

# Unit 9: Midterm Exam

## Classroom

Topic	Format	Learning Aids	Preparation
WRITTEN TEST	Discussion	Question Bank	Prepare and print final exam.
CASE STUDY PRESENTATION	Student presentation One or more pairs of students present their case study findings.		

## Computer Lab

Topic	Format	Learning Aids	Preparation
FINAL PROJECT <i>Proposal 2</i>	Hands-on Students will re-examine their final project proposal in light of what they've learned so far in this course.		

\* If you have an amazing lesson plan you'd like to share with the Stratasys Education Community, tell us.  
If we add it to our curriculum, you'll be eligible to receive free FDM or PolyJet materials for your 3D printers.

# Exam Question Bank

Because this course was built in a modular fashion allowing you to focus on topics that cater to your students' interests and fit within your yearly curriculum plan, this exam follows the same spirit. You may modify this test and choose questions relevant to units you have taught.

## Unit 1: Introduction

### Essay Questions

Compare the Third Industrial Revolution to the First Industrial Revolution. What are the differences and similarities?

#### Evaluator notes:

- The **First Industrial Revolution** changed the fabrication process dramatically:
  - Faster fabrication
  - Cheaper fabrication
  - Collaborative manufacturing
- The **Third Industrial Revolution**:
  - Uses machines to manufacture custom products
  - Anyone can design and fabricate products
  - Anyone can operate 3D printers
  - 3D printers can be used anywhere from factories to private homes – no size limitation
  - This has also led to smaller scale factories (Normal Ears is one example)
  - We've returned to an era of personal fabrication

Explain how technology shifts throughout history have made 3D printing possible.

Stalagmites and stalactites are natural products, formed by an additive process. Explain the resemblance to the 3D printing manufacturing method.

Explain how the designer's role has evolved over time. How is it likely to change as we move toward mass customization?

### Multiple-Choice Questions

Which of the following best describes Design Thinking?

- A. A process that progresses linearly from empathy to testing
- B. A process that progresses non-linearly from ideation to testing and production
- C. A process that cycles sequentially through repeatable steps
- D. A process for analyzing the success of a product

Which of the following is not a design consideration for 3D printing?

- A. Material
- B. Tolerance
- C. Size of build tray
- D. CAD software

The evolution of 3D printers is similar to the evolution of personal computers. What way(s)? Select all correct answers.

- A. Both began as professional tools that eventually expanded to personal use
- B. Both grew more accessible over time
- C. Both became cheaper due to mass production
- D. Both were revolutionary products

In what way(s) did 3D printing contribute to the reemergence of personal fabrication? Select all correct answers.

- A. It answered the innate human need to create
- B. It encouraged design sharing and collaborative learning
- C. It replaced all other fabrication methods
- D. It made design available and easy for more people

What Neolithic Age characteristic reappeared as a trend during the Third Industrial Revolution?

- A. Mass production
- B. Additive manufacturing
- C. Personal fabrication
- D. None of the above

Which of the following are reduced with personal fabrication?

- A. Production expenses
- B. Carbon footprint
- C. Shipping costs
- D. Manual labor

Carving, drilling, milling and chiseling are all examples of what?

- A. Additive manufacturing
- B. Subtractive manufacturing
- C. Cutting
- D. Forming

Which of the following crafts are more likely to use cutting as a fabrication method?  
Select all correct answers.

- A. Woodcraft
- B. Fur and leather craft
- C. 3D modeling
- D. All crafts use cutting as a fabrication methods

Glass blowing is an example of what manufacturing method?

- A. Additive manufacturing
- B. Subtractive manufacturing
- C. Cutting
- D. Forming

Which of the following is NOT an example of additive manufacturing?

- A. Electron binder jetting
- B. Electron beam melting
- C. Fused-deposition-modeling
- D. Lost-wax casting

## Unit 2: Introduction to 3D Printing

### Essay Questions

Explain what design freedom means and how 3D printing contributes to it.

Which technology would provide the best basis for food printing? Why?

Choose two technologies and describe how they work.

- Laser melting (LM, DLMS)
- Fused deposition modeling (FDM)
- Electron beam melting (EBM)
- Electron binder jetting (BJ)
- Stereolithography (SL, SLA)
- Material jetting (MJ, DOD)
- Photopolymer jetting (PolyJet)
- Selective laser sintering (SLS)
- Digital materials

### Multiple-Choice Questions

What purpose does support material serve in 3D printing?

- It increases the durability of the final product
- It allows easier assembly and post-processing
- It reduces waste
- It supports layers as they are printed, functioning as scaffolding

Which of the following technologies is capable of printing metal?

- Laser melting (LM)
- Fused deposition modeling (FDM)
- Electron beam melting (EBM)
- Electron binder jetting (BJ)
- Stereolithography (SL, SLA)
- Material jetting (MJ, DOD)
- Photopolymer jetting (PolyJet)

Which of the following technologies build parts through melting?

- Laser melting (LM)
- Fused deposition modeling (FDM)

- Electron beam melting (EBM)
- Electron binder jetting (BJ)
- Stereolithography (SL, SLA)
- Material jetting (MJ, DOD)
- Photopolymer jetting (PolyJet)

Which of the following technologies build parts in engineering plastics?

- Laser melting (LM)
- Fused deposition modeling (FDM)
- Electron beam melting (EBM)
- Electron binder jetting (BJ)
- Stereolithography (SL, SLA)
- Material jetting (MJ, DOD)
- Photopolymer jetting (PolyJet)

Which technology prints with Digital Materials?

- Laser melting (LM)
- Fused deposition modeling (FDM)
- Electron beam melting (EBM)
- Electron binder jetting (BJ)
- Stereolithography (SL, SLA)
- Material jetting (MJ, DOD)
- Photopolymer jetting (PolyJet)

What considerations must you make when choosing a 3D printing technology?

- Material
- Durability
- Melting point
- Surface finish
- Focus group input
- Time
- Detail
- Application

## Unit 3: What is a Mesh?

### Essay Questions

Explain the following: “A mesh can never be smooth.”

Describe the relationship between resolution and mesh smoothness.

Describe the relationship between mesh smoothness and file size.

What can be learned by studying the designs of others?

### Multiple-Choice Questions

Which term below describes a unique location in Euclidean space that has no dimensional attributes?

- A. Mesh
- B. Point
- C. Surface
- D. Line

Which of the following is a two-dimensional shape?

- A. Point
- B. Line
- C. Surface
- D. Polygon

Every mesh is a polysurface, but not every polysurface is a mesh. True or false?

- A. True
- B. False

What is a watertight mesh?

- A. A mesh that will hold water
- B. A mesh with no holes, cracks or missing features (surfaces, polygons, lines or points)
- C. A mesh that was designed to float
- D. All of the above

What type of mesh makes the smoothest model?

- A. High polygon density
- B. Smaller polygons
- C. Higher resolution
- D. All of the above

For faster printing, your mesh should be

- A. Lower resolution
- B. Smaller polygons
- C. Fewer polygons
- D. None of these

## Unit 4: Ctrl+P

### Essay Questions

Describe the advantages of designing an object using 3D software instead of 2D software.

Describe the advantages of 2D software over hand sketches.

Explain the role of CAM software in the printing process. Why is it needed?

### Multiple-Choice Questions

Which of the following describes CAD advantages over freehand drawing?

- A. Higher design accuracy
- B. Reduced need for measuring tools
- C. Better design reuse capabilities
- D. No design limitations

What was the storage medium on which manufacturing commands were encoded in NC machines?

- A. Standard RAM sticks
- B. Mini SD memory sticks
- C. Metal plates
- D. Cardboard slates

Why would you need to repair your mesh?

- A. A mesh with holes will not print correctly
- B. A mesh with holes will damage the 3D printer
- C. A mesh with holes will double the material use
- D. A mesh with holes will print a faulty part

## Units 5 & 6: Closed Gear Systems

### Essay Questions

Describe the unique considerations involved when designing a gear system for 3D printing.

### Multiple-Choice Questions

Two or more gears working in tandem are called what?

- A. Torque
- B. Cog
- C. Rack
- D. Transmission

What are the advantage(s) of using gear systems?

- A. Gear teeth prevent slippage
- B. Few elements can create great force
- C. Decreased power creates more force
- D. Gear systems are easy to design and manufacture

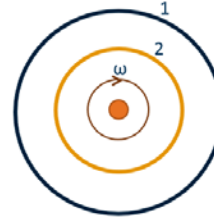
Force transmitted from a small gear diameter to a larger gear diameter is

- A. Increased
- B. Decreased
- C. Stays the same
- D. None of the above

In Spur gear systems, the tooth profile is

- A. inclined to the axis of rotation.
- B. vertical to the axis of rotation.
- C. parallel to the axis of rotation.
- D. None of these

If two discs are fixed by an axis, their radial velocity and acceleration is equal.



- A. True
- B. False

What important element must we consider when re-scaling a gear system design?

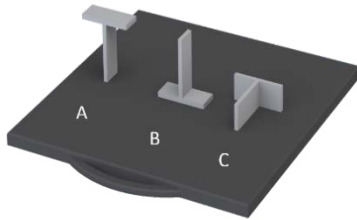
- A. Space between the elements
- B. Recommended minimal element thickness
- C. Removal of support material is still possible
- D. None of the above

## Unit 7: Dynamic Surfaces and Chains

### Essay Questions

Describe the making process of a dynamic surface. Include the four major phases (define, idea, prototype and production) in your description.

The image below shows three optional part orientations. Which orientation is most preferable to your opinion? Relate to printing speed, amount of support material needed and highest pack-density.



### Multiple-Choice Questions

What dynamic surfaces can be found in a classic SLR camera?

- A. Lens
- B. Shutter
- C. Aperture adjuster
- D. Film

Which of the following material attributes may present a problem in dynamic surface designing?

- A. Hardness
- B. Elasticity
- C. Opacity
- D. Smoothness

What does the term “tolerance” refer to when designing dynamic surfaces?

- A. Material durability
- B. The space between connected parts, designed for supported materials
- C. The friction and resistance between connected parts
- D. The dynamic surface design complexity

Which of the following parameters must be considered before the design phase of a dynamic surface? Select all correct answers.

- A. Tolerance
- B. Element size
- C. Friction
- D. Minimum thickness
- E. Support material removal
- F. Positioning

A dynamic surface is an array of connected surfaces that produces a mechanical effect; the movement of one surface causes predictable movement of the others.

- A. True
- B. False

Which of the following are basic elements of 2D nesting? Select all correct answers.

- A. Part orientation
- B. Part combinations
- C. Spacing between parts
- D. Material selection

Which of the following are benefits of proper nesting and positioning? Select all correct answers.

- A. Reduced material waste
- B. Reduced energy usage due to shorter print-head travel
- C. Sharper details and smoother surface finish
- D. Increased yield of parts per print job

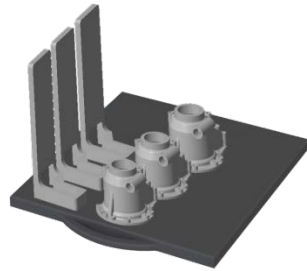
Part orientation can affect its strength. True or false?

- A. True
- B. False



Examine the image below. What would you do to improve the nesting layout and shorten print time?

- A. Print tall parts and short parts separately
- B. Rotate tall parts to shorten Z axis height and reduce height differences between two part types
- C. Align all 6 parts to one row to reduce print-head travel time
- D. Increase spacing between parts



## Units 8–11: The Future of Fabrication

### Essay Questions

Briefly describe the main stages along 3D printing technology evolution. How did the applications of the 3D printing technology evolve since it was first introduced to humanity?

Describe the concept of self-assembly and how it relates to 3D printing.

### Multiple-Choice Questions

The lesson presented a futuristic project for printing structures on the face of the moon. What element functions as support material for the printing of these structures?

- A. Lunar sand sprayed with binding material
- B. Carbon fiber scaffoldings
- C. Inflatable structure
- D. No support material is required

What is the part of 3D printing in tissue engineering?

- A. Printing a live tissue
- B. Prototyping the tissue
- C. Simulating the tissue function
- D. Printing artificial scaffoldings to grow the tissue on

Which attribute of 3D printing may become an advantage over other fabrication methods for printing fully functional electronic devices? Select all correct answers.

- A. The ability to easily interlock different parts
- B. The ability to print multiple materials
- C. Printing accuracy
- D. Printing speed

The case study presented "Genie" - an experimental food printer. What are the advantages of "printing" dry edible ingredients over using wet mixtures and pastes?

- A. Easier machine cleaning and maintenance
- B. Dry ingredients shelf-life is longer than wet ingredients
- C. Wet ingredients weigh more, and shipping costs increase
- D. Dry ingredients packaging is simpler and cheaper

### Multiple-Choice Questions

In 4D printing, what is the fourth dimension?

- A. Space
- B. Movement
- C. Time
- D. Material

What inspired the team at the MIT self-assembly lab to conceive the Autonomous Mass Assembly concept?

- A. The natural growth of viruses
- B. Japanese architecture
- C. Islamic patterns in traditional ornaments
- D. The movie "Avatar"

Which of the following are possible applications of 4D printing? Select all correct answers.

- A. Smart water pipes
- B. Self-assembled structures
- C. Ready-made electronic devices
- D. Superior sound systems

What activating energies are used in the 4D products presented in the lesson?

- A. Heat
- B. Water
- C. Microwave
- D. Sound-waves

## Unit 13: Factory of Tomorrow

### Essay Questions

Which of the business models that were described in the lesson, are likely to prosper to your opinion? Explain why.

### Multiple-Choice Questions

What part does the customer play in democratized industries? (Local motors model)

- A. The customer designs his car independently
- B. The customer only buys the end product
- C. The customer expresses his wishes and the professional team customizes executes
- D. The customer manages and funds the project

What is the concept behind "Independent industrial hubs"? (e.g., 3D hubs)

- A. Buy a 3D printer and do it yourself
- B. Connect to professionals and create your own product
- C. Rent your private 3D printer to others
- D. Make your 3D printer profitable by offer your 3D printing services to others

What are the advantages of professional industrial hubs (e.g., Shapeways and Redeye) over independent industrial hubs (e.g., 3D hubs)? Select all correct answers.

- A. Professional industrial hubs are more capable of manufacturing complex designs
- B. Professional industrial hubs work as a network and use a uniform range of high-quality materials and machinery
- C. Professional industrial hubs are oriented toward mass production
- D. Professional industrial hubs implement quality assurance procedures

Which of the following sentences are correct regarding the Shenzhai model (Mass production of replicas)? Select all correct answers.

- A. Shenzhai are collaborative manufacturing groups that include micro entrepreneurs and technical specialists
- B. Shenzhai manufacturing groups only replicate well-known products
- C. Shenzhai manufacturing groups replicate, re-design, improve and customize well-known products
- D. Shenzhai manufacturing groups strive to provide low-cost products to the common people of the world

## Unit A: Sound Printing

### Essay Question

Describe the different considerations a loudspeaker designer may have, while designing a 3D printed sound device.

### Multiple-Choice Questions

As a sound wave length grows, the sound tone becomes

- A. Sharper
- B. Higher
- C. Lower
- D. Louder

As a sound wave amplitude grows higher, the sound tone becomes

- A. Sharper
- B. Higher
- C. Lower
- D. Louder

Which of the following are typical sound wave behaviors? Select all correct answers.

- A. Transmission
- B. Stagnation
- C. Reflection
- D. Absorption

In loudspeaker design, what is the purpose of sealing the loudspeaker cabinet?

- A. Block rear sound waves from reaching the listener's ear
- B. Naturally amplify sound waves
- C. Preventing dust and other elements that effect sound quality
- D. Protecting the device from physical damage



## Unit B: Fluid Dynamics

To be developed by the course lecturer.

## Unit C: Post Processing

### Essay Question

Describe the basic FDM post processing workflow.

### Multiple-Choice Questions

Which of the following are achieved by post printing processing? Select all correct answers.

- A. Smoother feel
- B. Higher durability
- C. Antimicrobial resistance
- D. Color

What is the reason most 3D printed products do not have a smooth finish after coming out of the printer's tray?

- A. Printing file size and model resolution
- B. The layering fabrication method
- C. The material attributes
- D. The interaction with support materials

Which of the following are post processes that can be applied on 3D printed objects?

- A. Sand paper polishing
- B. Lacquering
- C. Metal coating
- D. Thermal treatment

What does Distress and Patina post processing aim to achieve?

- A. Product smoothness
- B. Product sturdiness
- C. Glossy finishing
- D. Antique/vintage look and feel

## Unit E: 3D Manufacturing Regulations and Carbon Footprint

### Essay Question

Describe one ethical dilemma related to bio-printing of artificial organs.

### Multiple-Choice Questions

According to the UC Berkley case study, what is the most effective way to reduce 3D printer's carbon foot print?

- A. Reduce amount of printed material
- B. Reduce usage of energy
- C. Develop toxin-free materials
- D. Limit the number of 3D printers

How can we reduce printer run time? Select all correct answers.

- A. Prefer single materials printing upon multiple material printing
- B. Print hollow parts rather than solid
- C. Orient parts for the fastest printing
- D. Fill the printer bed with multiple parts

Which of the following represent a legal challenge, related to the inclining use of 3D printers?

- A. Counterfeiting
- B. Unregistered weapons distribution
- C. Personal fabrication of spare parts
- D. Design rights violations

What are the positive environmental effects of 3D printing, in comparison to traditional fabrication methods? Select all correct answers.

- A. Production is done closer to the consumer, reducing shipping carbon foot-print
- B. 3D printing uses less support material, thus produces less waste
- C. 3D printing reduces the need for packaging
- D. 3D printing of spare parts increases a products sustainability and enables more moderate consumption patterns

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