## SEMINARS INVITED PROFESSORS

## CALENDAR – TIMETABLE

| | Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|---|
| | Classes Silvestre Pinho | | | | |
| | Classes Julien Jumel | | | | |
| | 4th March 2019 | 5th March 2019 | 6th March 2019 | 7th March 2019 | 8th March 2018 |
| **8:00** | | | | | |
| **9:00** | | | | | |
| **10:00** | | Lecture 2 J. Jumel<br>Room:<br>II-02A | Lecture 4 J. Jumel<br>Room:<br>III-03 | | |
| **11:00** | | | | | |
| **12:00** | | Lecture 3 J. Jumel<br>Room:<br>III01i | Lecture 5 J. Jumel<br>Room:<br>I-16i | | |
| **13:00** | | | | | |
| **14:00** | | | | | |
| **15:00** | | | | | Lecture 5 S. Pinho<br>*Advanced numerical methods for fracture*<br>Room:<br>II-01 |
| **16:00** | Lecture 1 S. Pinho<br>*Recycling of composite materials*<br>Room:<br>II-08 | Lecture 2 S. Pinho<br>*Failure criteria for composites*<br>Room:<br>II-01 | Lecture 3 S. Pinho<br>*Fibre bundle models for strength and toughness*<br>Room:<br>II-01 | Lecture 4 S. Pinho<br>*Bio-inspired composite microstructures*<br>Room:<br>II-03B | |
| **17:00** | | | | | |
| **18:00** | Lecture 1 J. Jumel<br>Room:<br>III01i | | | | |
| **19:00** | | | | | |
| **20:00** | | | | | |
| **21:00** | | | | | |

**DR. SILVESTRE PINHO – IMPERIAL COLLEGE OF LONDON**

Dr. Silvestre Pinho

Imperial College London

*Session 1 (2 hours) – Recycling of composite materials*

Processes for reclaiming carbon fibres are still embryonic, with the first commercial fibre-reclamation facility opening in the UK only recently. The properties of reclaimed carbon fibres depend heavily on parameters of the fibre reclamation process, and consequently so do the properties of composites manufactured with reclaimed fibres. Even in situations where fibre reclamation is possible, life cycle analyses show that, from an environmental point of view, whether it is appropriate to reclaim the fibres depends strongly on the application given to the reclaimed fibres and on the material they replace in these applications.

*Session 2 (2 hours) – Failure criteria for composites*

Unlike homogeneous materials, composites fail in a variety of distinct ways, known as modes. Failure criteria are typically functions of stresses that define failure surfaces. On the one hand, some failure criteria are based on models that offer insights into the failure process, and from an engineering perspective they are useful for structural design, thus making them a standard staple for many engineers and researchers in computational mechanics. On the other hand, failure criteria often include idealisations and empiricism that makes them less appealing to some materials scientists.

*Session 3 (2 hours) – Fibre bundle models for strength and toughness*

Fibre-reinforced composites derive their high strength from the fibres. Therefore, longitudinal tensile failure – both in terms of strength and energy dissipation – is a key performance indicator for composites. It is also one of the most challenging to understand.

During the process of longitudinal tensile failure, a significant amount of energy is dissipated by fracture of the interfaces between fibres and matrix, and by friction during pull-out of the fibres. The energy dissipated by this process does not scale as might be at first expected due to the complex fractal-like features that form on the fracture surface. Only very recently was a model developed that predicts this size-dependent translaminar fracture energy.

*Session 4 (2 hours) – Bio-inspired composite microstructures*

Nature does not design microstructures in the same way engineers do. Many natural composites, such as bone, wood and sea shells, to name a few, contain many different scales of reinforcement carefully arranged to promote damage diffusion and increased energy dissipation during fracture. In recent years, researchers have invested considerable effort in mimicking suitable aspects of these micro-structures for the design of composites microstructures with improved damage tolerance. In one case, improvements in translaminar toughness by a whopping ≈500% were achieved.

*Session 5 (2 hours) – Advanced numerical methods for fracture*

Most complex composite structures require the use of numerical methods, such as the finite element method (FEM), for their design. Within FEM, the numerical representation of the propagation of damage has always been a challenge. Historically, engineers first proposed plydiscount methods, followed by continuum damage mechanics (CDM) models, smeared-crack models, the extended finite element method (X-FEM), the phantom node method and finally the Floating Node Method. In the latter, floating degrees of freedom are used to repartition (effectively refine) individual elements during an analysis. The FNM has shown to be able to represent the formation and simultaneous growth of hundreds of cracks in composite components. These include complex networks of kinking and interacting cracks.

**DR. JULIEN JUMEL– UNIVERSITÉ BORDEAUX**

Dr. Julien Jumel

Their sessions are linked to the optional subject “Structural dynamics”.

*Session 1 (2 hours)*
- 1 D.O.F. system - Damping of vibration (1 hour lecture)
- Transient vs harmonic vibration: shock spectrum (1 hour exercise)

*Session 2 (2 hours)*
- Multidegree of freedom system with damping complex mode shape / Dynamic damper design

*Session 3 (2 hours)*
- Exercise - Structure coupling / effect of modal truncature

*Session 4 (2 hours)*
- Vibration of bars and beams free and forced response

*Session 5 (1-2 hours)*
- Exercises