Second Semester Examination
2020/2021 Academic Session

July/August 2021

EMM242 – Dynamics

Please check that this examination paper consists of **FOUR (4)** before you begin the examination.

Special instruction as follows:

a. This is an open book examination (useful equations can be found from EMM242 lecture notes.)
b. Using wildcard data generated from EMM242 e-learning pages for Question 3.
c. Examination duration is shown in Table 1.

Table 1: Examination duration

The examination duration is 2 hours and 15 minutes and the time to upload the answers to elearning is 15 mins for each numeral numbered question. Each question will be given in a serial time block. Total examination time is 2 hours and 45 minutes. Breakdown of time allocation for each question is as follows: Question No. 1 – First block of 45 minutes (answering) dan 15 minutes (upload), Question No. 2 – Second block of 45 minutes (answering) dan 15 minutes (upload), Question No. 3 – Third block of 45 minutes (answering) dan 15 minutes (upload), All answers must be uploaded using pdf format to the appropriate submission button on e-learning.

Instructions : Answer **ALL** questions.

Answer to each question must begin on a new blank/lined A4 paper.

1. Figure 1 shows a slider-crank mechanism. Assuming that the engine is running at constant speed of 3600 rpm and the dimensions are OA=40 mm AB=120 mm, calculate the following when the angle BOA = 90 degrees

    (i) The angular velocity of the connecting rod AB **(20 marks)**

    (ii) The linear velocity of the piston B **(20 marks)**

    (iii) The angular acceleration of the connecting rod AB **(20 marks)**

    (iv) The acceleration of the piston B **(40 marks)**

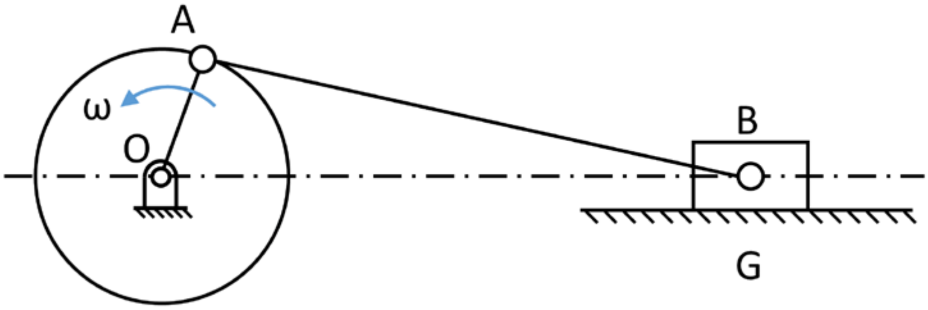

Figure 1

2. [a] Figure 2 [a] shows a *m** kg object with radius of gyration, ρ_G*= *k* m, about its center of gravity, *G* is pinned at point *O* and is subjected to the couple moment, M_c^* Nm. If at this instant, it has angular velocity of ω* rad/s:

   (i) Draw the free body diagram and the kinetic diagram of the object.
   (ii) Determine the support reaction at point *O*.

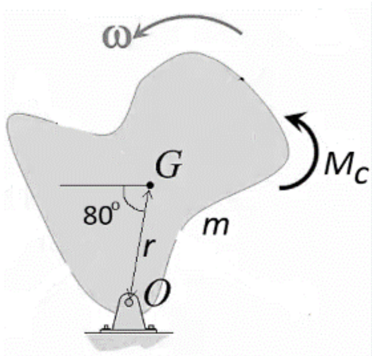

Figure 2 [a]

**The constants: r, m, ρ_G, M_c and ω will be provided using a wildcard function on EMM242 e-learning webpage related to Q2[a].*

(50 marks)

[b] Consider the spring-pendulum system in Figure 3 [b] below. The pendulum is supported by a linear spring of constant, *k** and unstretched length, r_u^*. Neglect friction at the pivot *O*, the mass of the spring, and air resistance. Treat the pendulum bob as a particle of mass, *m** and use polar coordinates. The gravity is acting downward.

   (i) Draw the free body diagram and the kinetic diagram of the pendulum bob.

   (ii) Derive the equations of motion for the pendulum bob.

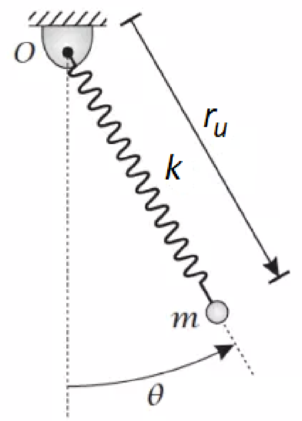

Figure 3 [b]

** The constants: k, r_u, m and θ will be provided using a wildcard function on EMM242 e-learning webpage related to Q2[b].*

(50 marks)

3. [a] Figure 3 (a) shows the operation of two tugboats which exerting a constant force F on the ship. These forces are always directed perpendicular to the ship's centreline. The ship has a mass m and a radius of gyration about its center of mass of ρ. The ship is originally at rest. Based on principle of work and energy and neglect the effect of drag,

   i. explain the movement of the ship due to the operation of the tugboats with the equal force F for each tugboat, and

   ii. explain the effect of unequal force from each tugboat.

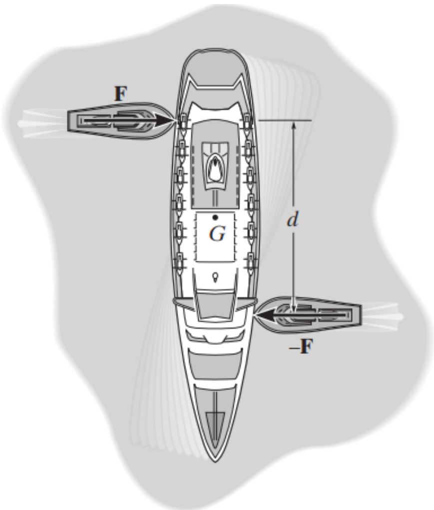

Figure 3 (a)

(40 marks)

[b] Figure 3(b) shows rod AB, with (2+Y) kg mass where Y is the last digit of student's matric number. The rod AB hangs in the vertical position. A block with 1 kg mass, sliding on a smooth horizontal surface with a velocity of 3.6 m/s, strikes the rod at its end B. Determine the velocity of the block immediately after the collision. The coefficient of restitution between the block and the rod at B is e = 0.8.

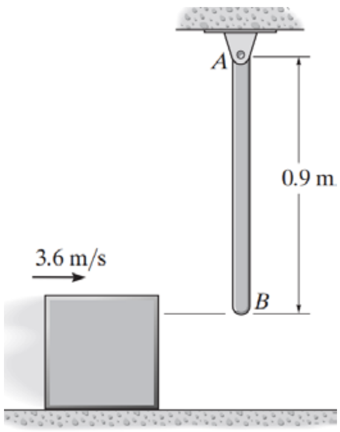

Figure 3 (b)

(60 marks)

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