Ultra High-Speed Imaging Methods in Explosives Engineering
EXGN 6001
Course Syllabus
Spring 2018

Times and Location:
March 26-30, 2018, Monday – Friday 8:00- 5:00, Lecture Classroom Brown Building 125, Explosives Research Laboratory in Idaho Springs, Colorado

Instructor:
Dr. Vilem Petr: BB 120, (303) 273-3232, vpetr@mines.edu

Teaching Assistant:
TBD

Lab Coordinator:
Ray Johnson: BB 121B, (303) 272 3080, rjohns@mines.edu

Course Website:
http://axpro.mines.edu/LongDistance.html
http://www.mines.edu/elearning/

Course Objectives

This week-long course offers students, who desire to continue their education in graduate studies, the opportunity to introduce themselves to and develop a fundamental knowledge of ultra-high speed imaging methods and flash x-ray systems. Specifically, this course will cover the topics of the fundamental differences between high-speed imaging and ultra high-speed imaging, lighting and lens selection, flash x-ray system selection, radiography, radiation safety, high voltage techniques, system trouble-shooting, laser lighting, and software analysis. Students will ultimately gain a greater understanding of ultra high-speed imaging techniques and through classroom and blast chamber demonstrations and experiments, industry expert lectures, and hands-on practical exercises at the Explosives Research Lab.

Grading

This course is assessed on the traditional grading scale.
Students will demonstrate their knowledge through the completion of homework, lab reports, quizzes, and a final exam. Homework and quizzes will be given after each topic covered.

Lab reports will be completed after each session of practical training at the ERL.

> 93	**A**
90-93	**A-**
87-89	**B+**
84-85	**B**

80-83	**B-**
77-79	**C+**
74-76	**C**
70-73	**C-**
60-69	**D**
< 60	**F**

Attendance

Regular class attendance and the timely completion of assignments is required in order to pass this course.

You are required to attend 90% of the lectures given; penalties will be given for additional lectures missed.

ERL Policies

Safety Training attendance is MANDATORY. In order to participate in any of the practical exercises of this course, you must satisfactorily pass the Safety Quiz and sign the Student Waiver Form.

The following dress code is MANDATORY when working in the Explosives Research Laboratory in Idaho Springs. Violators of any ERL rule will be immediately expelled and not allowed to re-enter for the duration of the course:

- Jeans with no holes, tears, etc.
- Steel-toed shoes
- Shirt long enough to cover your back when you kneel down
- Appropriate additional clothing at the site due to weather conditions

We will provide all other required safety equipment.

You must have approval from the instructor before taking videos or pictures of any activities at the test site.

Please let your instructor know if you have any medical conditions that are relevant to the activities of this course.

Due to safety requirements, there is a maximum class capacity of 20 students.

Ultra High-Speed Framing Imaging for Research and Experimentation

Schedule

March 26-30, 2018

Detailed Course Outline

Day One: Monday March 26, 2018 (8:00 – 18:30)

08:00 – 08:30	Welcome & Introductions	Dr. Vilem Petr (CSM)
08:30 – 08:45	Course Overview and Instructions	Dr. Vilem Petr (CSM)
08:45 – 09:00	Coffee Break	
09:00 – 09:45	Safety Training and Quiz	
09:45 – 10:30	Intro to Explosive, Detonation, Initiation and Shock Wave Physics	Dr. Vilem Petr (CSM)
10:30 – 11:15	Guest Lecturer	TBD
11:15 – 12:30	Lunch Break	
12:30 – 13:45	Intro to Ultra High-Speed Imaging	Frank Kosel (SI)
13:45 – 14:00	Coffee Break	
14:00 – 14:45	Lenses & Optics in Ultra High-Speed Video	Frank Kosel (SI)
14:45 – 15:00	Coffee Break	
15:00 – 15:45	Illumination & Lighting Considerations	Frank Kosel (SI)
15:45 – 16:00	Coffee Break	
16:00 – 16:45	Camera Triggering & Synchronization	Frank Kosel (SI)
16-45 - 17:00	Q & A / Class Dismissal	All Presenters
17:30 – 18:30	Small Buffet Reception (Hill Hall 300)	Everyone

Day Two: Tuesday March 27, 2018 (8:00 – 17:00)

8:00 - 8:45	Intro to Flash X-Ray (continued)	Peter Laurence (L3)
08:45 – 09:00	Coffee Break	
09:00 – 09:45	Intro to Flash X-Ray (continued)	Peter Laurence (L3)
09:45 – 10:00	Coffee Break	
10:00 – 10:45	Intro to Flash X-Ray (continued)	Peter Laurence (L3)
10:45 – 11:00	Coffee Break	
11:00 – 12:00	Flash X-Ray Settings	Peter Laurence (L3)
12:00 – 13:00	Lunch Break	
13:00 – 13:45	Experimental Analysis	Peter Laurence (L3)
13:45 – 14:00	Coffee Break	
14:00 – 14:45	Image Analysis	Peter Laurence (L3)

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14:45 – 15:00	Coffee Break	
15:00 – 15:45	Examples of Results and Analysis	Peter Laurence (L3)
15:45 – 16:00	Coffee Break	
16:00 – 16:45	Experimental Setups	All Groups
16:45 – 17:00	Question and Comments	All Groups

Day Three: Wednesday March 28, 2018 (8:00 – 17:00)

08:00 - 08:45	Camera Setup DAQ	Frank Kosel (SI)
08:45 – 09:00	Coffee Break	
09:00 – 09:45	Intro to Laser Lighting	Frank Kosel (SI)
09:45 – 10:00	Coffee Break	
10:00 – 10:45	Software Analysis	Frank Kosel (SI)
10:45 – 11:00	Coffee Break	
11:00 – 12:00	Classroom Experiment 1	Frank Kosel (SI)
12:00 – 13:00	Lunch Break	
13:00 – 13:45	Classroom Experiment 2	Frank Kosel (SI)
13:45 – 14:00	Coffee Break	
14:00 – 14:45	Classroom Experiment 3	Frank Kosel (SI)
14:45 – 15:00	Coffee Break	
15:00 – 15:45	Blast Chamber Experiment 1	Frank Kosel (SI)
15:45 – 16:00	Coffee Break	
16:00 – 16:45	Blast Chamber Experiment 2	All Groups
16:45 - 17:00	ERL Safety Overview and Q & A / Class Dismissal	All Presenters

Day Four: Thursday March 29, 2018 (8:00 – 17:00)

07:45 – 08:15	Meet for Transport to ERL at Golden, CSM campus	All Groups
08:15 – 09:00	Travel to Idaho Springs, ERL	All Groups
09:00 – 10:00	Safety Training/Group Picture at Test Site	Dr. Vilem Petr (CSM)
10:00 – 15:00	Hands-on Explosive Experiments (11 parts)	All Groups
16:00 – 16:45	Transportation back to CSM campus	

Day Four: Friday March 30, 2018 (8:00 – 17:00)

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8:00 – 8:45 a.m.	Intro to TEMA Software	Chris Tenney (TEMA)
8:45 – 9:00 a.m.	Break	
09:00 – 09:45	Intro to TEMA Software continued	Chris Tenney (TEMA)
09:45 – 10:00	Coffee Break	
10:00 – 10:45	Intro to TEMA Software continued	Chris Tenney (TEMA)
10:45 – 11:00	Coffee Break	
11:00 – 12:00	Practical software Analysis	All Groups
12:00 – 13:00	Lunch Break	
13:00 – 15:00	Group Analysis of Recorded Data	All Groups
16:00 – 17:00	Presentation Delivery	All Groups
17:00 – 17:30	Wrap-up (Q&A, Evaluations and Awards)	Everyone