Ain Shams University
Faculty of Engineering
Eng Physics & Math.Departement

Engineering Math (PHM 663)
Fall 2021
Allowed Time: 2 Hrs.

Total mark (70)

The exam is composed of 6 questions in one page. The mark for each question is (20) marks

Part (1): Answer TWO questions only

1) a) Show that the function: $u(x,y) = e^{3x} \cos 3y + 6x - 12y + 10$ is harmonic and find its corresponding analytic function

$f(z) = u(x,y) + iv(x,y)$, Find $f'(z)$.

b) If C is the circle $|z| = 8$ and if $g(z_o) = \oint_C \frac{2z^4 + 3z^2 + 6z + 8}{(z-z_o)^3} dz$. Find: i) $g(3+i)$, ii) $g(9+4i)$

2) a) Find all values of z such that:

   i) $e^{2z+2} = 4 + 4i$, ii) $\cos 2z = 15$, iii) $2z = \ln(5 - 5i)$

b) Evaluate the following integrals:

   i) $\int_0^\infty \frac{dx}{(x^2+4)(x^2+25)}$

   ii) $\oint_C \frac{\cosh(2z)}{z^4 + 4z^2} dz$, where C: $|z| = 3$

   iii) $\oint_c (z^3 + 5z^2 - 8) e^{\frac{2}{z}} dz$ where C: $|z| = \frac{1}{2}$

3) a) Find all Laurent series that represent the function $f(z) = \frac{11z + 12}{z^2 - z - 6}$ in different domains.

b) Evaluate the following integrals: i) $\int_{-\infty}^\infty \frac{dx}{(x^2+9)(x^2+1)}$ ii) $\oint_C \frac{\sinh(3z)}{z^3 + 2iz^2} dz$

c) Find all values of z such that: i) $z = (2 + 2i)^{3i}$ ii) $e^{2z} = (4 + 4i)$

Part (2): Answer TWO questions only

4) a) Evaluate the following integrals: $\int_0^\infty x^{\frac{-5}{2}} (2 - e^{-3x}) dx$. Hint: the first step use the integration by parts.

b) Find the series solution of: $(x^2 + 4)y'' + 6xy' + 4y = 0$, near ordinary point $x = 0$.

5) a) Find the area enclosed by the equation of the curve $x^{2/3} + y^{2/3} = a^{2/3}$.

b) Solve the initial value problem: $3y' - 4y = \sin(2t)$, given that: $y(0) = \frac{1}{3}$, using **La Place Transform**

c) Sketch the function $f(t) = \begin{cases} t & ; & 0 \le t \le 1 \\ 2 & , & t > 1 \end{cases}$ and use Heaviside unit step function to find its LaPlace Transform.

6) a) Solve the system of differential equations by using La Place Transform:

   $\frac{dx}{dt} + 2y = 1$, $\frac{dy}{dt} - x = 0$, given that $y(0) = x(0) = 0$

b) Solve the equation: $x(t) = \sin(t) + \int_0^t x(t-u)\cos(u) du$

c) Evaluate: $L^{-1}\left(\frac{s}{(s^2+1)^2}\right)$ and hence evaluate: $L^{-1}\left(\frac{1}{(s^2+1)^2}\right)$

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AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
MECHATRONICS ENGINEERING DEPARTMENT
Postgraduate

1st Semester, January 2022   Final Exam   Time: 2.00 Hrs

MCT 610: Design of Mechatronic system

17/1/2022   1/2

Support your answers with sketches and drawing as much as you can

Question (1)

a) What is the difference between Conventional Design (sequential) and Mechatronics System design (concurrent) using block diagram (2.5 marks)

b) Verification and validation are two essential terms of the V model. Locate these terms on their proper position of the V model and explain their function in designing the mechatronics system .

c) What are the main characteristics of the *concurrent engineering* and why does mechatronic design methodology is based *on concurrent approach*?

d) Explain the design procedures and stages that followed by VDI 2206 to design a mechatronic system. Use neat sketches to support your answer.

Question (2)

A bottling plant uses an automated mechanism for filling the containers and transporting them from one point to another as shown in Figure 2. The sensors monitor the amount of solid or liquid filled. A conveyor mechanism transports the containers. Under the concept of VDI 2206, design a mechatronic system for the case described. Identify the types and features of sensors you use, describe how the system works and explain how you are going to interface and control the system. Make suitable sketches if needed.
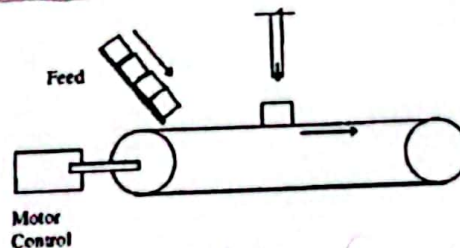

Fig. 2

Question (3)

A conveyor; shown in Fig.3; is used to transfer bags 15 kg in a production line. The conveyor main roller is connected to main servomotor through a gear box with the following specifications: Roller diameter=300mm, Roller length=1000mm, gear box reduction ratio=50:1, orientation=20° to the horizontal plane, conveyor belt weight=10 kg, working temperature=35°C, maximum number of bags on conveyor at the same time=10 bags. The motion profile: Type: 1/10 - 4/5 - 1/10 –Trapezoid, distance =500mm, move time=30s, dwell time=3s. Determine the peak and root mean square torque of the servo motor.
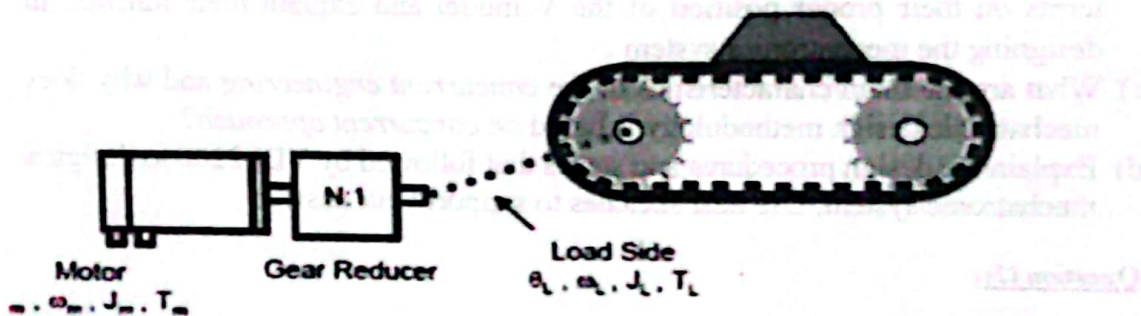

Motor
ω_m, ω_m, J_m, T_m

Gear Reducer
N:1

Load Side
θ_L, ω_L, J_L, T_L

Fig. 3

Best wishes

Examiner:
Dr. Shady Ahmed Maged