"An Introduction to Modern Mechanical Engineering" A New Course to Introduce Students to the Dynamic and Evolving Engineering Disciplines.

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Abstract

The Mechanical Engineering Department at the School of Engineering, University of New Mexico offered a new class in the spring of 2019 titled "An Introduction of Modern Mechanical Engineering". The class aims to offer hands-on activities and interactive research projects on modern and varied applications of mechanical engineering, while describing the science and math behind them. The objective of this course is to introduce engineering early career students to the various fields and sub-disciplines of the mechanical engineering profession. The paper describes the motivation behind creating the new course, the different components and structure of the course, as well as provide evidence of student activities and survey data from their participation in the course.

Introduction

Engineering students spend the first 1-2 years taking pre-engineering classes with little exposure to actual engineering related courses that form their conceptualization on what are engineers do in their careers. During the freshman year, students take several math, physics and other pre-requisite classes, during which they do not see the relevance to an engineering career[1]. Consequently, many students change their interest to other degrees path, which result in low enrollment in the engineering schools. This issue even become more convoluted by the natural low enrollment in small schools that play important role in graduating much-needed talents that serve the local private, state and federal businesses[2,3]. The University of New Mexico (UNM) located in the central region of the state that host several national laboratories such as Sandia National Laboratories, Los Alamos National Laboratory, and Air Force Research Laboratory, in addition to several other state, manufacturing and processing industrial complexes. Therefore, the engineering school must create new ways to recruit new students and increase retention of existing students.

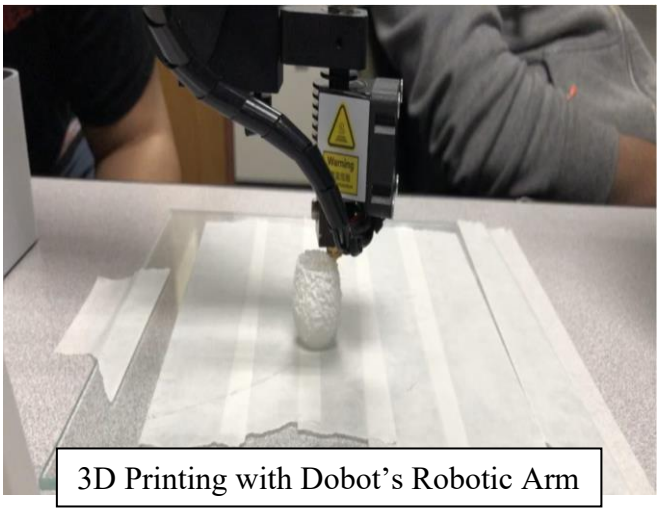
In a previous study by the first author, a skill gap analysis for the advanced manufacturing workforce in the state of New Mexico concluded that UNM and Central New Mexico Community College (CNM) and their respective remote branches produce 66.41% of the total annual awards related to the advanced manufacturing industry[4]. The skill gap analysis projected an annual gap of 459 occupancies among engineering occupations needed for advanced manufacturing in the state for the next 10 years, which predict that hiring and retaining qualified candidates in advanced manufacturing will be a major challenge for the local economy. The skills gap analysis is built on the results of several industry forums held in different regions of the state as well as the analysis of skills gap surveys completed by the advanced manufacturing's stakeholders. Majority of employers surveyed highlighted the importance of integrated skills among engineering graduates such as problem-solving, professional and interactive skills.

Therefore, the mechanical engineering department at UNM introduced a new course in the spring of 2019 titled "An introduction to modern Mechanical Engineering, ME150" to increase the retention of engineering students. The objective of this course is to introduce engineering freshman students to the various applications of the mechanical engineering profession. By the time students complete this course, they should be able to:

- describe mechanical engineering fields and related activities such as Energy, Engineering Materials, Biomedical Engineering, Mechatronics, Computational design, 3D Printing, Propulsion and Engine Systems, and Advanced tribology
- understand some of the subfields of mechanical engineering (HVAC, thermal fluids; solid mechanics, material science, biomechanics, controls, dynamics and vibrations, and manufacturing)
- distinguish mechanical engineering from other types of engineering;
- demonstrate mechanical engineering design and management;
- utilize engineering measurements and tools, units, and conversions;
- perform data analysis and graphical display of information;
- describe the different types of forces, motion and machine components;
- demonstrate understanding of various types of mechanical energy and the nexus between energy-water-environment

Class Design

The class offers non-traditional education experience to the students, where more than 80% of the class time is spent on conducting interactive hands-on research. Students get engaged in research using experimental tools to learn about machine learning and control, Newton's three laws of motion, advanced tribology, propulsion and engines, and bioengineering. Students were able to successfully complete various experiments, collect data, and present in the class. Students conducted various laboratories experiments working on a bench scale robotic arm to conduct machine learning programming as well as use it for laser engravement, plotting, 3D printing, which are components of manufacturing automation.



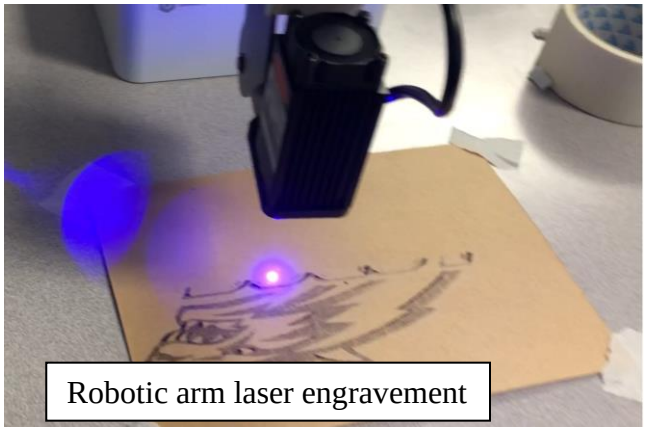
3D Printing with Dobot's Robotic Arm

Students work on machine learning with Dobot's Robotic Arm

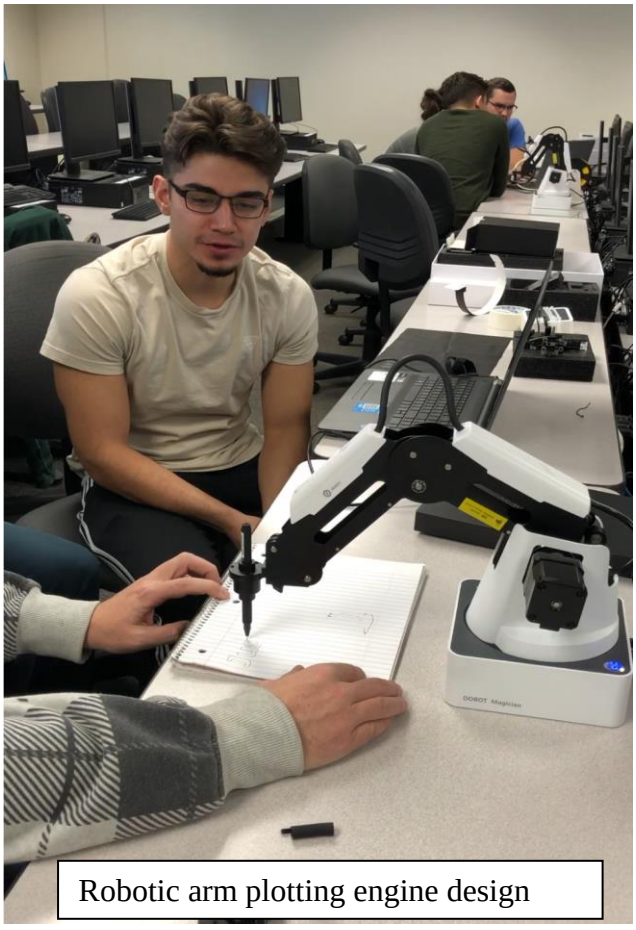
Students were able to demonstrate what they learned from the robotic experiments by performing supervised assisted welding trials when visited the fuse maker space at CNM. Students conducted

bench scale experiment to learn about mechanical and static forces by building different design bridges and compare the calculated forces versus the measured ones. They conducted time-of-flight experiment to build their background on aerospace applications by predicting a projectile height, speed, time and landing site. Students learn about renewable energy by using an experimental kit that help them to study the effect of wind speed and light intensity on electrical production.

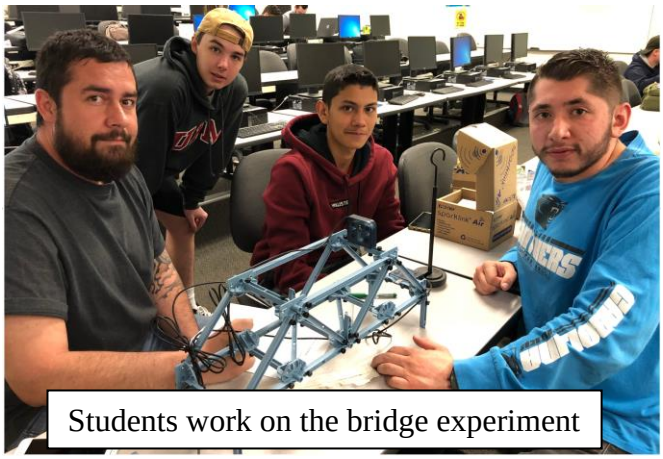
Robotic arm assisting welding at CNM



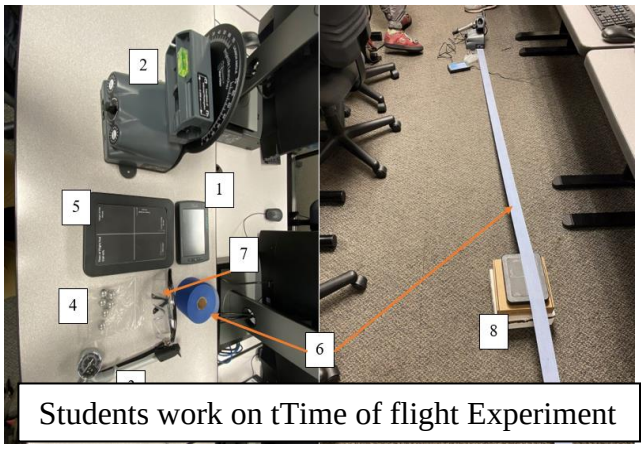
Robotic arm laser engravement



Robotic arm plotting engine design



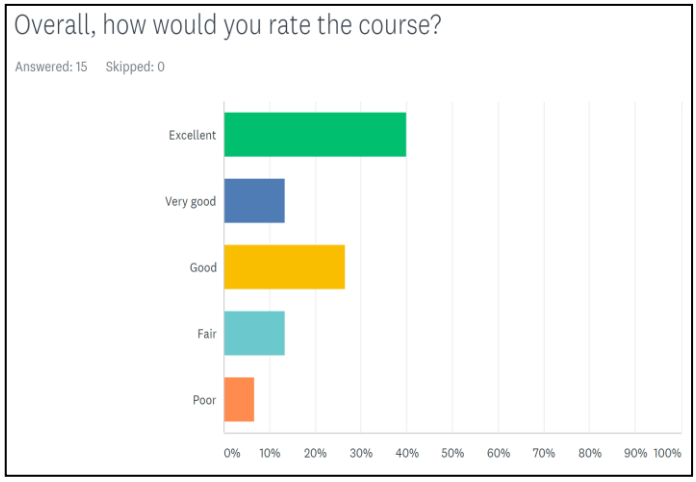
Students work on the bridge experiment

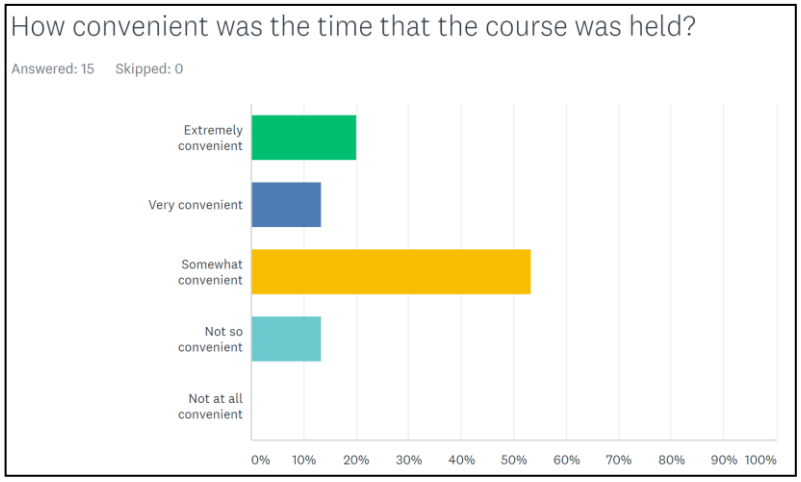


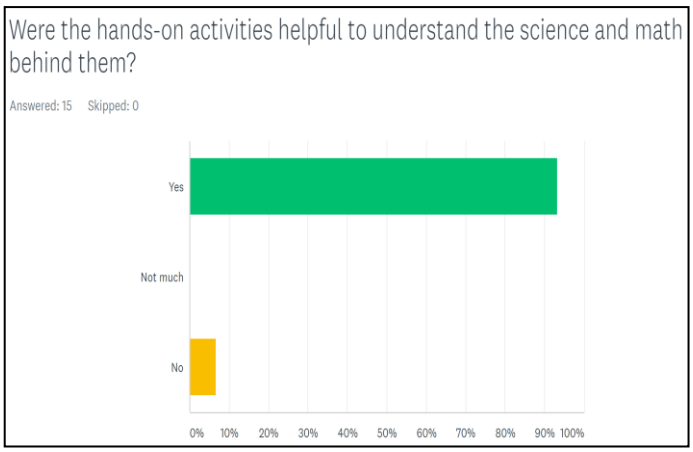
Students work on tTime of flight Experiment

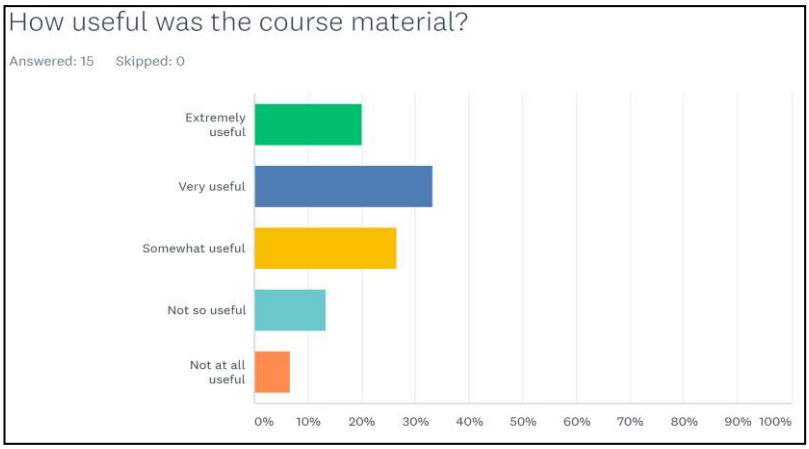
A nine-questions anonymous survey was distributed to the students to reflect on the success and effectiveness of the course and identify areas for improvement. The results of the survey are

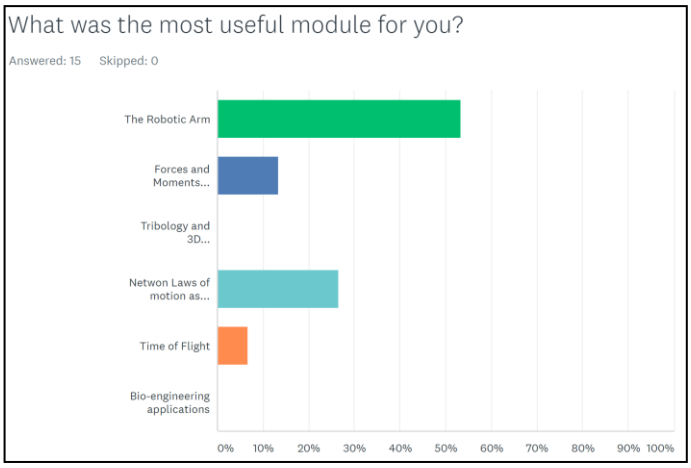
displayed in the following charts.

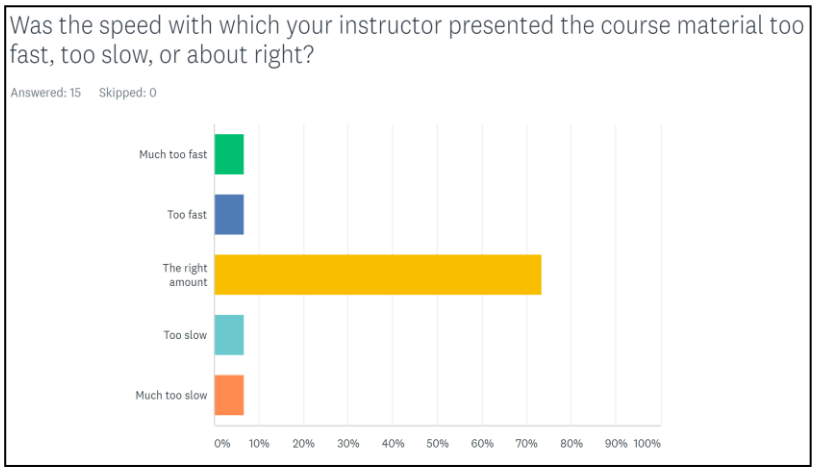


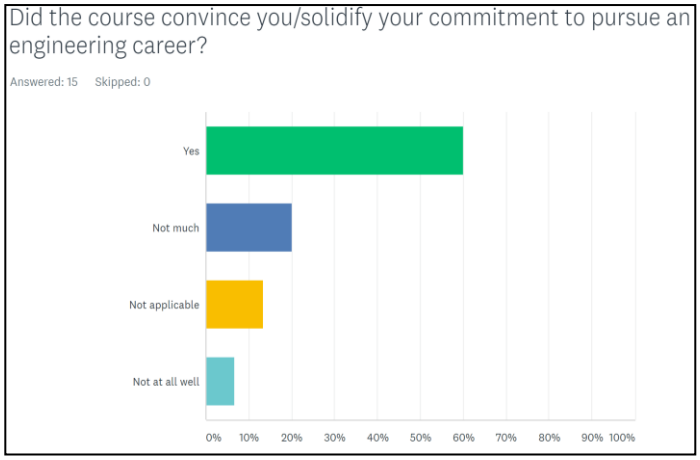


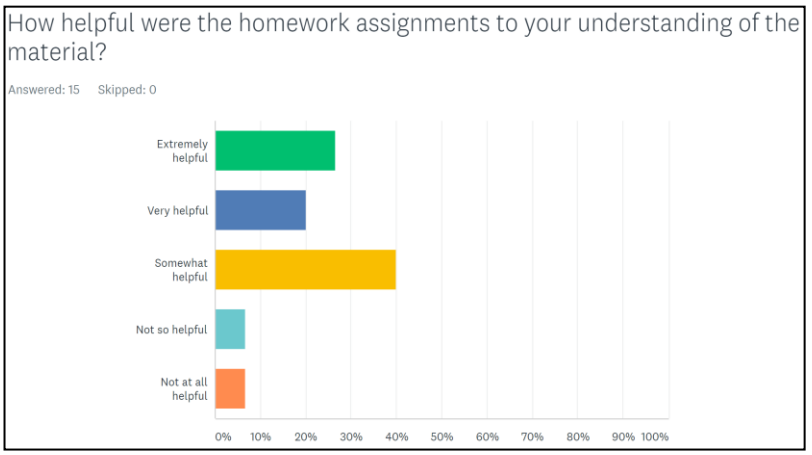


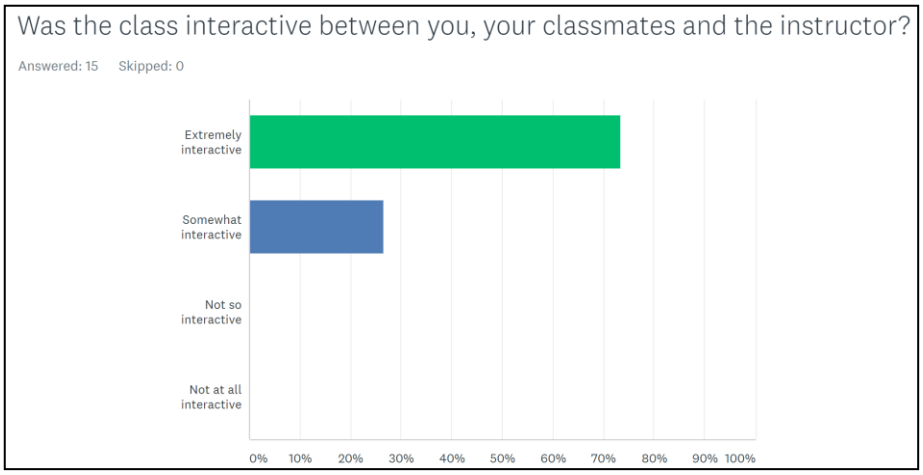












A matrix is used to gauge the success of ME150 in retaining students in the engineering program, especially mechanical engineering. Tables 1 and 2 show the enrollment list of 29 students who took ME150 class in spring and fall of 2019. The tables show students who continued their enrollment in the mechanical engineering program or engineering program in general. Thirteen out of the fourteen students were retained in the fall 2019 and 11 out of 15 were retained in the spring 2020 in the engineering program, mostly in the mechanical engineering degree program. Additional data will be collected on the retention of pre-engineering students who did not take ME150 to compare against the data in tables 1 and 2. This comparative study will provide more quantitative measure on the impact of ME150 on students' retention in the engineering program.

Summary and Conclusions

In summary, the rational for to create ME150 at the Mechanical Engineering Department, University of New Mexico was discussed. The design of the course was explained including the various research and laboratory activities conducted by the students. Students were surveyed to gauge the success if the course in meeting its objectives. Students were able to conclude the relevance of math and physics knowledge to building an automobile, aircraft, and power plant. Students were able to learn more about the new trends in jobs evolution in mechanical engineering in the aerospace, bioengineering, manufacturing and robotics. Students value the interactive learning

process, which was emphasized before by McShannon et al., 1999[5]. The course made 60% of the students committed to engineering career. The course received an overall rating between good to excellent from 86.66% of the students.

In conclusion, the initial assessment of the course after two semesters reveal that the new course is on track to achieve its goals. Tacking the progress of the students toward the completion of their engineering degree will provide additional data to update the assessment. Surveying more students in the upcoming semesters would provide additional data to increase the accuracy of assessment.

Table 1. ME150 Students Retention in Engineering Program – Fall2019

Crse Subj Code	Crse #	Major	Acad Pd	Instr Last Name	Fall 19
ME	150	Mechanical Engineering	Spring 2019	Hasan	ME
ME	150	Mechanical Engineering	Spring 2019	Hasan	ME
ME	150	Pre Mechanical Engineering	Spring 2019	Hasan	PreME
ME	150	Pre Mechanical Engineering	Spring 2019	Hasan	PreME
ME	150	Pre Mechanical Engineering	Spring 2019	Hasan	PreME
ME	150	Pre Mechanical Engineering	Spring 2019	Hasan	PreME
ME	150	Mechanical Engineering	Spring 2019	Hasan	ME
ME	150	Pre Mechanical Engineering	Spring 2019	Hasan	PreME
ME	150	Pre Mechanical Engineering	Spring 2019	Hasan	PreME
ME	150	Pre Mechanical Engineering	Spring 2019	Hasan	PreME
ME	150	Pre Mechanical Engineering	Spring 2019	Hasan	PreME
ME	150	Pre Chemical Engineering	Spring 2019	Hasan	PreCHEM
ME	150	Pre Mechanical Engineering	Spring 2019	Hasan	last enr Sp19
ME	150	Pre Mechanical Engineering	Spring 2019	Hasan	PreME

Table 2. ME150 Students Retention in Engineering Program – Spring2020

SUBJECT	CRSE #	MAJOR	ACAD PD	REGISTRATION_STATUS	INSTR LAST NAME	Spring 2020
ME	150	Pre Mechanical Engineering	Fall 2019	Student Registered	Hasan	PreME
ME	150	Pre Mechanical Engineering	Fall 2019	Student Registered	Hasan	PreME
ME	150	Pre Mechanical Engineering	Fall 2019	Student Registered	Hasan	PreME
ME	150	Undecided	Fall 2019	Student Registered	Hasan	PreCS
ME	150	Pre Mechanical Engineering	Fall 2019	Student Registered	Hasan	PreME
ME	150	Pre Business Administration	Fall 2019	Drop	Hasan	PreBA
ME	150	Undecided	Fall 2019	Student Registered	Hasan	Undec
ME	150	Mechanical Engineering	Fall 2019	Student Registered	Hasan	BSME
ME	150	Non-Degree	Fall 2019	Student Registered	Hasan	NonD
ME	150	Pre Mechanical Engineering	Fall 2019	Drop - Perm Req	Hasan	PreME
ME	150	Pre Mechanical Engineering	Fall 2019	Student Registered	Hasan	PreME
ME	150	Mechanical Engineering	Fall 2019	Student Registered	Hasan	BSME
ME	150	Pre Mechanical Engineering	Fall 2019	Student Registered	Hasan	PreME
ME	150	Pre Mechanical Engineering	Fall 2019	Student Registered	Hasan	BSME
ME	150	Pre Mechanical Engineering	Fall 2019	Student Registered	Hasan	PreME

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