



Mansoura University
Faculty of Engineering



Final Exam –2-6-2024

Mechanical Design and Production Engineering Department

Time allowed: 3 hrs.

CAD CAM Principles (PDE342)

The Exam Consists of Four Questions in two A3 Pages

Maximum Points: 100 Points

Notes: It is forbidden to have any notes, books, or any other materials with you in the examination hall.

Model (1)

Question 1: (30 points)

Answer the following questions with **true** or **false**:

1. The maximum value for maneuverability at mobile robots can't exceed 4 for multiple steering vehicles.
(a) **True** (b) False
2. The main advantage of using CAM is the use of skilled labour with high performance computer techniques.
(a) True (b) **False**
3. Computer Aided Planning (CAP) is the process of managing the complete journey of a product from cradle to grave.
(a) True (b) **False**
4. Thermoplastic is a rapid prototyping technique that uses a liquid resin, which is then solidified by discriminating exposure to a specific wavelength of light.
(a) True (b) **False**
5. The main advantage of using NC machines is the low cost of maintenance and ease of use.
(a) True (b) **False**
6. Absolute mode in part programming is described in a distance related to the previous programmed point.
(a) True (b) **False**
7. Stalling condition occurs when the speed of the rotor part of the driver is equal to zero.
(a) **True** (b) False
8. Product analysis involves modification of the real part design based on market feedback.
(a) **True** (b) False
9. DC motors are preferable drivers for systems that need fast response and non-linear relationship between torque and speed.
(a) True (b) **False**
10. Calibration is considered a requirement of the periodic maintenance of CNC machines.
(a) **True** (b) False
11. Resolution in sensors is defined as the smallest increment in the measured value that can be detected.
(a) **True** (b) False

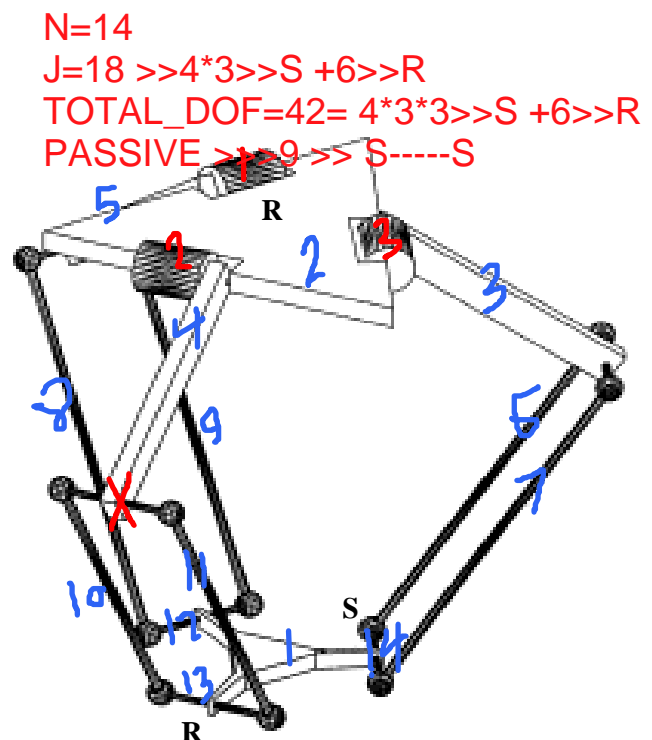
12. Passive DOF exist in parallel manipulators' limbs with spherical joints at both ends.
(a) **True** (b) False
13. The total deflection in serial manipulators is calculated based on weight of motors only.
(a) True (b) **False**
14. The instantaneous center of rotation of a multi-wheel mobile robot is the intersection of all parallel lines to the wheels' surfaces.
(a) True (b) **False**
15. Autonomous mobile robots detect obstacles and stop until the obstacle is removed.
(a) True (b) **False**
16. Cylindrical configuration (RRR) of serial manipulator is considered to have the largest workspace compared to other configurations.
(a) True (b) **False**
17. Digital sensors are more accurate and consume more power compared to analog sensors.
(a) True (b) **False**
18. Tactile sensors appear in many applications such as controlling the flow of materials at a production line.
(a) True (b) **False**
19. Parallel manipulator has workspace larger than serial manipulator.
(a) True (b) **False**
20. Brushed DC motors had a shorter life compared to DC brushless motors.
(a) **True** (b) False

Question 2: (30 points)

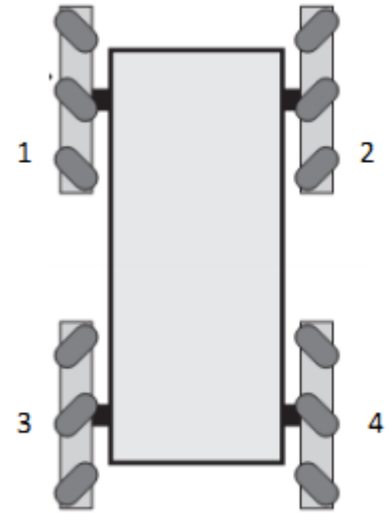
Select the **best** answer for the following questions.

For the parallel manipulator shown in figure below:

1. The total number of joints is equal to
(a) 12 (b) 15 (c) **18** (d) 39
2. The total number of DOF of whole manipulator is equal to
(a) 3 (b) 6 (c) 9 (d) **12**
3. The total number of DOF in case of considering passive DOF of each limb will be equal to
(a) **3** (b) 6 (c) 9 (d) 12



For the mobile robot shown in figure below, answer the following:



4. If wheels 1, 3 have forward motion and 2, 4 have backward motion, the whole direction of mobile robot will be
 (a) CCW Turn (b) Left Shift
 (c) **CW Turn** (d) Right Shift
5. If the same previous case, but wheel 3 will be placed Right and wheel 4 will be at left, the whole direction of mobile robot will be
 (a) CCW Turn (b) Left Shift
 (c) CW Turn (d) **Right Shift**
6. If wheels 1 and 2 are replaced with passive standard wheels, the total maneuverability of this mobile robot will be equal to
 (a) 2 (b) ~~4~~ (c) 5 (d) 7
7. The main advantage of parallel manipulator is that all motors are positioned
 (a) **at the base** (b) at the end effector (c) on links (d) b & c
8. parallel robot is considered one of the most famous manipulators that is used mainly in packaging at medical factories.
 (a) medical (b) surgical (c) **Delta** (d) Tricept
9. Quadruped robot is a type of a legged robotic system which have only legs.
 (a) 2 (b) 3 (c) **4** (d) 6
10. The point at torque-speed curve for a DC motor that cannot be work with a speed larger than the value at this point is called
 (a) stall point (b) No-load (c) singular (d) **operating point.**
11. The maximum cutting thickness for laser cnc machine is equal to
 (a) **2.75 inches** (b) 3.5 inches (c) 100 inches (d) 0.1 inches
12. mobile robots are used to climb mountains and walk on rough surfaces.
 (a) Wheeled (b) ROV (c) **Legged** (d) Flying
13. wheels are used at mobile robots and have three degrees of freedom during motion.
 (a) Omni-direction (b) Mecanum (c) **a & b** (d) castor
14. The maximum value of coefficient of friction used at wheeled mobile robots is equal to
 (a) 0.75 (b) 0.2 (c) 1.1 (d) **0.35**
15. loads are proportional to square of speed of motion such as air drag on aircrafts.
 (a) Constant (b) Linear (c) **Quadratic** (d) dynamic

16. elements are considered the most accurate elements to be used during meshing of complex bodies with small sharp edges.
 (a) **Tetrahedron** (b) Prism (c) Triangle (d) Pyramid
17. Engineers use to reduce the number of physical prototypes and run virtual experiments to optimize their designs.
 (a) optimization (b) FEA (c) PDEs (d) **a, b & c**
18. methods are considered the most accurate methods for analyzing any engineering system.
 (a) Analytical (b) Practical (c) Numerical (d) **a, b**
19. is the process of integrating CAD and CAM with CAP to design and analyze an accurate and optimum engineering system.
 (a) Numerical methods (b) **CAE** (c) CAPP (d) b & c
20. is the end row of any part programming to end the part programming code.
 (a) G21 (b) **M30** (c) M05 (d) G91

Question 3: (40 points)

Figure below shows a wheeled mobile robot with four wheels. If the total robot's weight is about **80 Kg**, and it can move with maximum speed **4 Km/hr** within **2 minutes** only on horizontal ground with maximum friction coefficient equal to **0.18**.

Answer the following questions based on the previous data given

1. The maximum pulling force needed to overcome friction for each wheel will be equal to N.

- (a) 13.76 (b) 141.12
 (c) 50.56 (d) **35.28**

2. The total power needed to drive the mobile robot with its maximum speed is equal to Watts.

- (a) 15.68 (b) 98.694
 (c) 156.8 (d) **157.5**

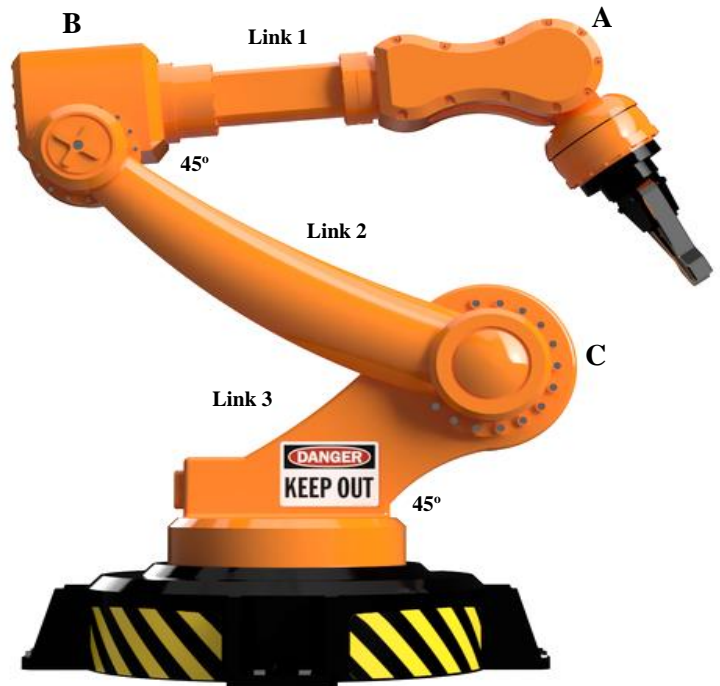


3. If the robot is climbing a terrain with angle equal to 15° . The maximum pulling force needed for the whole robot to overcome friction will be equal to N

- (a) 7.056 (b) **339.226** (c) 33.92 (d) 84.8

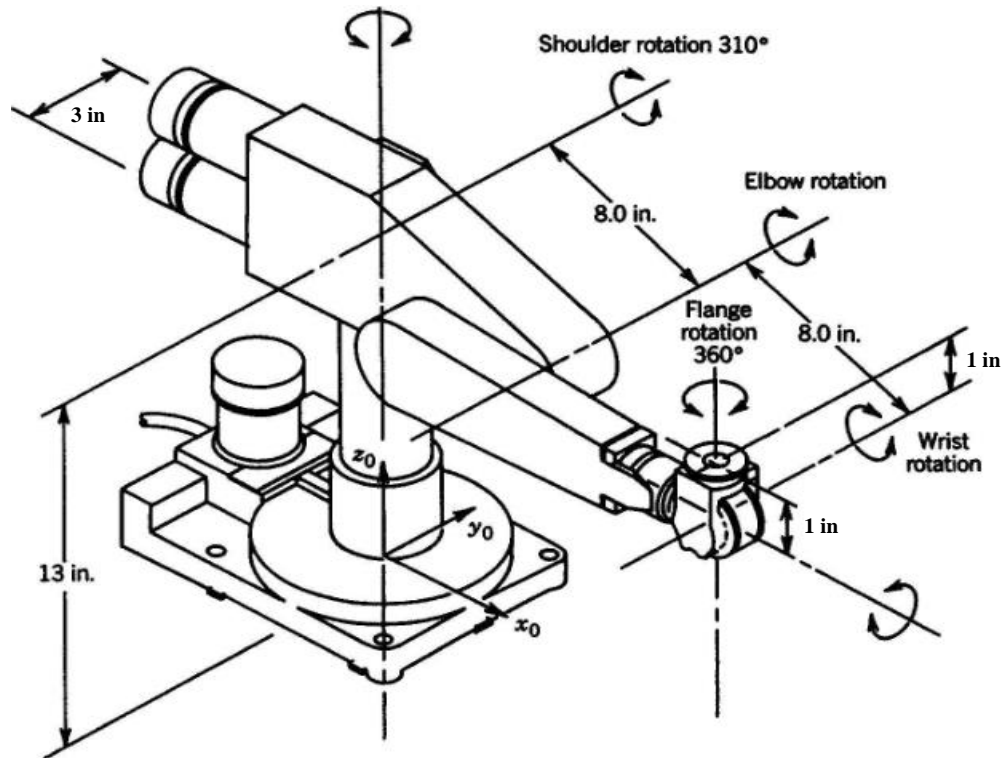
4. If the robot is climbing a terrain with angle equal to 15° . The total power needed to drive the mobile robot with its maximum speed is equal to Watts.
 (a) 220.1034 (b) 220.34 (c) **339.966** (d) 136.839
5. The total mobility for the shown mobile robot is equal to
 (a) 2 (b) **3** (c) 4 (d) 5
6. If this robot has only two standard wheels with differential steering, the **maneuverability** of this robot will equal to
 (a) 2 (b) **3** (c) 4 (d) 5
-

For the arm robot shown right, if link 1 weights about **20 kg** with length **40 cm**, link 2 has **15 kg** weight with **35 cm** length, link 3 weights **50 kg** with length **15 cm** and gripper's weight is about **1.5 kg** with external payload of **4 kg**. if link 1 and 2 have a moment of inertia equal to **155 cm^4** and **209 cm^4** . Elastic modulus and rigidity modulus are **210 GPa** and **70 GPa**. Answer the following questions based on previous data.



7. For the arm robot shown right, , the deflection based on payload of link 1 is equal tomm
 (a) 0.000963 (b) 0.00257 (c) **0.003533** (d) 0.0353
8. The torsional stiffness of link 1 with reduction of gears equal to 3 will beN/mm
 (a) 5425×10^5 (b) **48825×10^5** (c) 16275×10^5 (d) 25825×10^5
9. The angular deflection of link 1 will be equal to
 (a) 1.244 (b) **1.244×10^{-5}** (c) 0.1269×10^{-5} (d) 0.442×10^{-5}
10. The total deflection of link 1 will be equal tomm
 (a) 2.5 (b) 8.5×10^{-4} (c) 3.542×10^{-5} (d) **8.509×10^{-3}**
11. The total torque applied to joint C will be equal toN.cm
 (a) 3254 (b) 82451 (c) **17395** (d) 4042.5

Figure below shows the assigned frames for a Puma 260 arm manipulator, answer the following questions:



- DOF for the shown manipulator is equal to
 (a) 3 (b) 4 (c) 5 (d) **6**
- The shown robot is considered as
 (a) **RRRPRP** (b) **RRRRRR** (c) **PPRRPR** (d) **RRPRPR**
- The D-H parameters as $[a, \alpha, d, \theta]$ for **joint 2** will be as
 (a) **[13, -90, 3, θ_2]** (b) **[3, 8, -90, θ_2]** (c) **[0, +90, 3, θ_2]** (d) **[8, 0, 3, θ_2]**
- The D-H parameters as $[a, \alpha, d, \theta]$ for **joint 4** will be as
 (a) **[0, -90, 8, θ_4]** (b) **[0, 0, -90, θ_4]** (c) **[0, +90, 8, θ_4]** (d) **[0, 0, 8, θ_4]**
- The D-H parameters as $[a, \alpha, d, \theta]$ for **joint 6** will be as
 (a) **[0, -90, 13, θ_6]** (b) **[3, 8, -90, θ_6]** (c) **[0, +90, 1, θ_6]** (d) **[0, 0, 1, θ_6]**

☺ End of Exam, Good Luck ☺
 Dr.Eng. Ahmed Sameh