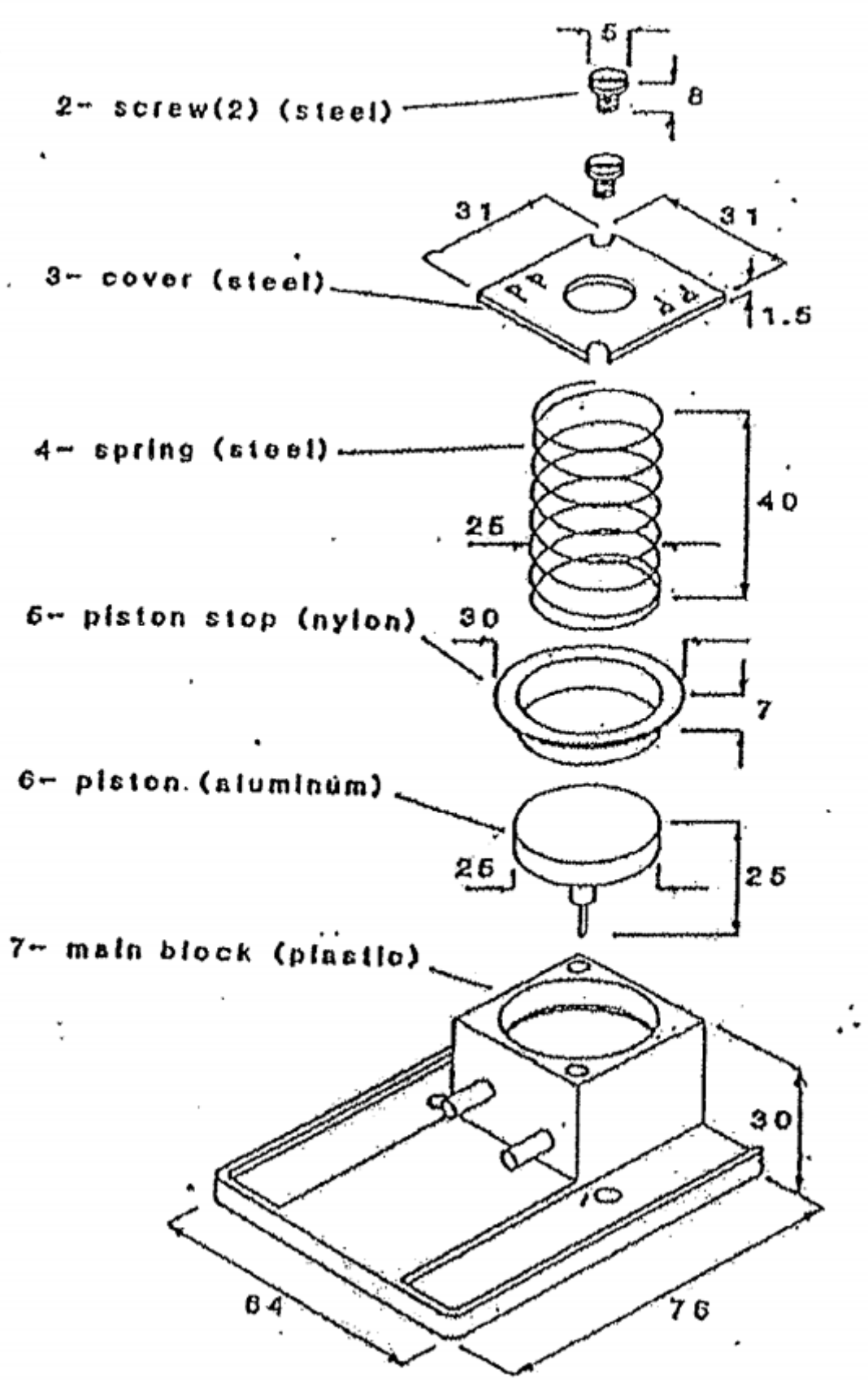
Students are required to submit a report describing the design of the manufacturing cell. The key components of the report should include:

a) **Component rationalisation/redesign for robot assembly**: reasonable components alteration that promotes efficiency (in terms of cost, complexity and time) are permitted.
b) **Design of jigs/fixtures**: jigs/fixtures are required for location and support of components of the selected products during the assembly process. Minimal automation is allowed.
c) **Design of grippers**: the end effector of the robot manipulator has to be uniquely designed for the manipulation and assembly of components. Single gripper design is recommended as gripper change requires additional fixture and assembly routine.
d) **Design/selection of storage systems, feeders and orientation devices:** for each unique components, a series of storage, feeder and orientation system is required so that the components are readily aligned for assembly.
e) **Selection of industrial robot:** detailed technical justification based on speed, size and etc must be provided.
f) **Flowchart of robot program:** in the assembly cycle, a logical and efficient flowchart is required without compromising work safety. The flow chart should include decision making of the robot based on the operating sensors on the manufacturing cell.
g) **Dimensioned layout of manufacturing cell:** the cell size should take account of the work envelope of the selected robot manipulator to avoid space redundancy. A 2D (top view) waypoint routine should be marked on the cell plane to indicate how the robot will move around the cell.
h) **Cycle time analysis for robotic assembly:** the cycle path is greatly determined by the placement of the robot manipulator, its working envelope and the shape of the manufacturing cell.
i) **Design of safety system for robot based assembly cell:** emergency stop, circuit breaker and isolation are examples of typical safety measures.

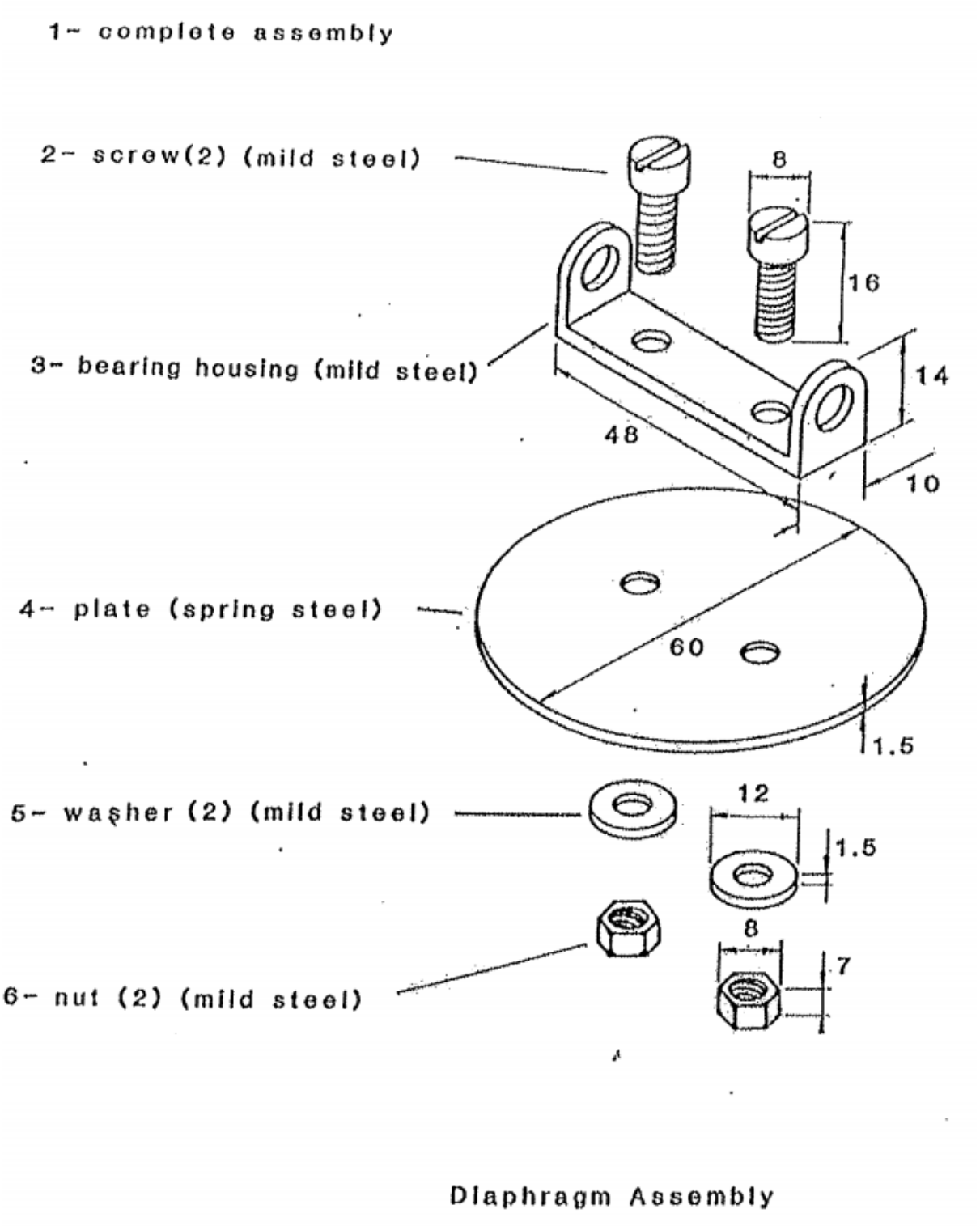
For each components, assumption may be made regarding dimensions and material properties of individual components if required. Justifications are to be provided.

Please refer to “Design of a Robotic Assembly Cell (Explanatory Notes)” for further information and guidance on the project.

Section 2A: Pneumatic Piston Sub-Assembly (dimensions in mm)



Section 2B: Diaphragm Assembly (dimensions in mm)



Diaphragm Assembly

Section 3: Marking Rubrics

1. **Component rationalisation/ redesign (2 marks)**
2. **Fixture design (3 marks)**
3. **Selection/design of orientation and feeding devices (3 marks)**
4. **Gripper Design (3 marks)**
5. **Robot Selection (2 marks)**
6. **Flowchart of robot program (2 marks)**
7. **Workcell layout (2 marks)**
8. **Cycle time analysis (2 marks)**
9. **Design of safety system (2 marks)**
10. **Report presentation and comprehension (2 marks)**
11. **Challenge (2 marks)**

Challenge:

In modern industry, robot system with modular design are preferred to achieve lower cost and higher efficiency in assembly production. Modular design promotes convenience in system maintenance, lower replacement cost and flexible production. Therefore, students are encouraged to design a robot based manufacturing cell with modular design.

Design of a Robotic Assembly Cell (Explanatory Notes)

1. Select either the Pneumatic Piston Subassembly or Diaphragm Assembly for your project.
2. If you selected the Pneumatic Piston Subassembly you can reduce the number of components as part of component rationalisation and redesign. The number of components cannot be reduced for the Diaphragm Assembly.
3. Note that the circular shape of the plate should remain unchanged in the Diaphragm Assembly.
4. Read sections 5.1-5.9 of notes (RSD Assignment Notes.pdf) and relevant lecture notes on Canvas prior to carrying out component re-design/rationalisation. Design changes may be carried out to components to aid automated feeding, orientation, gripping by robot, insertion, assembly or to reduce cycle time. All design changes have to be approved by your tutor prior to implementation.
5. A fixture is required to securely hold the components during the assembly process. The fixture could contain pneumatically operation components.
6. Read section 5.10 of notes (RSD Assignment Notes.pdf) and relevant lecture notes on Canvas prior to designing/ selecting feeding and orientation devices for components in assembly. Detailed drawings/ sketches have to be provided on the track design if incorporated in the feeders.
7. Read sections 1.1 to 1.6 of notes (RSD Assignment Notes.pdf) and relevant lecture notes on Canvas prior to carrying out the Robot Selection exercise. At least three types of robots have to be compared in terms of payload, work envelope, repeatability, speed, acceleration and degrees of freedom prior to selecting the preferred option.
8. Read Section 6 of notes (RSD Assignment Notes.pdf) and relevant lecture notes on Canvas prior to carrying out end effector design for the robotic assembly operations. Grippers have to be pneumatically operated. Vacuum grippers and screw driver mechanisms can also be used if required. Detailed drawings/sketches have to be provided to describe the operation of the gripper mechanism(s).
9. The flowchart for the robot program for product assembly should contain information on all events relating to robot motion, component manipulation, assembly and sensing operations. The robot motion across the cell should be marked by waypoint on the manufacturing cell plane from the top view to illustrate the path planning in your flowchart.
10. The assembly cell design should incorporate a structured environment. Hence only simple on/off snesors (ie: microswitches, inductive sensors, capacitive sensors, light sensors are permitted). Sensors that are not listed here must be approved by tutor prior to its implementation.
11. A dimensioned drawing/sketch should be provided for the workcell layout. It should contain information relating to the location of the robot, fixture and component feeders. They waypoint of the robot assembly routine should also be marked clearly.
12. Read section 4.2.2 of notes (RSD Assignment Notes.pdf) and relevant lecture notes on Canvas prior to carrying out cycle time analysis. In carrying out cycle time analysis, ensure that all robot motions are split into three elements; fast, medium and slow speed as appropriate to ensure reliable assembly of the product. It is recommended that these speeds are fixed at 90%, 50% and 10% of the maximum speed listed for the selected

robot. Ensure that sufficient delay elements (ie:0.5~1.0 sec) are included at appropriate points in the assembly cycle to ensure consistent and reliable assembly operations.

13. Read section 3 of notes (RSD Assignment Notes.pdf) and relevant lecture notes on Canvas prior to designing the safety system for the robot assembly cell. Only hardware and procedural elements of the safety system need to be described.

Please note that all design changes to components have to be approved by your tutor prior to proceeding with the rest of the assembly cell design.