Evaluation scheme

Evaluation for each of the days is attached below

Day-01: Optimization Intro and MATLAB warmup

- The first day is only warmup and is not evaluated

Day-02: Robot Design [100]

Five-bar workspace optimisation [50]

Working code to obtain the solution for the constrained problem [25]

- Q1. What do you observe upon solving the unbounded optimisation problem, i.e., what is the solution and what does it mean? [5]
- Q2. What do you observe upon solving the bounded optimisation problem, i.e., what is the solution and what does it mean? [5]
- Q3. How do the results compare with the two-link robot optimised using pen and paper?
    - Draw the robot configuration corresponding to the optimal values [2.5]
    - Explain the resulting optima (why the link lengths and the offsets are so) [2.5]
- Q4. (Bonus) Considering collision between the robot links and the human ellipse as a non-linear constraint by checking intersection between links and the ellipse [10]

Attachment point optimisation [50]

Working code of the unconstrained problem [25]

- Q1. Draw the flow-chart for the bi-level optimisation problem (design and forces) [2.5]
- Q2. Draw ADG for the optimisation problem [2.5]
- Q3. Plot objective function value vs iterations of the optimisation [5]
- Q4. Qualitatively how do you choose the termination iterations [2.5]
- Q5. What are the optimal values for the design variables? Add an image of [5]
- the cables and the link.
- Q6. Modify the swarm size with atleast two different values and repeat the experiment and document how it affects the optimal value and the computation time. [5]
- Q7. What are the function and convergance tolerance for the chosen algorithm in the linear programming and how does it affect the solution? (see linprog documentation) [2.5]

Day-03: Control Synthesis [100]

2R-robot trajectory optimisation [50]

Working code of the robot moving from [0,0,0,0] to [pi,0,0,0] [25]

- Q1. Solve the problem using fmincon and provide reasons for your observations? [4]
    - Document the state and control values obtained for your chosen initial and final state values [2]
    - Document the motion of the robot as a gif/video [2]
- Q2. Solve the problem using different algorithms available, \`sqp\`, \`active-set\`, \`interior point\` and note the following: [5]
    - Number of iterations [1]
    - Time taken [1]
    - Number of function evaluations [1]
    - Objective function value at optima [1]

    - Difference in the obtained solution by plotting the corresponding states and torques on the same plot [1]
- Q3. How does the final solution change when: (change atleast to two values and document the solution obtained with atleast one expected reason for the solution) [7]
    - tf is changed [1]
    - N is changed [1]
    - x0 is changed [1]
    - xf is changed [1]
    - g is changed [1]
    - l1, l2, m1, m2 are changed [1]
    - Difference in the obtained solution by plotting the corresponding states and torques on the same plot [1]
- Q4. Give a better initial guess for the states and see how the simulation time and iterations and the solution quality changes (Ex. Use any interpolation between initial and final states as initial guess) [2]
- Q5. Modify the bounds on states and control and see how the behavior of the solution changes? can you find a solution for a small value of control bounds? Why? [2]
- Q6 (Bonus). Modify the discretisation scheme from Euler to Hermite-Simphson or another and document the nature of the solution. See how system behavior changes [2.5]
- Q7 (Bonus). Give the obtained control input to the system and observe the system performance? Does the robot reach the final position as expected? [2.5]

Musculo-skeletal robot trajectory optimisation [50]

Working code for the musculo-skeletal robot [20]

- Q1. How does modifying these variables effect the solution obtained? [5]
- Q2. Plot the resulting states and control input [3]
- Q3. Write a code similar to `robolinplot` to visualise the resulting trajectory of the musculo-skeletal robot [5]
- Q4. Repeat Q1-Q2, Q3.1-3.4, Q4, Q5 from the previous problem [17]

Day-04: Co-design [50]

2R-planar robot: Bi-level optimisation [50]

Working code of the bi-level optimisation [25]

- Q1. What is the trivial solution for link lengths when there are no constraints? Why? [5]
- Q2. Add a cost for control input (J), workspace, cost of the robot with appropriate weighting to get a non-trivial solution? Qualitatively explain the solution. [10]
- Q3. Choose different weighting between cost functions and document the result of the mechanical design variable values [5]
- Q4. (Bonus) Add strength constraints and re-optimise the problem and document and qualitatively explain the solution [5]

Total score possible: 250

But since bonus is included you do not have to solve all the questions.