

CIMET Course catalogue

Semester 2 - Course offer 2011-2013

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CIMET Radiometry, sources and detectors

Course name: Radiometry, sources and detectors
Course level: Master

Course CIMET RSD
ECTS Credits: 5.00

Course instructors: Joaquin Campos Acosta (University of Granada-CSIC), and Jean Louis Meyzonnette (University Jean Monnet)

Education period (Dates): 2nd semester

Language of instruction: English

Prerequisite(s): Module "Photonics and Optics Fundamentals" (1st semester)

Expected prior-knowledge: Basic geometrical optics.

Aim and learning outcomes:

This course develops an understanding of the measurement of electromagnetic radiation in spectral regions from ultraviolet to infrared. The course covers principles of radiometric, photometric and spectrophotometric instrumentation, including the study of light sources and physical detectors.

On completion of this course the student will be able to:

- Understand (i.e. to describe, analyse and reason about) how to use the methodology in quantifying electromagnetic radiation, from ultraviolet to infrared.
- Correctly use radiometric and photometric quantities and units.
- Understand (i.e. to describe, analyse and reason about) how to characterize light sources with different emission spectra.
- Understand (i.e. to describe, analyse and reason about) how to characterize photodetectors with different properties and responsivities.
- Demonstrate the use of mathematical tools to solve problems in radiometry and photometry.

Topics to be taught (may be modified):

- Fundamentals of radiometry: Radiometric quantities and important laws.
- Photometric quantities: Photometry versus radiometry, radiometric and photometric quantities.
- Sources: Thermal sources (blackbody and incandescent lamps), gas discharge, luminescent, laser, solid state (light emitting diodes).
- Secondary light sources. Transmission, reflection, absorption.
- Photodetectors: Important features and types (thermal, photoemissive, photoconductive and photovoltaic detectors).
- Electronics reviews: detector electronics, detector interfacing.
- Noise in detection. Performance limits.
- Matrix detectors.
- Design and calibration of a radiometric system. Measurement uncertainty.
- Radiometric, spectroradiometric and photometric instruments.
- Radiometric measurements of satellite observation and remote sensing.
- Radiometry of laser and coherent sources.

Practical Laboratory Sessions:

- Verification of photometry laws.
- Design and built a radiance meter.
- Photodetector calibration.
- Source calibration.

Teaching methods: Lectures, lab classes, and homework exercises.

Form(s) of Assessment: 60% for the exam(s) versus 40% for practical (seminar, exercises, project...)

External/internal examiner: --

Examination support: None

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

Reference book:

Wolf, W. L., "Introduction to Radiometry", Ed. By SPIE-The International Society for Optical Engineering (Bellingham, 1998).

Additional books:

Grum F. and Becherer J., "Radiometry", vol. 1 of "Optical Radiation Measurements", Ed. By Academic Press, 1979.

Boyd R. W., "Radiometry and the detection of optical radiation", Ed. By John Wiley & Sons, 1983.

Parr A. C., Datla R. U. and Gardner J. L., editors, "Optical Radiometry", Elsevier Academic Press, 2005.

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CIMET Optical Imaging and Processing

Course name: Optical Imaging and Processing
Course level: Master

Course code: CIMET OIP
ECTS Credits: 5.00

Course instructors: Javier Hernandez Andres & Juan Luis Nieves (University of Granada), Corinne Fournier, Joelle Surrel and Isabelle Verrier (University of Saint- Etienne)

Education period (Dates): 2nd semester

Language of instruction: English

Prerequisite(s): Module "Photonics and Optics Fundamentals" (1st semester)

Expected prior-knowledge: Image formation fundamentals and diffraction phenomenon, Fourier analysis and linear systems.

Aim and learning outcomes:

This course develops an understanding of the fundamentals of diffraction limited and aberrated limited imaging systems. The course covers advanced topics in diffraction, Fourier Optics and optical image processing. Different architectures for optical-based image manipulation will be given, including optical correlation, wavefront coding, recording and manipulation, spatial filtering techniques, optical pattern detection, recognition and extraction, and optical correlators used in inspection industry. This course provides also an opportunity to engage with practical and theoretical aspects of optical and digital holography.

On completion of this course the students will be able to:

- Understand how diffraction and aberrations influence optical image quality.
- Analyze how an optical image can be encoded, manipulated and processed using optical-based techniques, with emphasis on coherent image formation.
- Make appropriate use of Fourier techniques in optical image processing.

Topics to be taught (may be modified):

- Overview of optical imaging: domains of image science. Electromagnetic waves and rays.
- Basics of signal processing. Fourier analysis in two dimensions. Linear systems. Two-dimensional sampling theory: the Whittaker-Shannon theorem.
- Diffraction. The Rayleigh-Sommerfeld formulation of diffraction. Fresnel and Fraunhofer approximations. Fundamentals of wave scattering.
- Diffraction-limited imaging. Image formation with coherent and incoherent illumination. Analysis of optical resolution.
- Frequency analysis of optical imaging systems. Frequency response for diffraction-limited optical systems: coherent and incoherent imaging. Optical transfer function (OTF), modulation transfer function (MTF) and phase transfer function (PTF): characterisation and measures.
- Aberrated imaging systems. Generalized pupil function. Apodization. Image quality in aberrated systems.
- Fundamental of wavefront modulation. Spatial light modulators. Diffractive optical elements.
- Spatial filtering. The VanderLugt filter. The Joint Transform Correlator. Optical pattern recognition architectures: the Matched Filter. Image processing tools for pattern recognition.
- Optical image restoration. Optical Transfer Function for image motion and vibration. Effects of atmospheric blur and target acquisition.
- Optical holography. Recording of digital holograms. Numerical reconstruction of digital holograms. "Inverse problem": approach to process holograms. Applications.

Practical Laboratory Sessions:

- Simulating diffraction using MATLAB.
- Visualization of diffraction patterns using an optical processor.
- Optical Fourier filtering: practical implementation of a 4f-Fourier processor.
- Digital Fourier filtering: simulations with MATLAB.
- Measure of the modulation transfer function (MTF) of an imaging system.
- Making a transmission hologram.
- Making a reflection hologram.
- Recording of a digital hologram and numerical reconstruction.

Teaching methods: Lectures and lab classes, and homework exercises.

Form(s) of Assessment: Written exam (50%), Practical work (50%)

External/internal examiner: --

Examination support:

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

Reference book:

Goodman, J.W., "Introduction to Fourier Optics", 2nd Ed. McGraw-Hill (New York, 1996).

Additional books:

VanderLugt, A., "Optical Signal Processing", Ed. John Wiley & Sons, 1992.

Hariharan, P. "Optical holography. Principles, Techniques and Applications", Cambridge Studies in Modern Optics, Cambridge University Press, New York, 1996.

T. M. Kreis, Handbook of Holographic Interferometry, Optical and Digital Methods. Berlin: Wiley-VCH, 2005.

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Practical sessions only

Home page: <http://www.master-erasmusmundus-color.eu/>

CIMET Advanced Colorimetry

Course name: Advanced Colorimetry
Course level: Master

Course code: CIMET AC
ECTS Credits: 5.00

Course instructors: Manuel Melgosa and Rafael Huertas (University of Granada), Alain Trémeau (University of Saint-Etienne)

Education period (Dates): 2nd semester

Language of instruction: English

Prerequisite(s): Module "Color Science" (1st semester), Module "Human Vision and Computer Vision" (2nd semester)

Expected prior-knowledge:

Aim and learning outcomes:

To supply an introduction color difference models and color appearance models, their evolution and present development. Also, basic knowledge on color reproduction methods and perceptual and physical evaluation of color images.

On completion of this course the students will be able to:

- Describe the color difference models.
- Describe the perceptual attributes of colour and the different systems for the representation of colour
- Demonstrate the use of colour measurement instruments and the interpretation of colour measurement data
- Demonstrate the computation of uniform colour space coordinates from reflectance measurements
- Describe the requirements for consistent colour reproduction across different media.
- Practical implementation of measurements of the appearance.
- Skills on methods of evaluation of the quality of color images.
- Basic methods of color reproduction on the industry.

Topics to be taught (may be modified):

- Weighted color difference equations. Color tolerance experiments. CIE94 and CIEDE2000 color-difference formulas.
- Effects of viewing conditions. Achromatic adaptation models. The structure of chromatic adaptation (CAT) models.
- The appearance attributes of colored materials viewed against a neutral grey background. The appearance attributes of colored areas within images. The influence of surrounding and background color on the appearance of a central color element.
- The structure of color appearance models: CIECAM97's, CIECAM02. CAM implementation. CAM testing.
- S-CIELAB color-difference formulae. Image appearance models: iCAM
- Visual appearance(color + gloss, translucency and texture)
- Visual color matching. Instrumental color matching. Image color matching. Introduction to psychophysical methods of assessing of the perceived quality of images.
- Management of the transfer of color information between image capture devices and image production devices. Device characterization, Gamut mapping algorithms, Device calibration. Concepts of device dependent and device independent methods of color specification.
- Image quality Measurements. Rendering HDR Images
- Whiteness Measurements. Industrial Colorimetry.

Teaching methods: Lectures and lab classes, and homework exercises.

Form(s) of Assessment: Written exam (60%), practical work (40%)

External/internal examiner: --

Examination support:

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

Reference book:

M.D. Fairchild, Color Appearance Models, Second Edition, Wiley-IS&T Series in Imaging Science and Technology, Chichester, UK (2005).

R. S. Berns, Billmeyer and Saltzman, Principles of Color Technology, 3rd ed., John Wiley & Sons, New York, (2000).

W.D. Wright, 50 years of the 1931 CIE standard observer for colorimetry, AIC Color 81, Paper A3 (1981).

G. Wyszecki, Current developments in colorimetry, AIC Colour 73, 21-51 (1973).

Additional books:

Digital color management: Encoding Solutions, E. Giogianni & T. Madden, Addison Wesley, (1992).

Colour Engineering, Achieving device independent colour, P. Green & L. MacDonald, John Wiley and Sons Ltd, (2002).

The reproduction of colour, R.W.G. Hunt, Foutain Press, (1995).

Colour physics for industry, R. McDonald, Society of Dyers & Colourists, (1997).

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CIMET Human Vision and Computer Vision

Course name: Human Vision and Computer Vision
Course level: Master

Course code: CIMET HVCV
ECTS Credits: 5.00

Course instructors: Sérgio Nascimento & Juan Luis Nieves (University of Granada), Éric Dinet & Alain Trémeau (University of Saint-Étienne)

Education period (Dates): 2nd semester (Dates to be determined)

Exam period: --

Language of instruction: English

Prerequisite(s): Module "Color Science" (1st semester)

Expected prior-knowledge: Modules "Photonics and Optics Fundamentals" (1st semester) and "Radiometry, Sources and Detectors" (2nd semester)

Aim and learning outcomes:

The aim of the course is to provide a solid and integrated view of the visual processes with an emphasis on the physical aspects and on automatic processing of visual information. This more quantitative approach is complemented with notions of retinal and cortical organization and with the fundamentals on visual psychophysics. Although the course aims at a solid theoretical basis, practical issues and problem solving will be considered wherever appropriate and independent project development and research will be strongly encouraged.

On completion of this course the students will be able to:

- anatomically and functionally identify the main components of the human visual system.
- apply visual optical to describe the imaging process in the eye.
- identify the physical constraints imposed on the visual system and to relate them with the limitation on visual performance.
- identify and to describe the main psychophysical aspects of human vision and to describe the basic psychophysical techniques.
- describe and to apply basic image processing algorithms in the context of automatic vision problems

Topics to be taught (may be modified):

- Introduction to visual perception. Visual perception and the main components of the human visual system. The visual process: image formation, transduction, codification, retinal and cortical processing. Receptive fields, LGN and cortex processing. Basic numbers in human vision.
- Visual Optics. Optics of the eye, spherical and astigmatic ametropia, aberrations. Magnification. Accommodation. Contrast sensitivity.
- Photopic and scotopic vision. Photopic and scotopic vision: photopic, scotopic and mesopic vision. Spectral sensitivities and Purkinje Shift. Night myopia. Visual Fields, spatial and temporal summation. Perimetry.
- Colour perception. Fundamentals of colour perception: colour matching and the trichromacy, spectral sensitivities of photoreceptors. Hue cancellation and opponent colours. Colour constancy. Colour illusions. Acquired and inherited colour vision deficiencies.
- Spatial and temporal aspects of visual perception. Perception of objects and shapes. Perception of movement. Binocular vision and depth perception. Stereo acuity. Eye movements. Troxler phenomenon intensification.
- Image quality. Image quality and psychophysical methods of assessing of the perceived quality of images.
- Introduction to computer vision. Introduction to computer vision: what is computer vision? The Marr paradigm and scene reconstruction, Model-based vision. Other paradigms for image analysis: bottom-up, top-down, neural network, feedback. Pixels, lines, boundaries, regions, and object representations. "Low-level", "intermediate-level", and "high-level" vision.
- Applications of computer vision. Image Processing Shape from X Shape from shading. Photometric stereo. Occluding contour detection. Motion Analysis. Motion detection and optical flow structure from motion. Object recognition model-based methods. Appearance-based methods. Invariants.

Practical Laboratory Sessions (Some of these practical laboratory sessions will be held at Granada or at Saint Etienne following devices available):

- Colour measurement and illumination. Colour measurement and colour perception.
- Colour mixing and colour perception. Colour emotion.
- Optical illusions.
- Image processing, image quality evaluation and imaging system design (with ISET : Image Systems Evaluation Tools)
- Demos of stereo vision and measurement of stereo acuity (needs CRS card and goggles, for acuity a basic system with three vertical bars)
- Demos of apparent movement (needs CRS card)
- Cambridge Colour Test (needs CRS card)
- Measurement of CSF (needs CRS card and metropsis software)
- Calibration of monitors (and printers?)
- Anomaloscope

Specialized seminars (University of Granada):

- Sérgio Nascimento: Chromatic diversity perceived by the normal and colour deficient observer.
- Larry Maloney: Computational algorithms for colour constancy.
- Gavin Brelstaff: Mysterious aspects of color perception - beyond the trichromatic.

Teaching methods: Lectures and lab classes, and homework exercises.

Form(s) of Assessment: Written exam (60%), Practical work (40%)

External/internal examiner: --

Examination support: None

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

Basic textbook:

Foundations of vision, Brian A. Wandell, Sinauer Associates, 1995.

Eye, brain, and vision, David A. Hubel, W. H. Freeman & Co, 1988.

Color appearance models, Mark D. Fairchild, Addison-Wesley, 2005.

Principles of color technology, Roy S. Berns, Wiley-Interscience, 2000.

Sensation and Perception. E. Bruce Goldstein. 6th edition Wadsworth Publishing. ISBN: 0534639917, 2002

The image processing handbook, Fifth edition, John C. Russ, CRC Press, 2006.

Additional books:

Vision science: photons to phenomenology, Stephen E. Palmer, The MIT Press, 1999.

Visual space perception, Maurice Hershenson, The MIT Press, 1999.

The reproduction of colour, Robert W. G. Hunt, Voyageur Press, 2004.

Introduction to Visual Optics. Alan H. Tunnacliffe. Association of British Dispensing Opticians. ISBN 0-900099-28-1, 1993.

Computer Vision and Applications: A Guide for Students and Practitioners. Bernd Jahne. Academic Press, 2000.

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Home page: <http://www.master-erasmusmundus-color.eu/>

CIMET Color in Industry

Course name: Color in Industry
Course level: Master

Course code: CIMET CIND
ECTS Credits: 5.00

Course instructor: Manuel Melgosa (University of Granada).

Education period (Dates): 2nd semester

Language of instruction: English

Prerequisite(s): Module "Color Science" (1st semester)

Expected prior-knowledge: It is advisable to follow also the course "Advanced Colorimetry" (2nd Semester)

Aim and learning outcomes:

This course tries to supply an introduction to classical problems and hot topics arising in industrial colorimetry. On completion of this course the students will be able to understand and approach to some color problems in different industries.

Topics to be taught (may be modified):

- Introduction to industrial colorimetry.
- Color atlases in industry.
- Industrial color tolerances.
- Color assessment cabinets.
- Colorant formulation.
- Whiteness and tint.
- Color fastness.
- Color and gloss, translucency, or texture.
- Metallic and pearlescent colors.
- Color in soil science.
- Color in food science.
- Color in liquid samples: olive oils, wines, etc.
- Color in graphic arts.
- Colorimetry in the paper and textile industries.

Teaching methods: Lectures, seminars by invited experts, and homework exercises.

Form(s) of Assessment: Written exam (50%), Practical work (50%)

External/internal examiner: --

Examination support: None

Literature and study materials:

Basic textbook: to be done

Additional books: to be done

G. Wyszecki and W.S. Stiles, Color Science, 2nd Edition. Wiley Classics Library, 2000.

R. S. Berns, Billmeyer and Saltzman Principles of Color Technology, 3rd ed., John Wiley & Sons, New York, (2000).

J. Shanda. Colorimetry (Understanding the CIE System). Wiley, 2007.

R.D. Lozano. El Color y su medición (in Spanish language). Ed. Americalee, 1978.

The reproduction of colour, R.W.G. Hunt, 6th Ed. John Wiley & Sons Inc., 2004.

Colour physics for industry, R. McDonald, Society of Dyers & Colourists, (1997).

ASTM Standards on Color and Appearance Measurements, 5th Ed. American Society for Testing and Materials, 1996.

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CIMET Remote Sensing and Image Processing

Course name: Remote Sensing and Image Processing
Course level: Master

Course code: CIMET RSIP
ECTS Credits: 5.00

Course instructors: Lucas Alados-Arboledas (University of Granada) and Francisco José Olmo (University of Granada)

Education period (Dates): 2nd semester (Dates to be determined)

Exam period: --

Language of instruction: English

Prerequisite(s): Module "Fundamentals" (1st semester)

Expected prior-knowledge: Optics and photonics fundamentals.

Aim and learning outcomes:

This course develops the fundamentals of remote sensing techniques. The course covers the basic principles of remote sensing, a revision of the electromagnetic radiation and its interaction with matter, some basic ideas about the atmosphere both as a transfer medium and as an observational object, advanced topics in surface and atmosphere remote sensing. Different platforms and sensors used in remote sensing will be presented including imaging systems. Pre-processing aspects of remotely sensed data will be addressed paying special attention to atmospheric and radiometric corrections.

On completion of this course the students will be able to:

- Understand the bases of the remote sensing process.
- Approach to the remote sensing procedures applied to the surface and atmosphere.
- Distinguish the different kind of sensors and platforms used in remote sensing.
- Understand the need of atmospheric correction of surface remote sensing data.
- Apply atmospheric correction to real remote sensing data.
- Extract geophysical variables from remote sensing data.

Topics to be taught (may be modified):

- Remote sensing: basic principles
- Electromagnetic radiation and its interaction with matter.
- Basics principles of atmospheric remote sensing and radiative transfer: atmosphere, radiative transfer.
- Remote sensing platforms and sensors: airborne and surface systems, optical, infrared and microwave sensors, imaging and non-imaging systems.
- Pre-processing of remotely sensed-data: geometric correction, atmospheric correction, calibration.
- Extraction of geophysical variables from remote sensing data.

Practical Laboratory Sessions:

- Design of look up tables for atmospheric correction.
- Atmospheric correction of remote sensing images.
- Extraction of geophysical variables from remote sensing data.

Teaching methods: Lectures and lab classes, and homework exercises.

Form(s) of Assessment: Written exam (50%), Practical work (50%)

External/internal examiner: --

Examination support: None

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

Basic textbook: to be done

Additional books: to be done

CAMPBELL, J.B., Introduction to remote sensing, The Guildford Press, New York, 1987.

CURRAN, P., Principles of remote sensing. Longman Scientific & Technical, New York, 1985.

ELACHI, C., Introduction to the physics and techniques of remote sensing. John Willey & Sons, New York, 1987.

LENOBLE, J., Atmospheric radiative transfer. A. Deepak Publishing, Virginia, 1993.

LIOU, K.N., An introduction to atmospheric radiation. Academic Press, New York, 2002.

MATHER, P.M., Computer processing of remotely-sensed images. An introduction. John Willey & Sons, Chichester, England, 1999.

SLATER, P.N., Remote sensing. Optics and optical systems. Addison-Wesley Publishing Company, Reading, Massachusetts, 1980.

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CIMET Fundamentals of Spectral Science

Course name: Fundamentals of Spectral Science

Course code: CIMET FSC

Course level: Master

ECTS Credits: 5.00

Course instructors: Javier Hernández-Andrés and Eva M. Valero (University of Granada)

Education period (Dates): 2nd semester (Dates to be determined)

Exam period: --

Language of instruction: English

Prerequisite(s): Module "Fundamentals" (1st semester)

Expected prior-knowledge: Matlab knowledge

Aim and learning outcomes:

The main aim of this course is to provide the basis of the multispectral approach of color imaging, i.e., imaging systems that use more than three acquisition channels. The contents include image capture procedures, spectral characterization of image capture devices, estimation of spectral functions from conventional image capture systems, evaluation of the accuracy or performance of multispectral images, and a basic description of some of the most relevant applications of multispectral images.

On completion of this course the students will be able to:

- Demonstrate an understanding of basic multispectral color science.
- Analyze, compare, develop and implement algorithms for spectral estimation from camera responses.
- Describe, analyze and reason about how multispectral acquisition devices work and how can they be optimized for a particular application.
- To know the state of the art of spectral color science and some of its most relevant fields of application.

Topics to be taught (may be modified):

- Overview of color imaging: light and surfaces, color vision, colorimetry, physics of image capture. Spectral measurements: theory and instruments.
- Spectral characterization of image acquisition systems: experimental determination of spectral response curves, influence of noise.
- Mathematical modelization of spectral functions: reflectances, illumination, color signals, etc. Linear and non-linear models: principal and independent component analysis.
- Spectral estimation from camera responses: models, algorithms, a priori necessary information, selection of data sets, use of color filters, filter selection, quality evaluation of the spectral signals obtained, influence of noise.
- Spectral accuracy performance: theoretical and experimental evaluation.
- Experimental spectral image acquisition systems.
- Applications of spectral imaging.

Practical Laboratory Sessions:

Matlab laboratory topics in order to implement and master basic issues explained in the lectures.

Teaching methods: Lectures and lab classes, and homework exercises.

Form(s) of Assessment: Written exam (60%), Practical work (40%)

External/internal examiner: --

Examination support: None

Literature and study materials: Lessons outlines (presentations), description and guides for exercises' sessions. Handouts of the material covered in the lectures will be distributed.

Basic textbook:

Acquisition and Reproduction of color images: colorimetric and multispectral approaches. J.Y. Hardeberg, 2001 (Universal Publishers)?

Additional books:

Color image science: Exploiting Digital Media. MacDonald, Luo, 2002 (John Wiley and Sons)
http://books.google.es/books?id=IbexPr9IcjoC&dq=Multispectral+images+book&lr=&source=gbs_summary_s&cad=0

Spectral Imaging: Eighth International Symposium on Multispectral Color Science. Mitchell Rosen, Francisco H. Imai, Shoji Tominaga, 2006, SPIE. Este sería para algunas aplicaciones...

Remote sensing digital image analysis: an introduction. Richards, Xia,, 2006 (Springer).

<http://books.google.es/books?id=4PB5vhPBdJ4C&dq=remote+sensing+digital+image+analysis+an+introduction&pg=PP1&ots=AdMv5QdNUS&sig=UsezCWV1efMkDU4MWuKUFrtIYUc&hl=es&prev=http://www.google.es/search?hl=es&q=Remote+Sensing+Digital+Image+Analysis:+An+Introduction&btnG=Buscar+con+Google&sa=X&oi=print&ct=title&cad=one-book-with-thumbnail>

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CIMET Devices and Instrumentation

Course name: Device and Instrumentation
Course level: Master

Course code: CIMET DI
ECTS Credits: 5.00

Course instructors: Manuel Rubiño (University of Granada), Antonio Pozo (University of Granada)

Education period (Dates): 2nd semester

Language of instruction: English

Prerequisite(s): Module "Photonics and Optics Fundamentals" (1st semester)

Expected prior-knowledge: Fundamentals of Optics and colour vision

Aim and learning outcomes:

This course develops an understanding of emission and detection of the radiant energy. The course covers the study of photometric and colorimetric instrumentation, including the study of measurement methods and systems for the characterization of light sources, materials, displays and imaging systems.

On completion of this course the student will be able to understand (i.e. to describe, analyse and reason about)

- How the radiant energy is emitted and detected.
- How to design a measurement system using different light sources, optical components and physical detectors.
- How to characterize light sources, materials, displays and imaging systems.

Topics to be taught (may be modified):

- Fundamentals of Radiometry and Photometry. Radiometric and photometric quantities and laws.
- Fundamentals of Colorimetry. Colour terminology, standards and calculations.
- Light sources. Spectral properties and laboratory sources.
- Photodetectors. Applications in photometric and colorimetric instrumentation.
- Colour printing and scanners.
- Displays.
- Scientific electronic cameras.
- Digital still cameras and video cameras.

Lab classes:

- Spectroradiometric measurements of light sources.
- Spectrophotometric evaluation of materials.
- Colorimetric characterization of displays.
- MTF evaluation of array detectors.
- Optical-quality evaluation of multispectral imaging systems in terms of the MTF.
- Optical characterization of scanners in terms of the MTF.

Teaching methods: Lectures, lab classes, and homework exercises.

Form(s) of Assessment: Written exam (50%), Practical work (50%).

External/internal examiner: --

Examination support:

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

Reference book:

- Hunt, R.W.G., "The Reproduction of Colour ", 6th Ed. John Wiley & Sons, 2004.

Additional books:

- Bass, M., "Handbook of Optics, Vol. 1 Fundamentals, Techniques and Design", 2nd Ed. Optical Society of America, 1995.

- Berns, R.S., "Billmeyer and Saltman's Principles of Color Technology", 3rd Ed. John Wiley & Sons, 2000.
- Chirigov, V. G., "Liquid Crystal Devices. Physics and Applications", Artech House, 1999.
- Holst, G. C., "Electro-Optical Imaging System Performance", 4th Ed. JCD Publishing and SPIE Optical Engineering Press, 2006.
- Holst, G. C., Lomheim, T. S., "CMOS/CCD Sensors and Camera Systems", JCD Publishing and SPIE Press, 2007.
- Keller, P.A., "Electronic Display Measurement: Concepts, Techniques and Instrumentation", John Wiley & Sons, 1997.
- McDonald, L. W., Luo M. R. (Eds.), "Colour Imaging. Vision and Technology", John Wiley & Sons, 1999.
- Sproson, W. N., "Colour Science in Television and Display Systems", Ed. Adam Hilger, 1983.
- Wolfe, W.L., "Introduction to Radiometry", Ed. SPIE - The International Society for Optical Engineering, 1998.
- Wyszecki, G., Stiles, W.S., "Color Science: Concepts and Methods, Quantitative Data and Formulae", 2nd Ed. John Wiley & Sons, 2000.
- Yadid-Pecht, O., Etienne-Cummings, R. (Eds.), "CMOS Imagers: From Phototransduction to Image Processing", Kluwer Academic Publishers, 2004.

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CIMET Color in Art and Design

Course name: Color in Art and Design

Course code: CIMET CAD

Course level: Master

ECTS Credits: 5.00

Course instructors: Éric Dinet & Alain Trémeau (University of Saint-Étienne)

Education period (Dates): 2nd semester (Dates to be determined)

Exam period: --

Language of instruction: English

Prerequisite(s): --

Expected prior-knowledge: --

Aim and learning outcomes:

This course is designed to provide students with an introductory but in-depth orientation to interrelated fields of color in art and design of multi-cultural origins. Through exposure to the art and design elements of various cultures, students are encouraged to assess and interpret human values, attitudes, and social development and, in turn, to relate these to personal development.

This course provides coverage of most major fields of color in art and design with a focus on the interrelationships of each area. Western and Eastern perspectives are presented which promulgate the melding of cultures into a color language. Through the study of color, the students should gain a better understanding of the utilitarian and aesthetic effects of color on human social orders and communication.

Students are required to take a "hands-on" approach by extrapolating implications from color studies and media. Color forms the cornerstone of societies, affecting the way we eat, sleep, work and play. It is to the advantage of students from interdisciplinary areas to gain a thorough understanding of the complexities of color awareness and to relate that awareness to their environment.

Lectures and course outline:

1. Gray scale and values: from light to dark. Patterns and motifs. Illusionary volumes.
2. Color theory: the color wheel. Tint, shade and tone. Simultaneous contrast. Bezold effect. Gradation and texture. Transparency. Equiluminant colors.
3. Color meaning: patterns and motifs. Perspective and depth. Perceptual grouping.
4. Color history in art and science.
5. Color and culture: color symbolism. Color taboos. Color harmony. Visual arts.
6. Color for e-commerce: limitations of color capture and limitations of media. Color palette and color selection. Rendering. Color transfer.
7. Color in design: functional color. Color and emotions.

Practical Laboratory Sessions Practical laboratory sessions will be organized according to the available devices.

Teaching methods: Lectures and lab classes, and homework exercises.

Form(s) of Assessment: Written exam (50%), Practical work (50%)

External/internal examiner: --

Examination support: None

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

-Basic textbooks:

- *Vision and Art – The biology of seeing*, Margaret Livingstone, Harry N. Abrams, 2002.

- *Colour – Art & Science*, Trevor Lamb and Janine Bourriau, Cambridge University Press, 1995.
- *Cognition and the Visual Arts*, Robert L. Solso, MIT Press, 1996.
- *The Art of Color*, Johannes Itten, Wiley, 1997.
- *Color and meaning: Art, Science and Symbolism*, John Gage, University of California Press, 2000.

-Additional books:

- *Color and Culture: Practice and Meaning from Antiquity to Abstraction*, John Gage, University of California Press, 1999.
- *Design basics*, David A. Lauer and Stephen Pentak, Wadsworth Publishing, 1999.
- *Colors: the story of dyes and pigments*, Guineau Delamare and Ber Francois, Harry N. Abrams, 2000.

Additional information:

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Home page: <http://www.master-erasmusmundus-color.eu/>

CIMET Lighting and Image Capture

Course name: Lighting and image capture
Course level: Master

Course code: CIMET LIC
ECTS Credits: 5.00

Course instructors: Éric Dinet (University of Saint-Étienne)

Education period (Dates): 2nd semester

Language of instruction: English

Prerequisite(s): Module "Photonics and optics fundamentals" (1st semester)

Expected prior-knowledge:

Aim and learning outcomes:

This course aims to provide a general education including light sources, lighting fundamentals, lighting techniques in machine vision and fundamentals of solid-state imaging, with a focus on the repercussion of digital image capture on image processing stages. Industrial applications illustrate the theoretical concepts and demonstrate the great importance of lighting and image capture in machine vision systems.

On completion of this course the students will be able to:

- understand the fundamentals of light.
- identify and to describe the different light sources available for machine vision.
- identify and to classify the different techniques of lighting suitable for machine vision.
- understand how image sensors work.
- identify general characteristics of machine vision cameras and color cameras.

Topics to be taught (may be modified):

- Light fundamentals: brief review of radiometry and photometry. Luminous efficiency. Colour temperature. Colour rendering index.
- Light sources: incandescent light bulbs. High-intensity discharge lamps. Xenon arc lamps. Flash lamps. Fluorescent lamps. Inductive lighting. LED and OLED. Laser.
- Lighting fundamentals: photometric curves. CIE illuminants and standard sources. Types of reflection and transmission. Filtering. Polarization. Lighting geometry.
- Lighting in machine vision: common lighting techniques. Structured lighting. Colour lighting. Lighting products dedicated to machine vision. Examples of applications.
- Fundamentals of solid-state imaging: photon sensing. Photoelectric effect. Photodiode and MOS capacitor.
- Charge-Coupled Device (CCD): linear and array architectures. Charge transfer. Progressive scan. Time-delay and integration. CCD performance.
- CMOS sensor: linear and array architectures. Design variants. CMOS performance.
- Machine vision cameras: general characteristics. Sampling, resolution and MTF. Transfer function. Sensitivity. Dynamic range and quantization. Electronic shutter. CCD cameras versus CMOS cameras.
- Colour cameras: linear and array architectures. Bayer mask. RGBE filter. Dichroic beam splitter prism. Foveon X3 sensor. Multispectral devices.

Practical Laboratory Sessions:

- Digital camera simulation.
- Lighting techniques and lighting problems in machine vision.
- Feasibility studies.

Teaching methods: Lectures and lab classes, and homework exercises.

Form(s) of Assessment: Written exam (60%), Practical work (40%)

External/internal examiner: --

Examination support: None

Literature and study materials: Handouts of the material covered in the lectures will be distributed.

Basic textbooks:

Light: science and magic: an Introduction to photographic lighting, Fil Hunter, Steven Biver and Paul Fuqua, Focal Press, 2007.

Handbook of machine vision, Alexander Hornberg, Wiley-VCH, 2006.

CCD arrays, cameras, and displays, Gerald C. Holst, SPIE Optical Engineering Press, 1996.

Additional books:

Light and light sources: High-Intensity Discharge lamps, Peter Flesh, Springer, 2006.

Solid-state imaging with Charge-Coupled Devices, Albert J.P. Theuwissen, Kluwer Academic Publishers, 1996.

Additional information:

Éric Dinet

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CIMET Compression and transmission in media systems

Course name: Compression and transmission in media systems

Course code: CIMET CTMS

Course level: Master

ECTS Credits: 5.00

Course instructors: Damien Muselet (University of Saint-Étienne)

Education period (Dates): 2nd semester

Exam period: --

Language of instruction: English

Prerequisite(s): --

Expected prior-knowledge: --

Aim and learning outcomes:

To supply fundamentals and basic knowledge of image compression and transmission.

Learning outcomes :

- still image compression,
- video compression,
- video transmission.

Topics to be taught (may be modified):

- Fundamentals
 - introduction to compression
 - quantization
 - differential coding
 - transform coding
 - variable length coding
 - Run length and dictionary coding
- Still image compression
 - JPEG
 - Wavelet transform
 - Non standard image coding
- Motion estimation and compression
 - motion analysis and compensation
 - Block matching
 - PEL recursive technique
 - Optical flow
 - 2D motion estimation
- Video compression
 - digital video coding
 - video standards of MPEG- 1/2
 - applications of MPEG- 1/2
 - video standard of MPEG-4
 - video standards of H.261 and H.263
- Compressed video transmission
 - buffer constraints
 - video synchronisation
 - decoding and presentation
 - video buffer management
 - video transcoder
 - transport packet scheduling and multiplexing

Teaching methods: Lectures, lab classes and homework exercises.

Form(s) of Assessment: Written exam (60%), Practical work (40%)

External/internal examiner: --

Examination support: None

Literature and study materials: of the material covered in the lectures will be distributed.

Basic textbook:

"Image and Video Compression for multimedia Engineering (2nd edition – 2008)" by Yun Q Shi and Huifang Sun

Additional books:

"Transporting Compressed Digital Video" by Xuemin Chen

Additional information:

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CIMET Pattern Recognition

Course name: Pattern Recognition

Course level: Master

Course code: CIMET PR

ECTS Credits: 5.00

Course instructors: Elisa Fromont, Amaury Habrard, Marc Sebban (University Jean Monnet, Saint- Etienne)

Education period (Dates): 2nd semester

Language of instruction: English

Expected prior-knowledge: sufficient knowledge in statistics

Aim and learning outcomes:

This course presents an advanced study (with both practical and theoretical aspects) of some supervised learning algorithms useful to tackle pattern recognition tasks in computer vision. It aims to deal with not only feature vectors (with SVM, decision trees) but also with structured data represented in the form of strings (Hidden Markov models, grammatical inference algorithms, active learning). Some data mining techniques are also presented to show how to discover valuable knowledge from images and videos.

Topics to be taught (may be modified):

- Introduction to pattern recognition and machine learning; statistical learning theory; empirical and generalization errors; model quality estimates.
- Advanced decision trees.
- String-based models:
 - Hidden Markov models (Forward, backward and Viterbi algorithms, Expectation-Maximization algorithm),
 - Grammatical inference, Active Learning.
- Advanced Support Vector Machines, Kernel theory.
- Basic Data Mining.

Practical Laboratory Sessions:

"From image description to image classification"

Teaching methods: Lectures and lab classes.

Form(s) of Assessment: written exam (60%), practical work (40%)

External/internal examiner: --

Examination support: None

Literature and study materials:

Basic textbook:

Machine Learning, Tom Mitchell, McGraw Hill, 1997.

Pattern Recognition and Machine Learning, Christopher M. Bishop, Springer 2006.

Additional book:

Classification and Regression Trees, by Leo Breiman, Jerome Friedman, Charles J. Stone, R.A. Olshen, Chapman et al. 1998
(for data mining)

Jiawei Han and Micheline Kamber, Data Mining: Concepts and Techniques, 2nd ed.

The Morgan Kaufmann Series in Data Management Systems, Jim Gray, Series Editor Morgan Kaufmann Publishers <<http://www.mkp.com/datamining2e>>, March 2006. ISBN 1-55860-901-6

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CIMET Language course (UJM): French for beginners

Course name: French for beginners

Course code: CIMET OCF

Course level: Optional course

ECTS Credits: 5.00

Course instructors:

Education period (Dates): 2nd semester

Exam period: --

Language of instruction: French

Prerequisite(s): -none

Expected prior-knowledge: - a few basic words and phrases

Aim and learning outcomes: - To reach level A1 of the Common European Framework of Reference for Language Learning; understand basic instructions and take part in simple or factual conversations and be able to complete basic forms and write notes including times dates and places: to develop learning methodology for language study and learning.

Course outline: The course is organised in two parts: a semi-intensive week of 5 x 3 hour sessions of immersion in the language followed by 5 weekly sessions of 3 hours. Total 30h.

Practical Laboratory Sessions: Permanent access to the resource centre of the Centre International de Langue et Civilisation (CILEC).

Teaching methods: Learning will be organised around a communicative and functional course book suitable for A1 level students.

Form(s) of Assessment: Continual assessment via personal assignments and classroom participation and a 1 hour final test.

External/internal examiner: -Course teacher-

Examination support: None

Literature and study materials:

-Basic textbook: *ICI, Abry, Fort, Parpette, Stauder, Clé International, 2007*

-Additional books: *ICI* cahier d'exercices, French dictionary

Additional information:

Home page: <http://cilec.univ-st-etienne.fr>

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