END SEMESTER EXAMINATIONS (DECEMBER 2021/JANUARY 2022) - QUESTION PAPER - PART A

COURSE CODE : MTE 4062
COURSE NAME : SOFT ROBOTICS
SEMESTER : VII
DATE OF EXAM : 27/12/2021
DURATION : 45 + 5 minutes

Instructions for Students:
(1) ANSWER ALL THE QUESTIONS.
(2) EACH QUESTION CARRIES 1 MARK.
(3) YOU ARE INSTRUCTED TO INFORM THE INVIGILATOR AFTER SUBMISSION OF THIS FORM IN THE CHAT SECTION.

* Required

* This form will record your name, please fill your name.

1

STUDENT NAME: *

2

REGISTRATION NUMBER: *

The value must be a number

3

Identify the fully untethered robotic system in the fig as
(1 Point)

- Robust walking robot powered by on-board pneumatics (65 cm long).
- Biomimetic swimming robot powered by a hydraulic actuation system (35 cm long).
- Electro-adhesive walking robot powered by DEAs. (17 cm outer diameter) f, Caterpillar-inspired multi-gait robot powered bySMAs (10 cm long). g, Jumping robot powered by combustion (12.6 cm tall; 30 cm radius). h, Jumping robot with controllable orientation powered by combustion (8 cm tall; 15 cm radius).
- Ray-inspired swimming robot powered by DEAs (9.3 cm long).

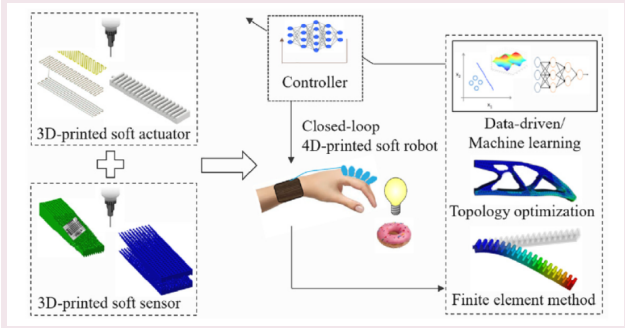
4

List the requirements to control soft actuators

(1 Point)

- internal pressure
- All the above
- interaction forces with objects in the environment
- monitoring their kinematics

5

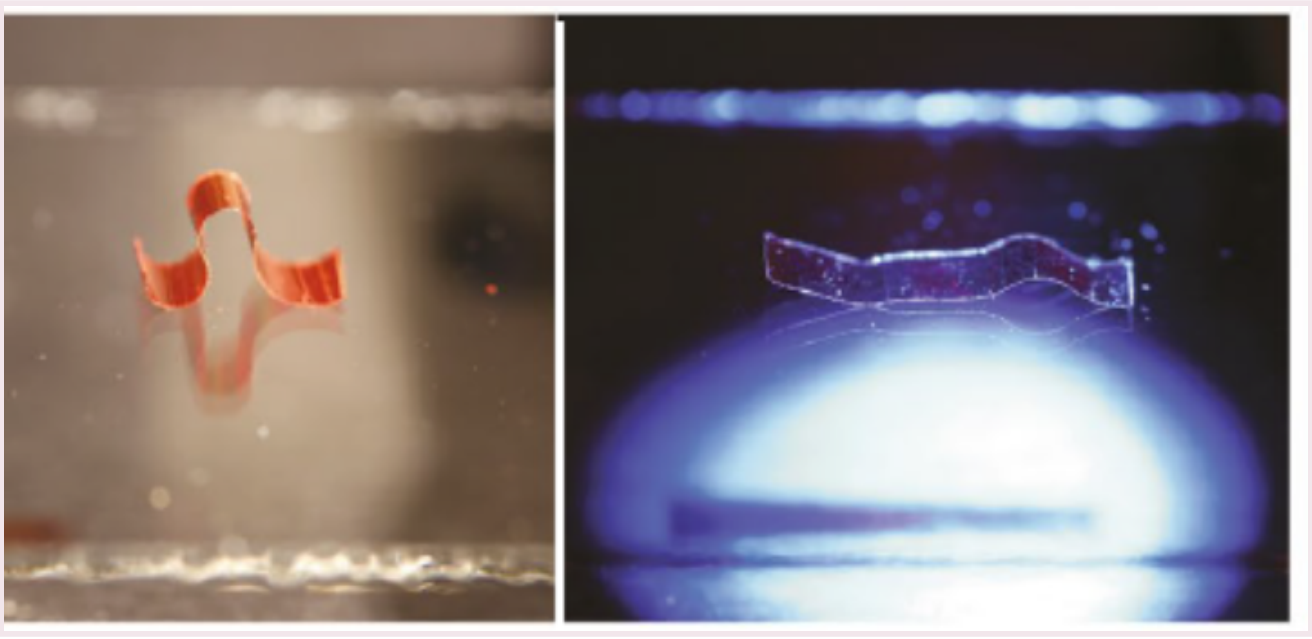


List the potential applications that are referred to the Diagram of closed-loop 4D-printed soft robot.
(1 Point)

- hydrogel-based drug delivery devices because of their water-soluble and ingestible properties
- All of the above
- used in autonomous surgeries, laparoscopy, and endoscopy
- Classification, grasping, and sorting tasks in the food and agricultural industries
- climbing or crawling agents for monitoring inaccessible environments, pipe inspections

6

Identify the method of soft actuation in the diagram as
(1 Point)



- d, SMA spring, which contracts in response to resistive heating.
- a, Vacuum-powered pneumatic actuator that creates contractile motion
- b, A light sensitive miniature LCE crawler (13 mm long) that moves in response to light.
- c, Bio-hybrid actuator (~4.6 mm long) with locomotion driven by electrically stimulated contraction of skeletal muscle.

7

List the material required for soft actuators fabrication

(1 Point)

- phase-transition materials
- macroporous gels
- All of the above
- electro-active polymers (EAPs)

8

Fused deposition modelling can be recalled as

(1 Point)

- A bed of solid, thermoplastic powder is selectively heated by a scanning laser. This irradiation causes localized melting and fusion of the material.
- A solid thermoplastic filament is extruded through a heated nozzle to melt, deposit and fuse the material.
- A liquid ink flows through a nozzle. Upon deposition, the ink solidifies into a solid object.
- Small droplets of liquid ink are simultaneously ejected from print heads. These droplets then solidify on the surface, often in response to light or heat.

9

List the principal manufacturing methods for soft robots
(1 Point)

- Continuous liquid interface production
- Stereolithography
- All of the above
- Spin casting
- Gravity molding

10

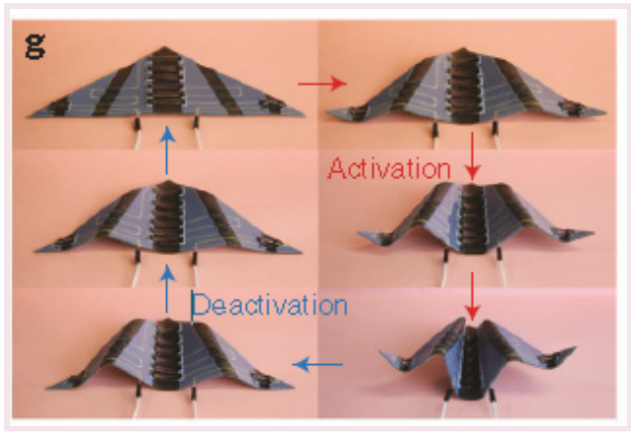
The gripper in the figure can be recalled as
(1 Point)

- Dielectric elastomer actuator gripper, with increased gripping strength resulting from electrostatic adhesion.
- Vacuum-powered pneumatic actuator that creates contractile motion
- Gripper (100 mm long) actuated by resistive heating in a SMA.
- Bio-hybrid actuator (~4.6 mm long) with locomotion driven by electrically stimulated contraction of skeletal muscle

11

Pneumatic Networks actuators (PneuNets) are the most common soft robots, their composition can be defined as it is made up of a
(1 Point)

- You come unless you don't want to
- soft material
- none of the above
- an elastomer within which pressurized fluids can navigate through a series of channels and chambers.



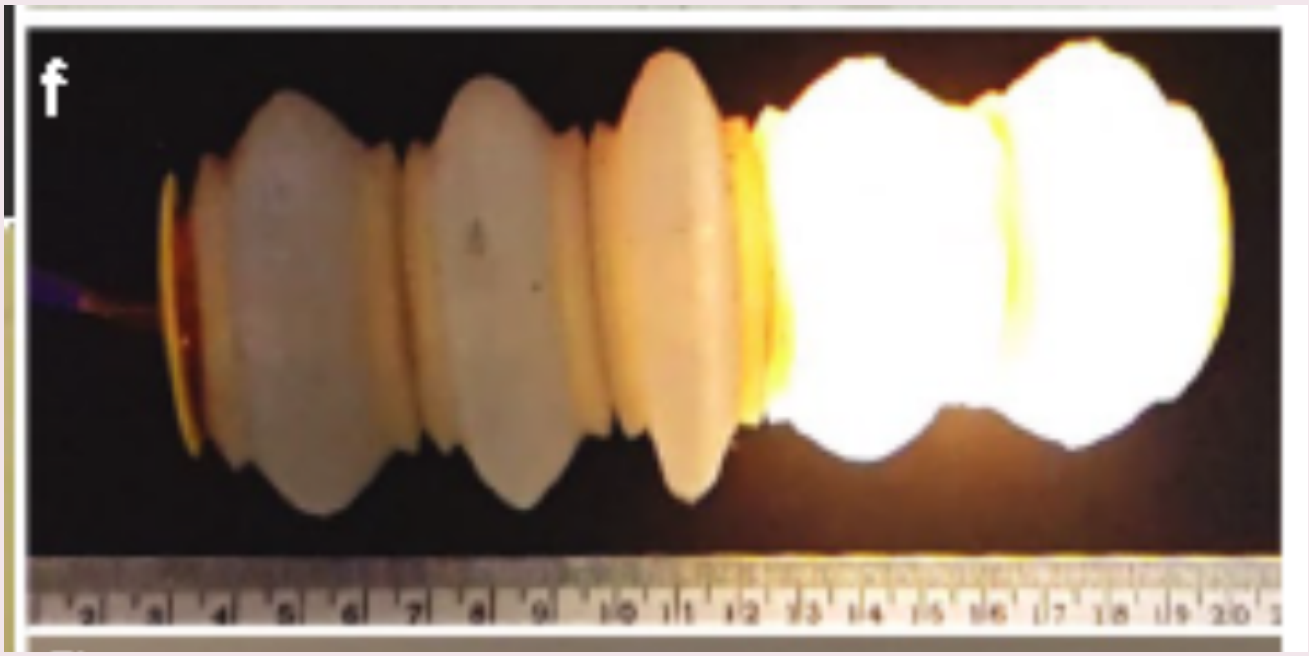
Methods of soft actuation for the diagram can be quoted as

(1 Point)

- Ionic polymer–metal composite-actuated caterpillar-inspired pipe crawling robot.
- Dielectric elastomer actuator gripper, with increased gripping strength resulting from electrostatic adhesion
- 3D-printed origami robot (110 mm side length) actuated by resistive heating in LCE hinges
- Entirely soft, DEA-powered crawling robot (90 mm arc length).

13

List the Implementation technique of soft actuators into robotic systems for the soft robot shown in the figure
(1 Point)



- Differential friction, DEA-powered annelid robot (17 cm).
- Electromagnetically actuated pneumatic worm robot
- SMA actuated fish (20 cm long).
- SMA-actuated peristalsis robot (13.9 cm)

14

Soft actuation is associated with challenges of achieving autonomous soft robots, and has been tackled with a wide variety of methods which includes
(1 Point)

- thermal actuation
- All the above
- photo-actuation
- pneumatic actuation
- electrical field actuation

15

Identify the control strategies can be employed to enable the soft robot to adapt to a dynamic environment
(1 Point)

- Closed-loop 4D printing integrates 3D-printed sensors, 3D-printed actuators, optimise the configuration of responsive materials but also to equip themwith feedback information and accomplish the functional target over time while interacting with uncertain environments in real-time.
- Closed-loop controllers and embedded soft sensors are therefore essential to handle uncertainties originating from dynamic surroundings and variations in thematerial properties of soft robotswhile preserving stiffness requirements and robustness.
- Open-loop controllers have been commonly used in high-speed trajectory-tracking tasks with minimum control effort
- All of the above

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The self-healing soft actuators developed through the technique, referred to as ‘‘shaping-through-folding-and self-healing.’’ can be described as

(1 Point)

- Finding inspiration in origami, this method exploits the healing ability in the manufacturing phase.
- All of the above
- Polygon structures are formed by consecutively folding and merging sheets through mild heat cycles.
- This technique permits combining multiple self-healing DA materials, with contrasting mechanical properties, in a single component

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Identify the material used in 4D-printed soft robot through FDM technique for the application of path planning
(1 Point)

- Ionic gel
- Cilia
- Silicone
- Copper/ABS, Magnetite/ABS,

18

Advantages of soft robots can be identified as

(1 Point)

- Difficult to control
- Advantages of soft robots are
- Elastically deformable and soft
- Compatible for human interaction (biocompatible and compliant)

19

Shape memory alloy wires which make them an ideal choice in various types of applications present characteristics could be listed as
(1 Point)

- (b) low weight,
- (a), (b), and (c)
- (a) force/weight ratio,
- (c) noiseless actuation,

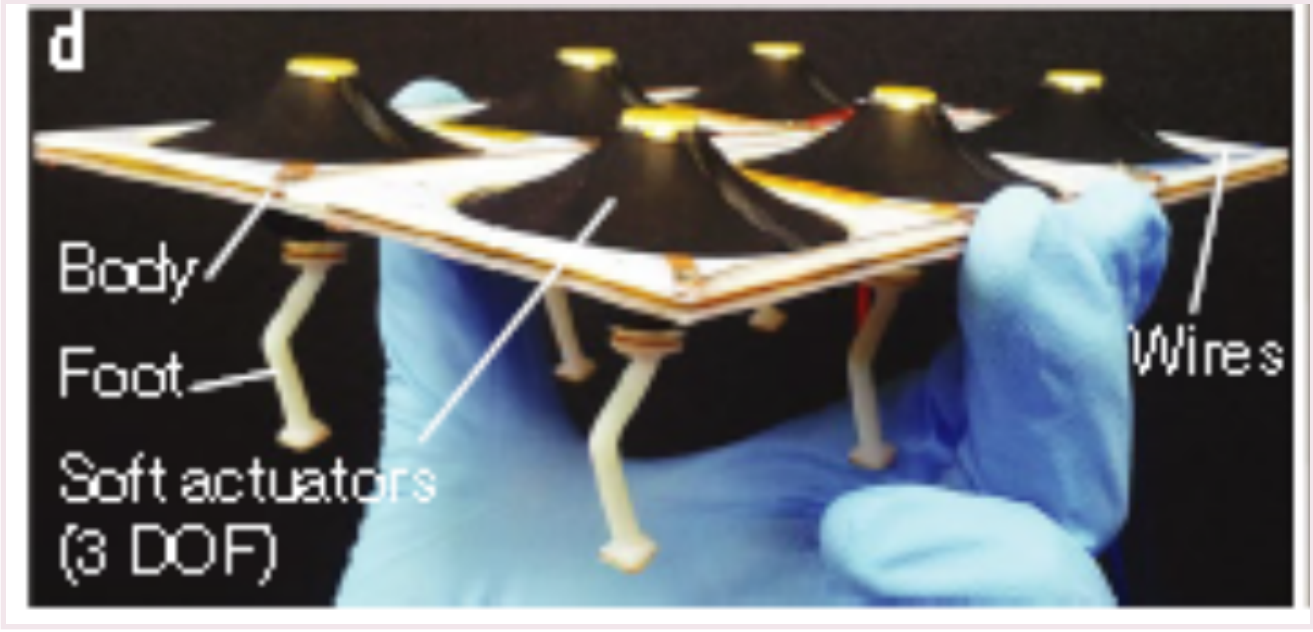
20

Dielectric elastomer generator applications can be listed as
(1 Point)

- (a), (b), (c), (d)
- (b) polymer engine,
- (a) heel-strike generator,
- (d) wave-power generator
- (c) windpower generator, and

21

Identify the Implementation of soft actuators into robotic systems in the figure as
(1 Point)



- SMA actuated
- A multi-degree-of freedom (DOF) DEA-powered walker.
- LCE-actuated gripper
- Electromagnetically actuated

22

Principle of operation of McKibben muscle is defined as

(1 Point)

- The internal chambers filled with colored dyes
- Inflabale Tubes containing a mesh within for circumferential stress
- multi-gait silicon elastomer

23

Identify the 3D-printed sensor in 4D-printed soft robot application such as Grasping and Trajectory tracking
(1 Point)

- Displacement
- Tactile
- Accelerometer
- Strain

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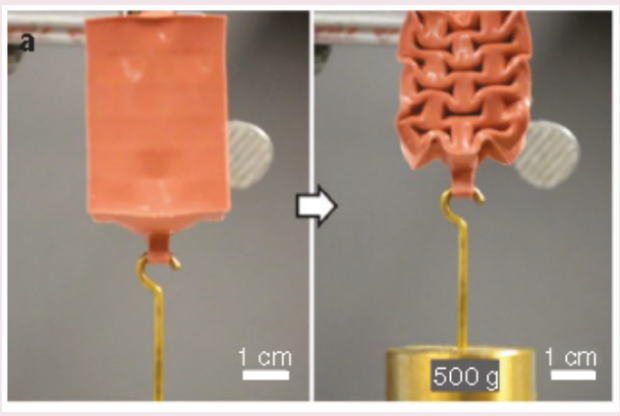


Methods of soft actuation for the figure can be described as
(1 Point)

- Vacuum-powered pneumatic actuator that creates contractile motion.
- SMA spring, which contracts in response to resistive heating. In the diagram
- Bio-hybrid actuator (~4.6 mm long) with locomotion driven by electrically stimulated contraction of skeletal muscle.
- A miniature LCE crawler (13 mm long) that moves in response to light.
- Gripper (100 mm long) actuated by resistive heating in a SMA.

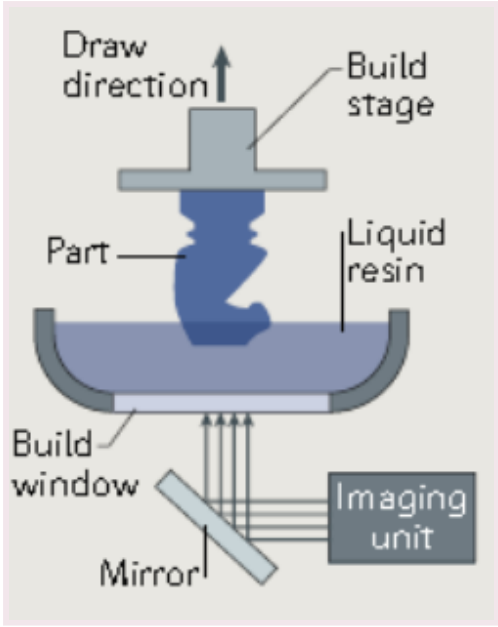
25

Material used in the production of Soft robotics is identified as

(1 Point)

- Ecoflex
- ELASTOSIL
- Silicon Rubber
- PDMS

26



Identify the Additive manufacturing technique for the fabrication of physical objects through the successive addition of material layers as shown in the figure

(1 Point)

- Fused deposition modelling (FDM)
- Inkjet printing
- Direct ink writing
- Stereolithography (SLA)
- Selective laser sintering (SLS)

27

Dielectric elastomer actuators (DEAs) can effectively perform when controlled and powered by which of the following options
(1 Point)

- mesh within for circumferential stress
- Compliant Electrodes
- None of the above
- network of chambers

28

An autonomous robot must have a basic body structure (the chassis), sensors, a central control system (microprocessor), actuators (motors), a power supply and an overall program for its behavior.
(1 Point)

- True
- False

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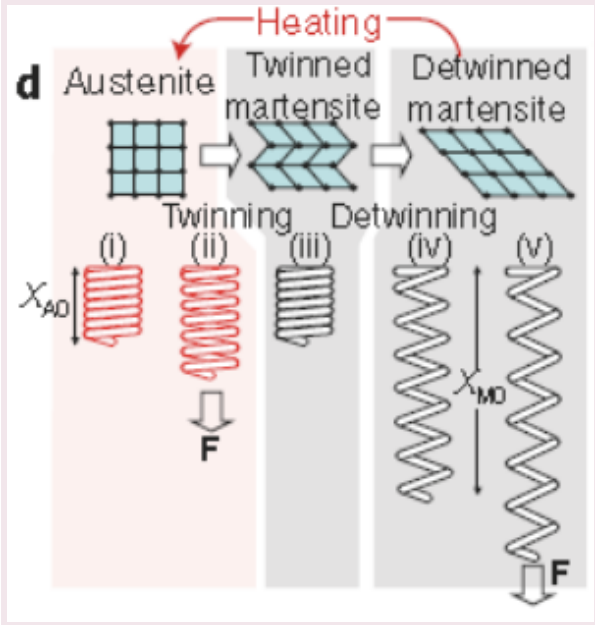
Recall the application in which Peano-HASEL actuators are found in

(1 Point)

- medical and industrial automation
- autonomous robotic devices
- active prostheses

30



Methods of soft actuation for the figure can be described as

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- Ionic polymer–metal composite-actuated caterpillar-inspired pipe crawling robot
- Dielectric elastomer actuator gripper, with increased gripping strength resulting from electrostatic adhesion
- Entirely soft, DEA-powered crawling robot (90 mm arc length).

31

Soft materials often have non-linear responses to forces with properties which could be identified as

(1 Point)

- viscoelasticity
- pseudo-elasticity
- anisotropy
- creep

32

Identify the Additive manufacturing technique for the fabrication of physical objects through the successive addition of material layers. In this technique, Small droplets of liquid ink are simultaneously ejected from print heads. These droplets then solidify on the surface, often in response to light or heat. Jetting and solidification are iteratively repeated until the entire object is built.
(1 Point)

- ◯ Selective laser sintering
- ◯ Inkjet printing
- ◯ Stereolithography
- ◯ Direct ink writing
- ◯ Fused deposition modelling

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