Test Project

Module 2 Mechanical design challenge

Mechanical Engineering CAD

Submitted by:

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Introduction

The project contains the following documents/files:

- Printed task
- Printed drawings of parts or assemblies for modeling
- Supplied files (folder…. /M2_GIVEN FILES).

Description of project and tasks

Your company is currently developing a robotic manipulator project. You are required to carry out further development as follows.

Apart from instructions, you are free to choose Inventor or Fusion to complete the task.

You have 6 hours to complete the project.

Instructions to the Competitor

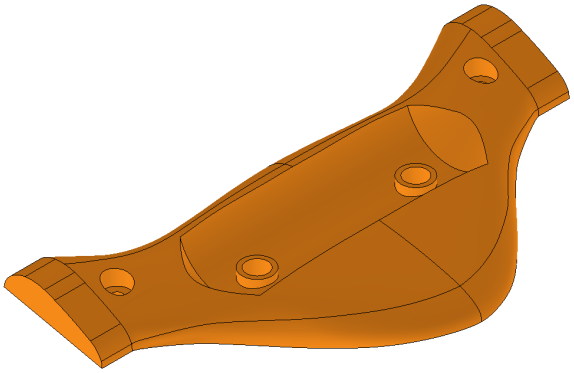
Review the printed drawings, Test Project description and 3D data files, then model the components as requested, and generate detailed drawings, an animation and 3D printed parts.

Model and Assemble Components

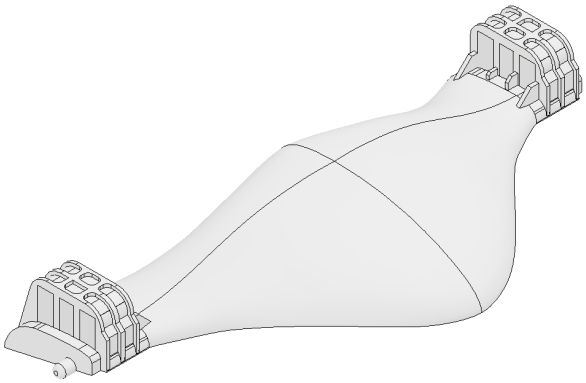
1. Based on the provided drawings, create the model of part G as follows:
   (a) Use Autodesk Inventor to create three (3) switchable Model States: G1, G2 and G3. Alternatively, you may use Configurations in Fusion.
   (b) Set the appearance as Clear – Blue.
   (c) Create the embossed text using the Tahoma font with a text height of 3.5 mm.
   (d) Save the part as G.ipt.
2. Based on the provided drawings, complete the design for the subassembly HM-06 as follows:
   (a) Calculate the missing dimensions E and F of connecting rod parts HM-06-B07 and HM-06-D04 so that part HM-06-B05 rotates through 38.86° and G1 delivers 1.81683 ml of liquid.
   (b) Modify the dimensions of parts HM-06-B07 and HM-06-D04 according to the calculated results. The dimensions shall be accurate to one (1) decimal place.
   (c) Complete the assembly of HM-06 as required.
3. Based on the provided drawings, complete the transmission design for the subassembly HM-03 as follows:
   (a) Based on the provided drawings and the provided parts HM-03-B04 and HM-03-D15, complete the design of the worm and worm gear set. The transmission ratio is 1:42, and the centre distance is 25 mm.
   (b) Based on the provided drawings and the provided parts HM-03-F04 and HM-03-B02, complete the design of the gear train. The number of teeth of part HM-03-F04 is 10.
   (c) The tooth profiles of both spur gears should be created by using the Export Tooth Shape function. Both export tolerances are 0.00765 mm.
4. Based on the provided drawings, complete the design for HM-09_M, design the 3D printed part and complete the assembly as follows:
   (a) Open parts HM-08-C01 and HM-08-D11. Refine the design of these parts according to the assembly requirements and injection moulding design principles to ensure they satisfy both assembly and manufacturing requirements. Particular attention shall be given to maintaining uniform wall thickness and adding appropriate reinforcing ribs.

(b) Use 3D scanner to obtain the necessary dimensions and features of the provided physical part HM-08-B08, and complete the reverse engineering model.
(c) Based on the mirrored solid of part HM-08-B08, design part HM-08-B09 so that it mates perfectly with HM-08-B08 and fulfils the intended function of HM-09_M.
(d) Based on the provided drawings, design the connecting rod part HM-08-D12 and assemble it into the assembly so that inputting 1.86983 ml of liquid into G3 can drive parts HM-08-C01 and rotate HM-08-C02 through 61.2°.
(e) The 3D printed parts HM-08-B09 and HM-08-D12 can be assembled with the related components without the use of any tools or additional standard parts. Design appropriate features and consider the relevant 3D printing manufacturing requirements.

5. Based on the provided drawings, complete the design for HM-11_T as follows:
   (a) Open parts HM-11-D05, HM-11-A15, HM-11-C12, and HM-11-F14. Refine the design of these parts according to the assembly requirements and injection moulding design principles to ensure they satisfy both assembly and manufacturing requirements. Particular attention shall be given to maintaining uniform wall thickness and adding appropriate reinforcing ribs.
   (b) Based on the provided drawings, design the connecting rod part HM-11-D03 and assemble it into the assembly so that inputting 1.86983 ml of liquid into G3 can rotate parts HM-11-B10 and HM-11-B11 through 43.4°. Refine the design of the part according to the injection moulding design principles.
6. Based on the provided drawings, refine the component HM-08_R by reusing the identical parts from HM-09_M.
7. Create mirrored component HM-10_L based on HM-08_R. Name the mirrored part of HM-08-A14 as HM-10-A11. All other parts need to be reused with their original names unchanged.
8. Based on the provided drawings, complete the structural design for subassembly HM-04 as follows:
   (a) Based on the provided drawings, design the missing limit features on part HM-04-C04, so that part HM-04-F18 has a travel range of 18° and remains relatively fixed at both end limit positions with reduced risk of unintended movement.
   (b) Based on the provided drawings, design the missing limit features on part HM-04-F18, so that part HM-08-A14 has a travel range of 45° and remains relatively fixed at both end limit positions and the intermediate position, with reduced risk of unintended movement.
9. Create mirrored subassembly HM-05 based on HM-04. Name the mirrored part of HM-04-C04 as HM-05-C05, and the mirrored part of HM-04-D14 as HM-05-D13. All other parts need to be reused with their original names unchanged.
10. Based on the provided drawings, complete the structural design for subassembly HM-02 as follows:
    (a) Open part HM-02-D01 and modify it as a right-hand lead screw with a lead of 3 mm.
    (b) Open part HM-02-F20 and design the required thread profile feature to mate with HM-02-D01.
    (c) Create a mirrored part of HM-02-D01 and save it as HM-02-D02.
    (d) Use 3D scanner to obtain the necessary dimensions and features of the provided physical part HM-02-C11, and complete the reverse engineering model.
    (e) Based on HM-02-C11 and with reference to the illustration below, design the mating part and name it as HM-02-D07.
    (f) Using Texture Extrude tool in Fusion, add the texture feature to the reverse-engineered HM-02-C11 model, export it as an STL file, and save it as HM-02-C11-ET.
    (g) The 3D printed part HM-02-D07 shall fit perfectly with the physical part HM-02-C11. Design appropriate features and consider the relevant 3D printing manufacturing requirements.



HM-02-D07



HM-02-C11

11. Create three (3) Model States in assembly HM-00, corresponding to the three (3) different installation positions of HM-11_T.
12. Add flexible hoses to HM-00 by using the Autodesk Inventor Tube & Pipe according to the drawing information.
13. Create a 3D printing file as follows:
    (a) Add embossed features where appropriate to state your workstation number (e.g., 001) on the surface of the three (3) parts requiring 3D printing: HM-08-B09, HM-08-D12, and HM-02-D07. Use the font ISOCPEUR. The text height for parts HM-08-B09 and HM-02-D07 is 8 mm, while the text height for part HM-08-D12 can be defined by yourself
    (b) The three (3) parts should be printed together in a single print job.
    (c) Printing material: PLA; layer height: of your own choice; printing time: no longer than 5 hours.
    (d) Generate the printing file using the software compatible with the 3D printer, and name it as "3DP_2-digit country code".
14. Based on the provided drawings, using Fusion's Generative Design module, complete the optimized design of part HM-06-B05. Export the design results as follows:
    (a) Generate one (1) optimized design result.
    (b) Export the mesh model of the optimized design result, named HM-06-B05-M, and save it in the "RESULT" folder.
    (c) Export the solid model of the optimized design result, using T-Spline tool to edit the part if necessary. Name it HM-06-B05-S and save it in the "RESULT" folder.
15. According to the design brief, using Fusion's Volumetric Lattice tool, complete the lattice structure design of part HM-06-D04. Export the design results as follows:
    (a) Generate the lattice design result according to the drawing requirements and save it as HM-06-D04-M.f3d in the "RESULT" folder.
    (b) Export the mesh model of the lattice design result and save it as HM-06-D04-M.stl in the "RESULT" folder.
16. Assemble all designed parts into the main assembly HM-00 and complete the final assembly.

Create Detailed Drawings

1. On a sheet (size A2), present the components HM-09_M and HM-11_T as follows:
    (a) Add position views of each component at its limit positions and indicate the piston travel dimensions.
    (b) In the position views, indicate the connecting rod lengths "G" and "E".
    (c) Fully present the part structures and annotate dimensions of parts HM-11-D03 and HM-08-D12.

2. On a sheet (size A2), create view of HM-00 as follows:

(a) Add three (3) views showing the three (3) possible installation positions of HM-11_T.
(b) No dimensions or other additional information are required.

3. On a sheet (size A2), create the assembly drawing of HM-00 as follows:
   (a) Add views showing the two (2) states of all fingers: the fully opened state and the fully gripped state.
   (b) Add position views showing HM-10_L and HM-08_R fingers adjusted 22.5° to the left and right, respectively, to demonstrate the adjustable range of subassemblies HM-04 and HM-05.
   (c) Add a detail view to show the connecting rod structure of HM-06 and indicate the required connecting rod length dimensions.
   (d) Add a shaded isometric view with edges. The pipes and piston cylinders should be displayed as transparent.
   (e) Add the necessary installation dimensions and range dimensions.

Create an Animation

1. Create an animation as follows:
   (a) Duration: not longer than 60s; format: AVI; screen size: 1920x1080
   (b) Rotate 360°, display the entire assembly in an isometric position.
   (c) From an isometric perspective, manipulate parts HM-06-C06, HM-06-D17, and HM-06-F10, HM-07-A07 to control the hydraulic cylinders to drive the finger movements, demonstrating the gripping and opening actions of the fingers.
   (d) Provide close-up views showing the adjustment process by rotating HM-03-D16, which drives the three (3) finger modules on the upper part of HM-03 to rotate and move up and down. Use multiple viewing angles to clearly demonstrate the internal motion of the worm gear mechanism.
   (e) Sequentially grasp a bottle and a steel ball. The movement should be reasonable.
   (f) Display the ±22.5° adjustment range of the finger joints on both the left and right sides.
   (g) During the entire motion process, all flexible hoses adaptively follow the movement of the robotic hand. The hoses shall not be hidden or interfere with any other components.
   (h) Save the animation file as "Motion Animation".

Marking Scheme

CRITERION	SUBCRITERION	MARKS		
		Judgement	Measurement	Summary
B1	Fulfillment of the Design Brief	-	11.7	11.7
B2	Model Design	-	3.1	3.1
B3	Optimization Design and Study	-	3.1	3.1
B4	3D Printing	1	2.3	3.3
B5	Motion Animation	1	2.8	3.8
		2	23	**25**

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