MODULE

BSEN40520 Optical Sensing Technology

MODULE OBJECTIVES

This module is designed for students who wish to understand and become critically aware of the basic principles, practice and applications of optical spectroscopic sensing. The fundamentals of visible, near infrared and mid-infrared spectroscopy will be presented. Standard approaches and configurations for acquisition and analysis of spectral and spatial data will be covered. Spectral pre-processing methods and methods of data selection will be introduced. Chemometric tools such as Principal components analysis for optical data analysis will be presented.

Learning Outcomes:

On completion of this module students should be able to:

1. Understand the basic principles of light-matter interaction at different wavelength ranges and spatial scales
2. Compare spectral responses of materials using a range of optical spectroscopic techniques
3. Analyse and interpret spectral data using MATLAB

Student Effort Hours:

Hours Lectures	**24**
Autonomous Student Learning	96
Total	120

Approaches to Teaching and Learning:

active/task-based learning; peer and group work; lectures; enquiry & problem-based learning

Title: REGRESSION **Duration:** 4h	**Module: BSEN 40500**	**Number in Sequence: 4**
Aim(s): Introduce Multivariate Regression in general and PLS-R applications to hyperspectral im.		
Outcomes: At the end of this lesson the students should be able to 1. Understand differences between clustering, classification, and regression models 2. Understand the basic principle of PLS regression (PLSR) 3. Understand key model performance metrics used in PLSR 4. Be able apply PLSR to a set of spectral images and interpret the results 5. Understand the structure of multiset hyperspectral images 6. Be able to apply pre-processing, pretreatments, concatenated PCA and PLSR to a multiset of spectral imaging data and interpret the results		
Time	**Teacher Activity**	**Student Activity**
SECTION1	INTRO	1.INTRO MULTIVARIATE REGR. METHODS
0 – 5 min	Covid statement/Covid guidelines. Check assistance, Check Zoom access.	Check assistance, Check Zoom access.
15-20 min **(5 min)**	Doubts from previous classes,	Write on Questionnaire (Brightspace), listen, discuss
5-10 min **(5 min)**	Presentation(1) on intro types of Multivariate methods.	Listen
15-20 min **(5 min)**	Quizz (differences regression, clustering, discrimination)	Answer to the class, Discuss
20-45 min **(20 min)**	Presentation(2). Need for PLS. Introduction to different regression methods,	Listen
Break **(45 – 55 min)**	Break 10 min	2.MODEL PARAMETERS AND PERFORMANCE METRICS
1h 0 – 20 min **(15 min)**	Presentation(3) Principle of PLS-Regression (Theory)	Listen
1h 30 – 40 min **(15 min)**	Presentation(4) on Calibration, validation, and model performance metrics	Listen & watch, participate in calculating metrics
1h 30 – 40 min **(15 min)**	Discuss any doubts on PCA and previous data	
Break **(1h 40 min – 2h 5 min)**	Break 25 min	3. Example PLSR WITH POINT SP.
2h 5 -15 min **(25 min)**	Present script SECTION 1 FOR DATASET1 (Simulated images)	- Work on data (via laptop, MATLAB) - Listen

	DATA EXPLORATION, DATA PREP. , CALIBRATION Check in with each group (3 people/group)	
2h 25 -50 min **(25 min)**	 Present CHALLENGE WITH DATASET2 CHEAKPEA DATA Check in with each group (3 people/group)	- Work on data (via laptop, MATLAB) - Ask questions and discuss - INPUT their RMSEP result - Prepare to explain their approach
Break (2h 50 min – 3h)	Break 10 min	4.PLSR APPLICATION TO MULTISET OF HSI
3h 0 min – 10 min (15 min)	Present winner from PLSR challenge	- Winner explains their approach
(15 min)	Work on assessments. Check in with each group (3 people/group).	- Work on assessments (via laptop, MATLAB) Ask questions and discuss
(15 min)	Present extra dataset for work on multiset	-
MATERIAL NEEDED **Ppt:** Theory presentations (5 Ppt of MATLAB scripts & results (3, one per dataset) **Activities:** 2 (ind.) formative act. for theory part; Quiz on previous concepts PCA, etc, to clarify doubts before the class. **Datasets:** 2 on point spectra, 1 Multiset of images **Videos:** ppt recordings of (2) and (3) theory presentations for zoom students. **AV :** *Laptop, camera and mic for zoom (+ trypod?) *laptop for class *Check how to connect to projector in workshop class.		**MATERIAL NEEDED** **Students:** Laptop , Matlab, access to class material in Brightspace