Department of Science Education
Institute of Education & Research
University of the Punjab, Lahore

Course Outline

Programme	BS Science Education	**Course Code**	**SEID-202**	**Credit Hours**	3
Course Title	**STEAM Education**				

Course Introduction

This course prepares prospective teachers to plan, implement, and assess integrated STEAM (Science, Technology, Engineering, Arts, and Mathematics) learning experiences in regular elementary and secondary classrooms. Students examine the conceptual foundations of STEAM education and models of disciplinary integration (multidisciplinary, interdisciplinary, and transdisciplinary), explore practical, low-cost strategies for teaching each STEAM discipline, and apply established instructional-design frameworks — the Engineering Design Process, the 5E Instructional Model, Project-Based Learning, and Design Thinking — to create standards-aligned, developmentally appropriate STEAM units. Emphasis throughout is on the practicality and ease of implementation of STEAM instruction in typical public-school settings with limited resources. The course culminates in the design, peer review, and presentation of an original STEAM instructional unit for either the elementary or secondary grade band.

Learning Outcomes

On the completion of the course, the students will:
1. Define STEAM education and distinguish multidisciplinary, interdisciplinary, and transdisciplinary approaches to disciplinary integration.
2. Describe practical, discipline-specific pedagogical strategies for teaching Science, Technology, Engineering, Arts, and Mathematics content in an integrated manner.
3. Apply the Engineering Design Process, the 5E Instructional Model, and Backward Design to plan STEAM lessons and units.
4. Design and implement low-cost, easily replicable STEAM activities suitable for regular elementary and secondary classrooms with limited resources.
5. Develop developmentally appropriate STEAM learning experiences for both elementary and secondary grade bands.
6. Construct rubrics and performance-based assessment tools appropriate for open-ended STEAM projects.
7. Design, present, and critically reflect on an original, standards-aligned STEAM instructional unit.

	Course Content	**Assignments/Readings**
Week 1	**Unit-I** 1.1 What Is STEM? What Is STEAM? Defining Science, Technology, Engineering, Arts, and Mathematics 1.1.1 STEAM versus STEM: Key Distinctions	Reading: Institute for Arts Integration and STEAM, "What Is STEAM Education?"
	Unit-I (cont.) 1.2 History and Rationale of STEAM Education (Maeda's Advocacy for the Arts in STEM; Yakman's STEAM Pyramid) 1.2.1 Why Integrate the Arts into STEM? Equity, Creativity, and Real-World Relevance	Reading: Wikipedia, "STEAM education" (overview); Yakman (2010/2017) Assignment: Reflective write-up on personal experience with STEM/STEAM in school
Week 2	**Unit-II** 2.1 The Disciplinary Integration Spectrum: Multidisciplinary, Interdisciplinary, and Transdisciplinary Approaches	Reading: Mazzeo Ortolani (2025), STEM and STEAM Education, and Disciplinary Integration (JRC report)
	Unit-II (cont.) 2.2 The National Academies' STEM Integration Framework: Content, Context, and Connections	Reading: Honey, Pearson & Schweingruber (2014), STEM Integration in K-12 Education, Ch. 1

		Assignment: Classify sample lesson plans by integration type (multi-/inter-/transdisciplinary)
Week 3	**Unit-III** 3.1 The Science (S) in STEAM: Inquiry-Based Science Teaching 3.1.1 Phenomena-Driven Lessons	Reading: NGSS Lead States (2013), framework overview
	Unit-III (cont.) 3.2 Bringing Scientific Inquiry into Regular Classrooms with Limited Lab Resources	Reading: NSTA, "Designing Units and Lessons" Assignment: Draft a phenomenon-based science mini-lesson for a chosen grade level
Week 4	**Unit-IV** 4.1 The Technology (T) in STEAM: Redefining "Technology" in the Classroom 4.1.1 Free Digital Tools and Simulations (e.g., PhET Interactive Simulations)	Reading: ISTE Standards for Students and Educators
	Unit-IV (cont.) 4.2 Introducing Basic Coding and Computational Thinking (e.g., Scratch) in Low-Resource Settings	Reading: EDUC 655 STEM Methods course materials — coding/Scratch integration module Assignment: Review one free digital simulation or coding tool; write a one-page integration plan
Week 5	**Unit-V** 5.1 The Engineering (E) in STEAM: The Engineering Design Process (Ask–Imagine–Plan–Create–Test–Improve)	Reading: NSTA, "What Does It Really Mean to Integrate STEM?"
	Unit-V (cont.) 5.2 Hands-On Engineering Challenges Using Recyclable and Low-Cost Materials	Reading: Edutopia and Left Brain Craft Brain — low-cost STEM activity guides Assignment: Design and prototype a simple engineering challenge (e.g., bridge, tower) from recycled materials; reflect on the design cycle
Week 6	**Unit-VI** 6.1 The Arts (A) in STEAM: Arts Integration and Yakman's STEAM Pyramid	Reading: Yakman (2010/2017), "What Is the Point of STEAM?"
	Unit-VI (cont.) 6.2 Using Visual, Performing, and Design Arts to Represent and Communicate STEM Content	Reading: Institute for Arts Integration and STEAM — arts-integration strategies Assignment: Create an arts-based representation (drawing, model, or skit) of a science or mathematics concept
Week 7	**Unit-VII** 7.1 The Mathematics (M) in STEAM: Mathematical Modeling and Quantitative Reasoning in Authentic Tasks	Reading: UNLV Integrated STEM Methods course materials — mathematical-modeling units
	Unit-VII (cont.) 7.2 Embedding Mathematics Within Interdisciplinary STEAM Projects	Assignment: Develop a short mathematical-modeling task connected to a real-world STEAM problem **Midterm Assessment (covers Weeks 1–7)**
Week 8	**Unit-VIII**	Reading: STEM Education Works & Vivify STEM — "5E vs. Engineering Design Process"

	8.1 STEAM Lesson Planning I: The 5E Instructional Model (Engage, Explore, Explain, Elaborate, Evaluate)	
	Unit-VIII (cont.) 8.2 Comparing the 5E Model and the Engineering Design Process	Assignment: Plan a lesson segment using the 5E Model for a STEAM topic
Week 9	**Unit-IX** 9.1 STEAM Lesson Planning II: Backward Design / Understanding by Design for STEAM Units	Reading: UWF Pressbooks, "Backward Design Process and Instruction Models"
	Unit-IX (cont.) 9.2 Aligning STEAM Units to Learning Standards and Objectives	Reading: UNC "Picking Up STEAM," Ch. 9 — Designing Effective STEAM Instruction Assignment: Draft the "desired results" and "assessment evidence" stages of a backward-designed STEAM unit
Week 10	**Unit-X** 10.1 Project-Based Learning as a STEAM Pedagogical Vehicle	Reading: NSTA project-based learning resources
	Unit-X (cont.) 10.2 Design Thinking in the Classroom (Empathize–Define–Ideate–Prototype–Test)	Assignment: Outline a project-based STEAM unit topic and driving question for the final capstone project
Week 11	**Unit-XI** 11.1 Practical and Low-Cost STEAM Implementation Strategies	Reading: Edutopia, "Low-Cost, Engaging STEM Programs" and "Integrating STEM Skills Across the Curriculum"
	Unit-XI (cont.) 11.2 Mini-Makerspace Corners, Community Partnerships, and Embedding STEAM Into Existing Subjects	Reading: Education Commission of the States, "Key Lessons from Effective K-12 STEAM Education Organizations" Assignment: Develop a low-cost resource toolkit for a STEAM activity feasible in a typical public-school classroom
Week 12	**Unit-XII** 12.1 STEAM in the Elementary Classroom: Developmentally Appropriate Practices	Reading: Elementary STEM/STEAM integration course materials
	Unit-XII (cont.) 12.2 Sample Elementary STEAM Activities and Cross-Curricular Connections	Assignment: Design a grade-appropriate STEAM activity for an elementary classroom
Week 13	**Unit-XIII** 13.1 STEAM in the Secondary Classroom: Discipline-Specific Applications	Reading: Secondary STEAM education course materials (grades 9–12)
	Unit-XIII (cont.) 13.2 Career Connections and Advocacy for STEAM Programs at the Secondary Level	Assignment: Design a grade-appropriate STEAM activity for a secondary classroom
Week 14	**Unit-XIV** 14.1 Assessing STEAM Learning: Diagnostic, Formative, and Summative Approaches	Reading: Institute for Arts Integration and STEAM, "Assessment Strategies"
	Unit-XIV (cont.) 14.2 Rubrics, Portfolios, and Performance-Based Assessment for Open-Ended STEAM Projects	Reading: EBSCO Research Starters, "Performance-Based Assessment" Assignment: Develop a rubric to assess a STEAM project designed earlier in the course
Week 15	**Unit-XV**	Compiled course readings; unit-planning guidelines

	15.1 Designing a Complete STEAM Unit: Integrating Content, Pedagogy, and Assessment	
	Unit-XV (cont.) 15.2 Peer Feedback and Revision Workshop	Assignment: Submit draft STEAM unit plan (lesson sequence, materials list, rubric) for peer review
Week 16	**Unit-XVI** 16.1 STEAM Unit Presentations	Final capstone: STEAM unit presentation and submission
	Unit-XVI (cont.) 16.2 Peer Review, Course Reflection, and Synthesis	Assignment: Reflective essay on growth as a STEAM educator **Final Assessment (covers Weeks 8–16, cumulative)**

Textbooks and Reading Material

Textbook.
Woods, C. (2019). Daily STEM: How to create a STEM culture in your classroom.
Suggested Readings
Books:
Institute for Arts Integration and STEAM. What is STEAM education? The definitive guide for K-12 schools. Retrieved from https://artsintegration.com/what-is-steam-education-in-k-12-schools/
Journal Articles / Reports:
Honey, M., Pearson, G., & Schweingruber, H. (Eds.). (2014). STEM integration in K-12 education: Status, prospects, and an agenda for research. National Academies Press. https://www.nationalacademies.org/read/18612
Mazzeo Ortolani, G. (2025). STEM and STEAM education, and disciplinary integration: A guide to informed policy action (JRC141438). European Commission, Joint Research Centre. https://publications.jrc.ec.europa.eu/repository/bitstream/JRC141438/JRC141438_01.pdf
Yakman, G. (2010/2017). What is the point of STEAM? A brief overview. ResearchGate. https://www.researchgate.net/publication/327449281
NGSS Lead States. (2013). Next Generation Science Standards: For states, by states. https://www.nextgenscience.org/
International Society for Technology in Education (ISTE). ISTE Standards for Students and Educators. https://www.iste.org
Education Commission of the States. Key lessons from effective K-12 STEAM education organizations. https://www.ecs.org/key-lessons-from-effective-k-12-steam-education-organizations/
Note:
It is preferable to use the latest available editions/versions of the above resources. References follow the APA 7th Edition publication manual.

Teaching Learning Strategies

Hands-on design challenges and engineering-design-cycle workshops
Project-based learning and design-thinking studio sessions
Collaborative small-group work on interdisciplinary tasks
Digital-tool exploration labs (free simulations, introductory coding platforms)
Peer teaching / microteaching of STEAM lesson segments
Gallery walk and peer critique of student-built prototypes
Reflective journaling on the practicality and feasibility of classroom implementation
Guest talks or shared case examples from practicing STEAM teachers, where available

Assignments: Types and Number with Calendar

Hands-on mini-project reports : Week 3 (Engineering), Week 6 (Arts), Week 7 (Mathematics)
Lesson-design assignments using the 5E Model and Backward Design (2): Weeks 8–9
Low-cost STEAM toolkit assignment: Week 11
Grade-band STEAM activity designs (2): Week 12 (Elementary) and Week 13 (Secondary)
Assessment rubric design assignment: Week 14
Midterm Assessment: Week 8 — covers Weeks 1–7
Final Assessment: capstone STEAM unit plan, peer review, and presentation — Weeks 15–16, cumulative