[Notice] Brunel University London will severely punish the students who are involved in the following list of academic misconduct as shown in the next page, and the detailed information on the academic misconduct is described in the following link).

In all proven cases of academic misconduct, the decision maker will seek to remove any academic advantage gained by the student through the identified misconduct. The decision maker will normally impose a penalty for proven cases (see the following link).

https://www.brunel.ac.uk/about/documents/pdf/Academic-Misconduct-Procedure-2020-07-01.pdf

**22.** The following is a non-exhaustive list of conduct which where proven will normally constitute academic misconduct:

a) **Plagiarism**, which is defined as the knowing or reckless presentation of another person's work or ideas as one's own, and includes the use of published or unpublished work without acknowledging the source;

b) **Unpermitted recycling / re-using work** which means submitting work for assessment which has previously been submitted, in whole or in part, for assessment at this or another institution, without explicitly acknowledging and referencing the assessment and qualification for which the material was previously submitted, and unless expressly permitted by the assessment brief;

c) **Cheating**, which is defined as acting dishonestly or unfairly in order to gain an academic advantage. This includes:

1. the falsification of information, data or evidence or experimental results; and/or
2. cheating in examinations or other formal assessment, including possession of unauthorised material or technology during an examination and/or attempting to access unseen assessment materials in advance of an examination;
3. arranging for someone else to impersonate a student by sitting their examinations;

d) **Collusion,** which is defined as aiding or attempting to aid another member of the University in order to gain an unfair academic advantage by;

1. The unauthorised and/or unacknowledged collaboration of persons in a piece of assessed work, and/or;
2. Allowing a piece of assessed work to be copied by another person or persons;

person or persons;

In both these instances, all persons involved are liable to be penalised;

e) **Contract cheating,** which is defined as obtaining or purchasing work from another person or organisation and submitting it as one's own for assessment, where such third-party input / assistance is not permitted (such as the use of essay mills, buying work online [including code and/or games]) or paying someone else to conduct research for them or sit their examinations;

f) **Research misconduct**, as defined in the Research Integrity Code of Practice (concerns about research misconduct should first be reported to the Registrar, who may refer a matter for consideration under this Regulation);

g) **Submitting fraudulent extenuating circumstances claims** or falsifying evidence in support of extenuating circumstances claims (this may also be considered non-academic misconduct as defined in paragraph 21 of the Student Disciplinary Procedure);

h) **Breaches** of any University rules, regulations, policies or procedures relating to academic activity or assessment, such as the Examinations Policy;

i) **Failing, without good reason, to cooperate in the University's process of assessment,** e.g. by refusing to take part in a *viva* for a taught assessment as set out in Senate Regulation 4.

**23.** Failure to comply with a decision taken under this procedure may constitute misconduct and may be referred for consideration under the Student Disciplinary Procedure.

**Reporting of concerns**

**24.** A concern that a student has committed academic misconduct as defined under Paragraph 22 should first be reported to the Deputy Dean (Academic Affairs) of the student's College.



## Computer-Aided Engineering 2023-24 (assignment ver 2023.Oct.29)

## Assignment: Synthesis and Dynamic Simulation of a mechanism

**Lecturer: Dr Yohan Noh (email: yohan.noh@brunel.ac.uk)**

## Question 1:

Given a mechanism with the link lengths $L_{1x}$ = 0.62 m, $L_{1y}$ = 0.19 m, $L_2$ = 0. 325 m, $L_3$ = 0.16 m, and $L_4$ = 0. 18 m, $L_{5x}$ = 0.1 m, $L_{5y}$ = 0.16 m, $L_6$ = 0.35 m, $l_{g2}$ = 0.17115 m, $l_{g3}$ = 0.09026, $l_{g4}$ = 0.09m, $l_{g6}$ = 0.175m, $I_2$ = 0.089191665 kg·m$^2$, $I_3$ = 0.01389689, kg·m$^2$ $I_4$ = 0.01435385 kg·m$^2$ , and $I_6$ = 0.130437 kg·m$^2$, find the values for $\theta_3$, $\theta_4$, $\theta_5$, $\theta_6$, $\omega_3$, $\omega_4$, $\omega_5$, $\omega_6$, $\alpha_3$, $\alpha_4$, $\alpha_5$, and $\alpha_6$ as shown in Figures 1, 2, and 3 for the open circuit of the linkage assuming $\theta_2$ = 54.12°, $\omega_2$ = -25 rad/sec, and $\alpha_2$ = -15 rad/sec$^2$.

The mass density is ρ=30000kg/m$^3$, the link thickness T is 0.02 m, the joint shaft and hole diameter is 0.025 m, and the link radius is 0.02 m.

There is an external torque ($\tau$ N·m) on one of the links, applied at the centre of mass on one of the links, and at the same time an external force of $F_p$ acts on link 5, applied at point $p$ and $l_f$ [m] away from point A. Please note that depending on your student ID, you will get a different $F_p$ and $l_f$ values (see the additional document).

Find $F_{12}$, $F_{32}$, $F_{62}$, $F_{43}$, $F_{54}$, $F_{56}$, and $F_{15}$ at the joints and the driving torque $\tau_{12}$ needed to maintain motion with the given angular velocity $\omega_2$ = 25 rad/sec and acceleration $\alpha_2$ = 15 rad/sec$^2$ for this instantaneous position of the link (Figures 1 to 3).

1) Find the values of $\theta_3$, $\theta_4$, $\theta_5$, $\theta_6$, $\omega_3$, $\omega_4$, $\omega_5$, $\omega_6$, $\alpha_3$, $\alpha_4$, $\alpha_5$, and $\alpha_6$
2) Find the centre of mass values $l_{g5}$ of link 5.
3) Find the mass moment of inertia (kg·m$^2$) about the centre of mass of link 5.
4) Find the values of $A_{g2}$ $A_{g3}$ $A_{g4}$ $A_{g5}$ $A_{g6}$ of links 2, 3, 4, 5, and 6 (see Figure 3).
5) Find the force and moment equations for dynamic force analysis on links 2, 3, 4, 5, and 6, and cast the equations in the matrix form, and find the values for $F_{12}$ ($F_{12x}$ and $F_{12y}$), $F_{32}$ ($F_{32x}$ and $F_{32y}$), $F_{62}$ ($F_{62x}$ and $F_{62y}$), $F_{43}$ ($F_{43x}$ and $F_{43y}$), $F_{54}$ ($F_{54x}$ and $F_{54y}$), $F_{56}$ ($F_{56x}$ and $F_{56y}$), and $F_{15}$ ($F_{15x}$ and $F_{15y}$) at the joints and the driving torque $\tau_{12}$ needed to maintain motion with the given angular velocity and acceleration of $\omega_2$ = 25 rad/sec and $\alpha_2$ =15 rad/sec$^2$, respectively, for this instantaneous position of the link (please use MATLAB to calculate the derived matrix, add all the codes to the assignment, and upload them on Wiseflow).

Regarding question 1, you have to write down the complete derivation of 1) to 5) rather than the final equation, and you have to write the assignment using MS WORD (please see an attached example assignment). I do not accept a handwriting report, and it will be 0 points.

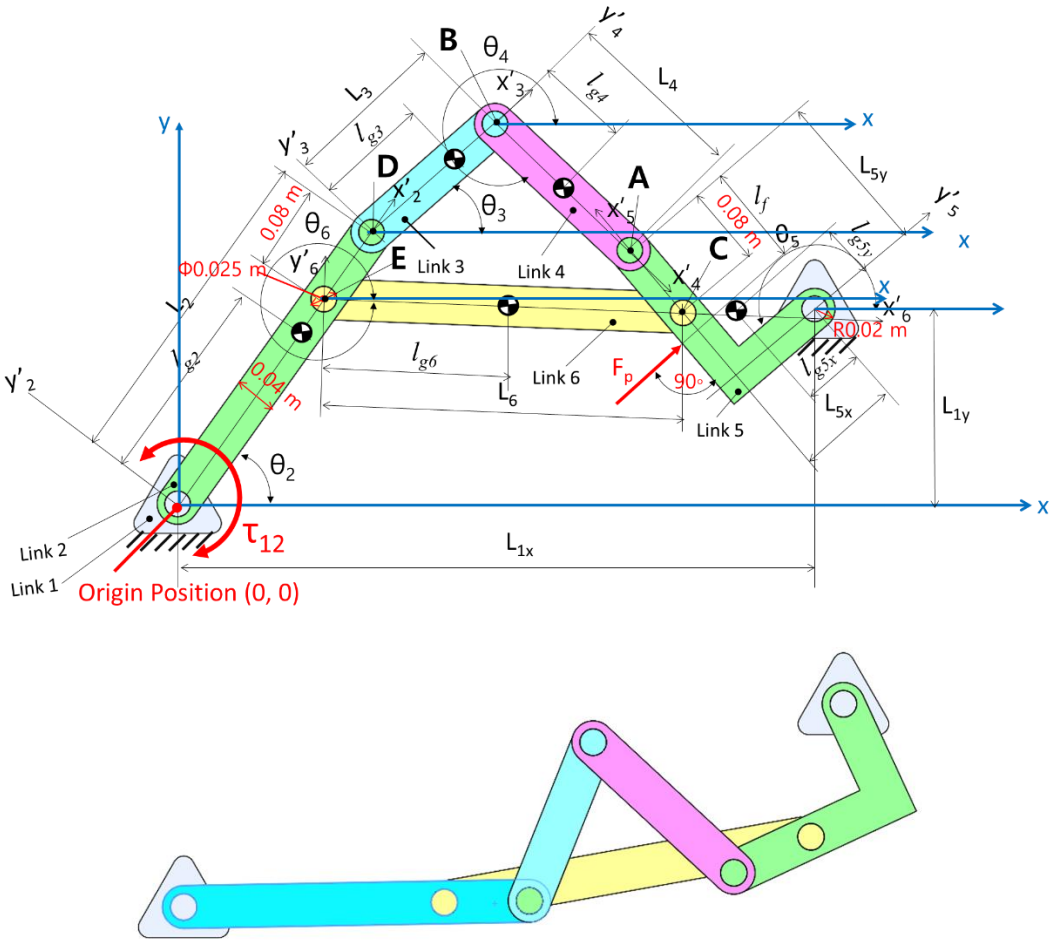


*Figure 1 Dynamic force analysis of a mechanism (front view)*

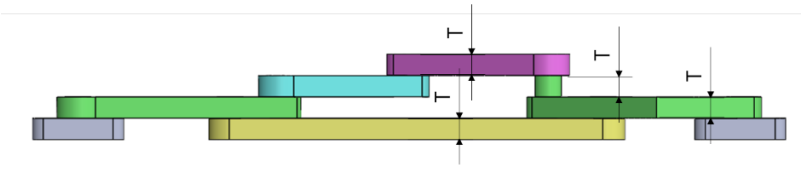


*Figure 2 Dynamic force analysis of a mechanism (bottom view)*

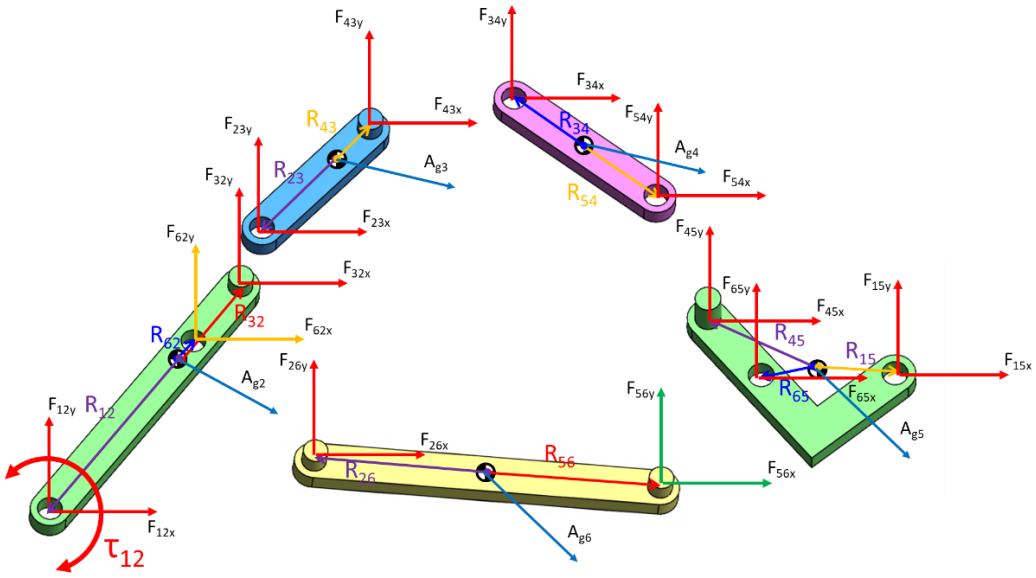


*Figure 3 Dynamic force analysis of a mechanism (free-body diagrams)*

**Question 2:**

For the mechanism described in Question 1, simulate it for the case in which the motion begins with a given crank angle $\theta_2$[rad] (find it in the figure), a given crank angular velocity $\omega_2 = 0$ rad/s and a given angular acceleration $\alpha_2 = -0.45$ rad/s$^2$ in link 2.

The matrix equation (matrix form in Question 1) is solved using a MATLAB User-defined function that will take all of the integrator outputs as input arguments (Figure 4).

1) Plot the values of $\theta_2$, $\theta_3$, $\theta_4$, $\theta_5$, and $\theta_6$ for the first 2 seconds.
2) Plot the values of $\omega_2$, $\omega_3$, $\omega_4$, $\omega_5$, and $\omega_6$ for the first 2 seconds.
3) Plot the values of $\alpha_2$, $\alpha_3$, $\alpha_4$, $\alpha_5$, and $\alpha_6$, for the first 2 seconds.
4) Plot the values of $A_{g2}$ ($A_{g2x}$ and $A_{g2y}$), $A_{g3}$ ($A_{g3x}$ and $A_{g3y}$), $A_{g4}$ ($A_{g4x}$ and $A_{g4y}$), $A_{g5}$ ($A_{g5x}$ and $A_{g5y}$), and $A_{g6}$ ($A_{g6x}$ and $A_{g6y}$) of links 2, 3, 4, 5, and 6 for the first 2 seconds.
5) Plot $F_{12}$ ($F_{12x}$ and $F_{12y}$), $F_{32}$ ($F_{32x}$ and $F_{32y}$), $F_{62}$ ($F_{62x}$ and $F_{62y}$), $F_{43}$ ($F_{43x}$ and $F_{43y}$), $F_{54}$ ($F_{54x}$ and $F_{54y}$), $F_{56}$ ($F_{56x}$ and $F_{56y}$), and $F_{15}$ ($F_{15x}$ and $F_{15y}$) at the joints and the driving torque $\tau_{12}$ needed to maintain motion for the first 2 seconds.

Regarding Question 2, you have to show the graphs of 1) to 5), paste the codes presented in the user-defined function (you have to add comments to explain why you used the MATLAB commands in the codes) on the assignment, and upload the simulink file (.slx) on WISEflow.

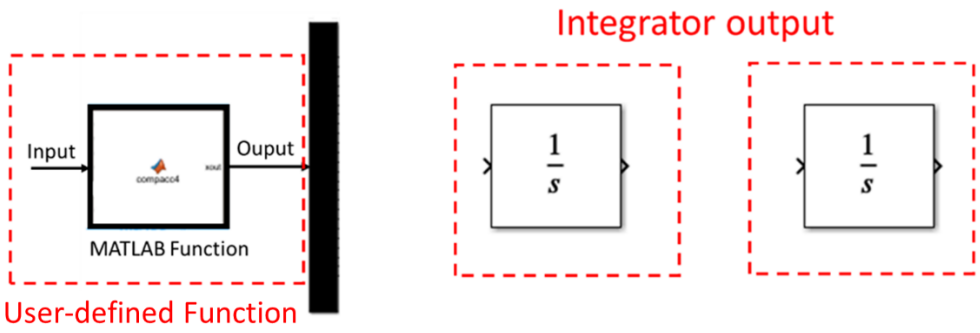


*Figure 4 Simulink realisation of full dynamics simulation of a mechanism*

If you have any questions on this assignment, please contact me at my email or text me on Team, I will kindly inform you of the questions.