

MEMS 0040: Manufacturing Processes and Analysis

FALL, 2026

NOTE: This syllabus may be adjusted to match class progress. Official announcements on Blackboard take precedence.

INSTRUCTOR: Shan Gong

OFFICE: SCUPI Building N406

EMAIL: shan.gong@scai-ji.cn

OFFICE HOURS: Tuesdays and Thursdays, 14:00-17:00

LECTURES: Fridays, 08:15-11:00, SCUPI Building S104. Materials and announcements: <https://pibb.scu.edu.cn>.

RECITATION: No separate recitation; problem solving and formative activities are integrated into lectures.

TEXTBOOK: Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, 7th ed.

TEACHING ASSISTANT: Yishuo Gao, 2024141520193@stu.scu.edu.cn, homework grading

PREREQUISITE: ENGR 0022: Materials Structure and Properties.

DESCRIPTION: A three-credit undergraduate course on manufacturing processes and quantitative process analysis. Coverage includes manufacturing systems and economics; mechanical, thermal, and surface properties; heat treatment; casting; bulk and sheet-metal forming; machining; and welding and joining.

COURSE OBJECTIVES: Develop a mechanistic understanding of manufacturing processes; build competence in engineering calculations for process performance, time, rate, and cost; and integrate material, geometry, quality, productivity, safety, and economic constraints in process selection.

LEARNING OUTCOMES FOR THIS COURSE:

By the end of the course, students will be able to:

1. Explain how material behavior and process physics govern capability, defects, and final properties across heat treatment, casting, forming, machining, and joining.
2. Apply engineering science and mathematics to calculate energy, forces, power, solidification time and thermal response, process time and rate, tool life, and per-piece cost.
3. Compare manufacturing routes and justify process and parameter choices using material, geometry, tolerance, surface finish and integrity, quality, productivity, safety, and economic requirements.

GRADE DETERMINATION:

Component	Weight	Description
Homework	30%	Problem sets aligned with the required weekly content.
Quizzes and in-class activities	10%	Combined points from short quizzes and submitted in-class activities; no separate subjective participation score.
Midterm examination	30%	Semi-open-book; tentatively scheduled for Week 9.
Final examination	30%	Semi-open-book; tentatively scheduled for Week 18.

EXAMS: There will be two examinations, one midterm and one final, both semi-open-book. The midterm is tentatively scheduled for Friday, October 30 (Week 9), and the final examination is tentatively scheduled during Week 18. The exact final-examination time and location will follow the university examination timetable and Blackboard announcement. For each examination, students may bring one A4 sheet of handwritten notes; both sides may be used. Printed, photocopied, or digitally reproduced notes are not permitted. Attendance at both examinations is mandatory. Examination absences and make-up arrangements are governed by the MAKE-UP POLICY below.

QUIZZES AND IN-CLASS ACTIVITIES: This 10% category is calculated from the combined points earned on short quizzes and submitted in-class activities; there is no separate subjective participation score. A quiz missed because of an ordinary absence cannot be made up. For a documented, unavoidable absence, the instructor may excuse the missed item or assign equivalent work, and the category grade will be adjusted accordingly.

GRADE REBUTTAL: Questions about grading should be raised promptly with the instructor and supported by the original graded work. The instructor will communicate the formal review procedure and deadlines. Questions about homework grading must be submitted to the responsible grader within one week after work is returned. Include MEMS 0040, item number, and supporting work.

HOMEWORK: Submit an individual solution through Blackboard by the stated deadline. Group discussion is encouraged, but copied work is not acceptable. Late work is not accepted unless an extension is approved in advance or a documented emergency prevents timely submission. Show the reasoning, units, and final answer, and include your name, and student ID.

ATTENDANCE: Regular attendance and active participation are expected because calculation workshops, process-analysis exercises, and process-selection discussions are integral to the course. Students are responsible for announcements, examples, and formative activities completed during class. Students should follow SCUPI procedures for documented absences.

MAKE-UP POLICY: If an unavoidable circumstance prevents attendance at an examination, notify the instructor before the examination begins whenever practicable. A make-up examination may be granted only with the instructor's approval and valid documentation. Except in documented extenuating circumstances, missing an examination without prior notice will result in a score of zero. Arrangements follow SCUPI policy and the instructor's announced procedures.

MATERIAL COVERED: Chapter references below indicate selected sections only. Required coverage is limited to the listed weekly topics and any additional sections explicitly assigned on Blackboard. Topic pacing and assessment dates remain subject to official announcements.

Week (Friday)	Lecture / Selected Textbook Coverage	Descriptions
1 <i>Sep. 4</i>	L1 / Ch. 1	Manufacturing as a technical and economic activity; quantity-variety and capability; process and operation taxonomy; machines, tooling, facilities, and support; batch time, cycle time, production rate, and per-piece cost; integrated in-class exercise.
2 <i>Sep. 11</i>	L2 / Ch. 3	Engineering and true stress-strain; elasticity and plasticity; flow curve; tension, compression, bending, torsion, hardness, and calculation practice.
3 <i>Sep. 18</i>	L2 / Chs. 4-5	Thermal and physical properties; heat capacity, expansion, conductivity, diffusivity, and mass diffusion; surface texture and integrity; manufacturing implications.
4 <i>Sep. 25</i>	NO CLASS	<i>Mid-Autumn Festival holiday; no Friday lecture and no make-up class.</i>
5 <i>Oct. 2</i>	NO CLASS	<i>National Day holiday; no Friday lecture and no make-up class.</i>
6 <i>Oct. 9</i>	L3 / Ch. 26	Focused heat-treatment lecture: controlled thermal paths; annealing and normalizing; TTT diagrams, cooling, and quenching; tempering; hardness versus hardenability and Jominy testing; precipitation and surface hardening; defects, safety, and route selection.
7 <i>Oct. 16</i>	L4 / Ch. 10	Casting system and sequence; heating and pouring; cooling and solidification; grain structure, shrinkage, Chvorinov's rule, and riser design.
8 <i>Oct. 23</i>	L4 / Ch. 11	Sand, investment, permanent-mold, and die casting; defects and inspection; casting design guidelines and economics; integrated casting problem and midterm scope check.
9 <i>Oct. 30</i>	Midterm Examination	Examination only. Required scope: Lectures 1-4 and all required content taught in Weeks 1-3 and 6-8. No lecture, or new content. Tentative schedule, subject to change.
10 <i>Nov. 6</i>	L5 / Chs. 17-18	Metal-forming fundamentals; true strain and flow stress; temperature, strain rate, friction, and lubrication; rolling analysis.
11 <i>Nov. 13</i>	L5 / Ch. 18	Forging, extrusion, and drawing mechanisms; load, force, torque, and power; defects, equipment, and process selection.
12 <i>Nov. 20</i>	L6 / Ch. 19	Sheet-metal cutting, blanking, and punching; bending and springback; deep drawing; tooling, forces, production rate, and economics.
13 <i>Nov. 27</i>	L7 / Ch. 20	Orthogonal cutting; chip formation; Merchant analysis; cutting forces, power, temperature, and cutting conditions.
14 <i>Dec. 4</i>	L7 / Chs. 21-23	Turning, drilling, and milling; machining time and removal rate; tool materials, wear, life, and fluids; machining economics.
15 <i>Dec. 11</i>	L8 / Chs. 28-29	Joining and welding classifications; joint and weld configurations; fusion-welding power density and heat balance; fusion zone, weld interface, and heat-affected zone; representative arc, oxyfuel, laser-beam, and electron-beam welding processes; arc-welding cycle-time and cost analysis.

Week (Friday)	Lecture / Selected Textbook Coverage	Descriptions
16 <i>Dec. 18</i>	L8 / Chs. 29-30	Fusion-weld quality, defects, residual stress, and distortion; resistance welding and its spot, seam, and projection variants; representative solid-state processes including friction, friction-stir, and ultrasonic welding; brazing and soldering; integrated cycle-time, cost, and joining-process selection.
17 <i>Dec. 25</i>	Comprehensive Review	Comprehensive review and integration of all required course content, including process physics, quantitative analysis, process selection, quality, productivity, safety, and economics. No new content.
18 <i>Dec. 28-Jan. 3</i>	Final Examination	Cumulative examination only. Covers all required instructional content taught through Week 16. No review or instruction. Exact time and location will follow the university examination timetable and Blackboard announcement. Tentative schedule, subject to change.