

# INFORMATION SESSION

## MS Engineering, specialization in Battery Technologies

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# Presenters

- **Dr. Shahab Ardalan**  
Academic Program Coordinator
- **Afifa Hamad**  
Program Specialist

**Graduate & Extended Studies  
Charles W. Davidson College of Engineering  
San Jose State University**





## San Jose State University is...

- **The oldest public University on the West Coast, established in 1857.**
- **SJSU's Charles Davidson College of Engineering:**
  - ✓ Offers 13 engineering disciplines
  - ✓ Employs 260 faculty and staff
  - ✓ Educates 7,000+ undergraduate and graduate students at any given time.
- **U.S. News & World Report, 2017 edition college rankings, recently ranked SJSU's College of Engineering third in the nation among public engineering programs offering BS and MS degrees.**
- **Local technology firms employ more engineering graduates from SJSU's College of Engineering than from any other college.**



# Program Highlights

- Program is flexible and typically not available in traditional MS programs
- MS degree in 2 years – made possible via cohort structure
- Designed to accommodate working professionals
- Dedicated program specialist
- Instructors include SJSU faculty and industry subject matter experts
- Cohort of 25 – 30 students



# Program Delivery

- **Classes are held on Lucas Business Complex, in Santa Clara, with an opportunity for hybrid delivery.**
- **Program is delivered in *cohort-style*, which means students go through the program with the same group of peers from the first course until graduation.**
- **Program is pre-designed and students take courses according to a predetermined schedule. All cohort members are guaranteed seats in each course without waiting**
- **Program is specifically designed for working professionals:**
  - ✓ **Classes are taught in the evening and on weekends**
  - ✓ **One course at a time**
  - ✓ **Courses are 8 weeks long (8 weekday meetings and two Saturday meetings)**
  - ✓ **MS Engineering degree in about two years**



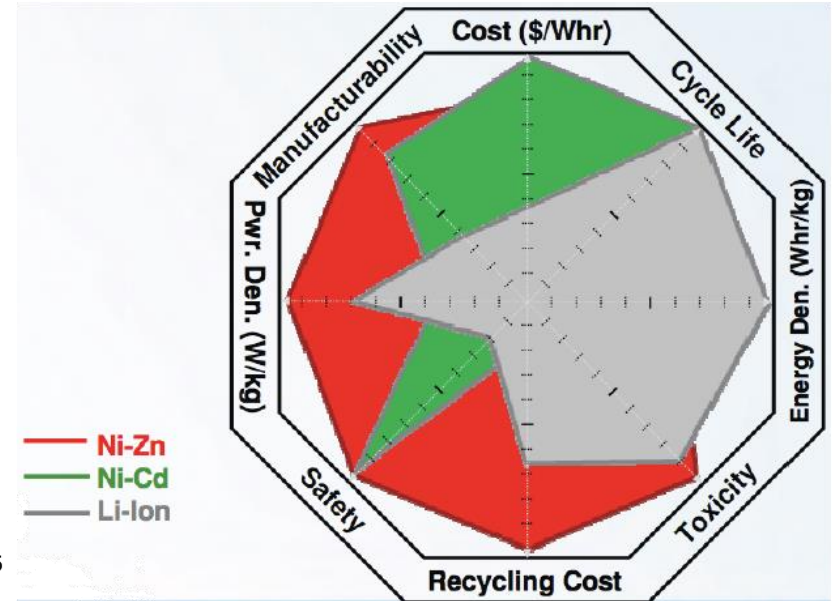
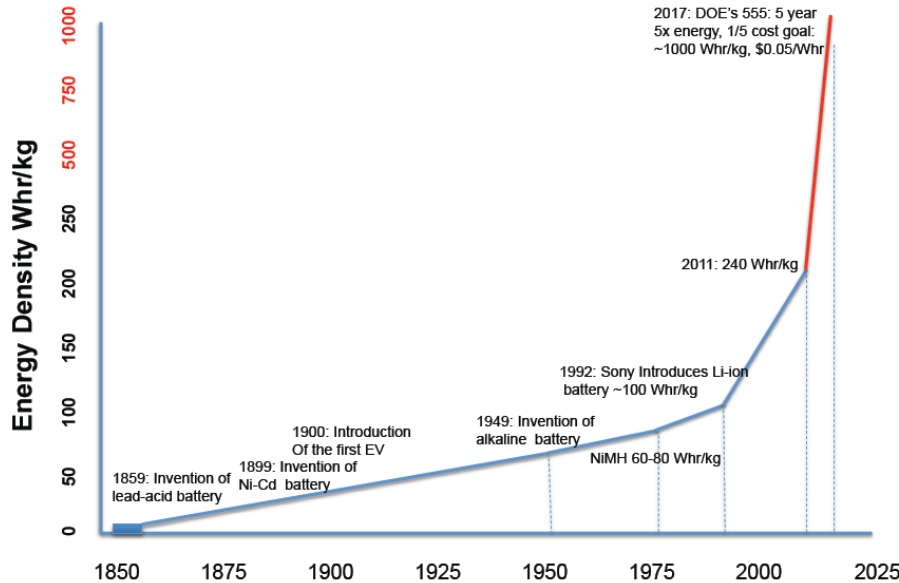
## Student's Time Commitment

- **Weekday class sessions are 3.5 hours long (6:00 – 9:30 pm)**
- **Saturday class sessions are 6 hours long (9:00 am – 3:30 pm)**
  - **Plan to attend all real-time lectures if possible**
  - **If unable to attend in person, you can join remotely via Webex**
- **Expect 1.5 - 2 hours of study time (homework/projects/reading) for each hour of instruction.**
- **Allow 6-8 months to complete team-based Master/Capstone Project**
- **Work related travel can be accommodated**
  - **Please inform program specialist and professor**

# Why Battery Technologies?

- **The first MS degree program of its kind to specialize in Battery Technologies.**
- **Designed to educate a specialty work force needed for the rapidly growing battery industry.**
- **Learn cutting edge technologies.**
- **Develop skills needed for success in your industry.**

# No Moore's law



## Challenges

- Cost
- Cycle Life
- ...



# Course Descriptions

- **Core (6 units)**
  - **ENGR 201:** Engineering Analysis
  - **ENGR 203:** Engineering Management
- **Specialization (18 units)**
  - **ENGR 206:** Renewable Energy Systems
  - **ENGR 264 :** Battery Manufacturing
  - **ENGR 263 :** Electrochemistry
  - **ENGR 261:** Battery Technologies I
  - **ENGR 262:** Battery Technologies II
  - **ENGR 265:** Battery Control System

# Course Descriptions

- **Project (6 units)**
  - **ENGR 295A** – Master Project I
  - **ENGR 295B** – Master Project II
- **Writing competency course (CSU requirement):**
  - **ENGR 200W**-Engineering Reports & Graduate Research
- **Total of 30 credit units (without ENGR 200w)**

# Program Schedule

Semester	Course	Units	Course Title
Fall 2017	ENGR 261	3	<a href="#">Battery Technology I</a>
Fall 2017	ENGR 206	3	<a href="#">Renewable Energy Systems</a>
Spring 2018	ENGR 264	3	<a href="#">Battery Manufacturing</a>
Spring 2018	ENGR 201	3	<a href="#">Engineering Analysis</a>
Summer 2018	ENGR 265	3	<a href="#">Battery Control System</a>
Fall 2018	ENGR 200W	3	<a href="#">Engr Reports &amp; Grad Research</a>
Fall 2018	ENGR 263	3	<a href="#">Electrochemistry</a>
Spring 2019	ENGR 203#	3	<a href="#">Engineering Management</a>
Spring 2019	ENGR 295A##	3	<a href="#">Master's Project I</a>
Summer 2019	ENGR 262	3	<a href="#">Battery Technology II</a>
Summer 2019	ENGR 295B##	3	<a href="#">Master's Project II</a>



# Admission Steps

## Pre-qualify:

- ✓ Fill out a web form at <http://ges.sjsu.edu/corporate-programs-prequalification>
- ✓ Your background and program suitability will be reviewed by graduate advisor
- ✓ You will be invited to submit a formal application for admission to SJSU



# Admission Steps

## Step 2: Apply to the University:

- ✓ **Four year bachelor's degree recognized by SJSU in Engineering or closely related field**
- ✓ **3.0 or above GPA (last 60 semester units or last 90 quarter units)**
  - ✓ Conditional admissions might be granted to applications with extensive experience if their GPA meets SJSU minimum requirement of 2.5
- ✓ **Meet English Language Proficiency Requirement (TOEFL, IELTS, PTE)**
- ✓ **Send Transcripts OR [World Education Services](#) evaluation**
  - ✓ All applicants with foreign coursework are required to provide “document-by-document” basic WES evaluation
  - ✓ Transcripts/Mark Sheets must be sent directly to WES and SJSU Admissions must receive the academic record and the evaluation directly from WES
  - ✓ SJSU will not accept evaluations from institutions other than WES



# Application Deadlines

- **For Fall 2017 Admission:**
  - **Application Deadline: May 31<sup>st</sup>**
  - **Document Submission Deadline: June 20<sup>th</sup>**



# Program Cost

- **San Jose State University application fee: \$55.**
- **Tuition: \$750 per unit or \$2,250 per course.**
- **Entire Program: \$24,750 (11 courses)**
- **Books and other materials (software, for example) are not included in the course fees and must be purchased separately.**



# Testimonials

- **88%** of students and graduates recommend the program to friends.
- “San José State was the only university that offered this graduate program for working professionals,” Gary Calderon said. He added that he most benefited from instructors with industry experience, and gained a new network of colleagues who are experienced with battery technologies. He also appreciated the lab experience that involved building actual lithium-ion coin cells for testing.





# Testimonials

- **Kelly Davis also chose Battery Tech. “I didn’t want to spend more years broadly studying engineering theory, when, in my work experience, most of that theory goes unused,” she said. “The laser focus on a specific topic with direct, real-world application to my present work led me to the Battery University program. I also didn’t want to quit my job to go back to school, but this program was tailored to working professionals like myself.”**



http://ges.sjsu.edu

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**SJSU | CHARLES W. DAVIDSON COLLEGE OF ENGINEERING**

**RANKED 3RD IN THE NATION BY U.S. NEWS AND WORLD REPORT**

Among public engineering programs offering bachelor's and master's degrees, excluding service academies.

Ranked 3rd Best College in the Nation in Engineering

- MySJSU
- Canvas
- Give to SJSU

**Navigation**

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**Apply for Pre-Qualification**

- OFF-CAMPUS
- CORPORATE

Graduate and Extended Studies  
 Charles W. Davidson College of Engineering  
 San José State University  
 One Washington Square,  
 San José, CA 95192-0205  
 Tel: 408.924.3968  
 Fax: 408.924.3818  
 engineering-techmart@sjsu.edu

Pre-qualify today!



- Accepting Applications**
  - MS Software Engineering, ...
- Programs In Progress**
  - Lockheed Martin – MS ...
- Future Programs**
  - KLA Tencor - MS Engineering, ...

# Questions?

**Academic Advisor: Dr. Shahab Ardalan**  
[shahab.ardalan@sjsu.edu](mailto:shahab.ardalan@sjsu.edu)

**Program Specialist: Afifa Hamad**  
[afifa.hamad@sjsu.edu](mailto:afifa.hamad@sjsu.edu)  
408.924.3196

# Course Topics

**Course topics are tentative and may change at the discretion of the instructor.**

# ENGR 261– Battery Technology I

ENGR 261 teaches basic and fundamentals about battery technologies. Concepts and understanding of electrochemical, kinetics and thermodynamics in batteries will be covered.

## Lecture Topics:

- Introduction to electrochemical energy storage systems: from chemistry to market.
- Electro Chem 1
- Lithium-ion cell fabrication demo - computer simulation or lab demo.
- Electro Chem 2
- Cell Design: Lithium-ion batteries: cell structure, components, Cell Characterization and Testing. International standards for certification and shipping.
- Lithium Ion Cell Manufacturing overview.
- Lithium Ion Manufacturing (conclude)
- Supply Chain
- Cell and material diagnostics - electrochemical and imaging based.
- From Cell to pack: control technology, pack design, pack manufacture.
- Next Generation Batteries: Li S Na ion
- Activity in the US

# ENGR 206 – Renewable Energy System

Basic concepts, material development and modeling of lithium-ion batteries will be discussed as well as understanding of flow batteries. Advanced and future technologies for next generation batteries will be introduced.

## Lecture Topics:

- Fossil resources and Electric and Gas System Operations.
- Solar Resource and Technologies.
- Baseload, Carbon-free Resources and Technologies: Hydroelectric, geothermal, and nuclear.
- Wind resources and technologies.
- Bio-mass, Bio-fuel and Bio-gas.
- Marine Energy: Tide and Wave.
- Transportation Combustion engines, Fuel Cells and Electric Vehicles.

# ENGR 264 – Battery Manufacturing

This course covers the manufacturing of lithium ion cells in detail. Lectures will cover detailed manufacturing steps, manufacturing indices, new product introduction, supply chain, and quality systems.

## Lecture Topics:

- Course Administration, Manufacturing Planning
- Process Flow and Bill of Materials
- Capital Equipment, Direct Labor
- Manufacturing Metrics and Ramp Curves
- Supply Chain
- Quality Systems
- Project Work Session
- Cost of Goods Sold
- Project Presentations

# ENGR 201 – Engineering Analysis

Course Description The course will cover advanced topics in differential equations. Linear algebra, and Probability and Statistics that are of interest to engineers and scientists. The focus will also be on the application of the acquired concepts for formulating and solving problems effectively. The course will be structured to address the needs and interests of engineers from a variety of disciplines including Engineering Management, Biomedical Devices, Electronic Materials and Devices, Environmental Health and Safety, Green Technology, and other topics areas as appropriate.

## Lecture Topics:

- Introduction First and Second Order ODEs and Models
- Higher order ODEs
- Series solution
- Systems of Nonlinear Differential Equations
- Fourier series and Fourier transform
- Linear algebra
- Eigen value/vectors Systems of ODEs
- Numeric Analysis.
- Linear programming, Probability Theory and Mathematical Statistics
- Mathematical Statistics Tests of Hypothesis and ANOVA



# ENGR 265 – Battery Control System

ENGR 265 teaches how to design, analyze, and perform experiments for model and system validation work on the battery control system by means of the advanced 2-level intelligent control system architecture in two key energy intensive system applications. The first application involves pure electric and plug-in electric vehicles. The second application involves solar and /or wind renewable energy storage and retrieval systems for the electric grid.

## Lecture Topics:

- Systems Engineering
- Two-level Intelligent Control Systems Architecture
- Multi-call Rechargeable Battery Control System
- Control Algorithms: MEC, PID and SEC
- Power Electronics: DC/DC, AC/DC and DC/AC
- System Loads, Resonance with Beats
- Sensor Electronics
- Computer Modeling and Simulation Principals
- Advanced Computer Simulation Language-x (acsix)
- Battery Charger Modeling and Simulation Examples
- Battery-powered wheel motor drive
- Battery-powered electric power steering system
- Solar Energy Storage/Retrieval with high energy battery for Electric Grid
- Wind/Solar Energy Storage/Retrieval with a high energy battery inverter for electric grid

# ENGR 263– Electrochemistry

This course will cover the basics of fundamental and applied electrochemistry through the lens of batteries, emphasizing the three central topics of thermodynamics, kinetics, and transport. Topics to be covered include electrochemical potentials, kinetics of electrode reactions, mass transfer effects, reference electrodes, porous electrodes, dilute and concentrated solution theory, and electro-analytical methods including voltammetry, coulometry, and impedance spectroscopy. The complex systems chemistry of commercially relevant batteries will be emphasized, as will experimental approaches in battery R&D and implications for manufacturing.

## Lecture Topics:

- Chemistry Review
- Introduction to Electrochemistry
- Understanding Potentials
- Demonstration/Lab: Cyclic Voltammetry
- Electrode Kinetics
- Transport Processes
- Electrochemical Methods I
- Electrochemistry of Energy Storage
  - Demonstration/Lab: Impedance Spectroscopy
  - Electrochemical Systems
  - Li-ion Batteries
  - Electrochemical Methods II
  - Electrochemistry in Industry
  - Advanced Topics

# ENGR 203 – Engineering Management

Students will develop contemporary expertise in the principles of engineering finance, management, IP, operations management, performance metrics, and their application to design, development, and commercialization of new products and services in dynamic environments.

## Lecture Topics:

- Introduction to Engineering Management, Challenges and Functions
- Organizational Structures, Initial Planning (Requirements -> Statement of Work)
- Initial Planning (Requirements -> Work Break Down Structure)
- Network Scheduling Techniques
- Engineering Management Functions:  
Leading and Controlling
- Pricing and Estimating and Cost Control
- Trade off Analysis
- Risk Management
- Managing Crisis Projects
- Ethics in Engineering Management, and Business Fundamentals for Engineering Managers
- Marketing Management for Engineering Managers
- Web-based Enablers for Engineering and Management
- Engineering Management Future trends, Globalization

# ENGR 262 – Battery Technology II

This follow-up course will provide an in-depth look at batteries with a focus on the cutting-edge research and development. Topics such as material synthesis techniques, science of electrode fabrication, advanced characterization techniques, battery life degradation mechanisms, design of battery electrodes, thermal management, and state-of-charge and state-of-health measurements will be covered.

## Lecture Topics:

- Review of Cell Design/Advanced Content. Historical Trends
- Cell Design Trade offs
- Battery Testing and Real time monitoring: basic and advanced techniques
- Cutting Edge research: High Voltage Cathode, High Voltage Anode, Silicon, Anode, Lithium
- Midterm Exam: Material Synthesis Techniques Thermal management
- Battery Pack Design, Control Systems and Thermal Management
- Advanced Technologies Lithium Air, Sulfur, Magnesium Ion
- Lab scale synthesis of material
- Cell Disassembly: Diagnose root cause of

# ENGR 200W – Engineering Reports & Graduate Research

Graduate level technical writing workshop designed to develop advanced communication skills that will readily transfer to the engineer's professional needs, along with research methodologies, copyright issues, and proper documentation for the master's thesis project.

# ENGR295A – Master's Project I

Students complete the in-depth project, write a detailed project report and make a comprehensive presentation and demonstration of project. Prerequisite: Admission to Candidacy of Master's Degree

# ENGR 295B – Master's Project II

A continuation of ENGR 295A. Students complete the in-depth project, write a detailed project report and make a comprehensive presentation and demonstration of project. Prerequisite: Admission to Candidacy of Master's Degree