COURSE PLAN 2021/1

REMOTE DISCIPLINE

PROFESSOR:

Suélia F. Rosa – Electric Engineer - suelia@unb.br

Ronni G. G. Amorim – Theoretical Physicist – ronniamorim@unb.br

COURSE: The introduction to the dynamic modelling techniques used in contemporary research in Biomedical Engineering and Bioengineering will be studied. The course is suitable for advanced graduate students, with a defined theme and orientation. Mathematical modelling is a tool that involves the use of calculations and software development. The classes will provide a basis for developing mathematical models using: i) Bond Graph Technical; ii) Fractional Calculus Applied to Biomedical Engineering. The course will promote in the student a knowledge of computer modelling to better analyse their research question. The approaches taught here can be grouped into the following categories: 1) models based on BOND GRAPH modelling; 2) models based on...

APPOINTMENT:

1) Synchronous meetings at the times established by the discipline with a new agenda discussed with the students (Following tools will be used: The chanel of PPGEB in Youtube (https://www.youtube.com/channel/UCrlUsSmL0izxC6rcAwMGZMg) MicrosoftTeams; Whatssap, Moodle Plataform).

2) Guarantee of Access to Teachers via WhatsApp for Monitoring; Clarification of Doubts and Assistance; Receiving Difficulty Reports linked to the technology and internet variable.

3) Final Evaluation of the Discipline, by the Students, - as a way of verifying the quality taught by the teacher.

4) Flexibility to the deadlines for carrying out activities, following the agenda built with the class.

5) Communicate and provide feedback to students and the institution - for Coordination.

6) Ensure that all material used in the classroom, books and academic content is made available to students without prejudice and with equity.

7) There will be no printing of material, all activities will be done in a virtual or manual or digital way, without the need for printing.

8) Clearly define the tasks, deadlines, and delivery method.

9) Guarantee individual feedback - with private discussions - if necessary.

10) Checking for plagiarism using tools https://www.turnitin.com/ that provide feedback.

GENERAL PROGRAM

The program will be divided in two parts:

Part 1 – Bond Graph Technical: General introduction to models and model construction: Model types, dimension and scale, model simplification. System identification: transient response estimation, spectral estimation, identification of parametric models, identification of non-linear models, validation. Physical Modeling: Physical principles, graphs of connections, models with differential-algebraic equations, object-oriented modelling. Simulations: choice of methods, stability, precision. • General principles of modelling • Physical modelling: dimension, dimensionless dimensions, scale • Models of physical laws in different domains • Analogies between physical domains.

Part 2 – Fractional Calculus Applied to Biomedical Engineering: - Historical aspects of fractional calculus. – Fundamental Tools: Gamma and Beta functions; Laplace Transform; Mittag-Leffler functions; Glefand-Shilov function. – Fractional Integral: Kinds of fractional integrals; Riemann-Liouville fractional integral; Properties of Riemann-Liouville fractional integral. – Fractional Derivative: Definitions; Riemann-Liouville fractional derivative; Caputo fractional derivative; Properties of Caputo Fractional Derivative. – Fractional Differential Equations: Definitions; elementary fractional differential equations. – Applications of Fractional Calculus in Biomedical Engineering: study of case using fractional logistic equation.

TEACHING METHODOLOGY

(X) Use of Youtube Video

(X) Use of Quis, Google and APP Systems (Nearpod - ThingLink)

(X) Use of TED Talks Video

(X) Use of discussion seminars

(X) Use WhatsApp

(X) Teams - camera on and frequency counted, time that must be present in the virtual mode at least 80% of the total time of the lesson, recorded lesson.

(X) Use of extra-class material

(X) Extended Summary Writing

(X) Digital Material Generation - drawings, graphs and analyses.

(X) Moodle Plataform

CONDITIONS FOR APPROVAL:

Parte (i) Bond Graphic Technic:

The grades will be counted in each activity that is scored - the students received partial grades every 3 weeks for personal control of their progress.

NA - theoretical and practical assessments - individual and group.

NAF is a simple average of the evaluation scores.

NE - extra-class and class activity to be carried out - individual and group.

NEF is a simple average of activity scores.

AL1 = simple mean of NAF and NEF.

Parte (ii) Fractional Calculus

In this part students will solve 5 quizzes (qi). The questionnaires will be made available on the Moodle platform. Each quiz will be score 10 points. Thus, the grade for this part will be the simple arithmetic average between the five questionnaires. In this sense, we define

AL2 =simple arithmetic average of quizzes.

The final grade of the course will be the arithmetic mean between AL1 and AL2.

THE STUDENT WILL BE CONSIDERED APPROVED if AL ≥ 5.0

THE STUDENT WILL BE CONSIDERED FAILED if AL <5.0.

Omitted cases - and not mentioned in this plan will be dealt with according to the university's bylaws.

BASIC BIBLIOGRAPHY

ROSA, Suelia de Siqueira Rodrigues Fleury et al. Mathematical modelling of the human tibia using Bond Graph. Rev. Bras. Eng. Biomed. [online]. 2013, vol.29, n.4, pp.329-342. Available from: ISSN 1517-3151. https://doi.org/10.4322/rbeb.2013.042.

System Dynamics and Control with Bond Graph Modeling Edição Inglês | por Javier Kypuros.

Bond Graph in Modeling, Simulation and Fault Identificatio (English Edition) Edição Inglês | por Ranjit Karmakar & Arun Kumar Samantaray Amalendu Mukherjee.

Karnopp D, Rosenberg RC. System dynamics: a unified approach. New York: Wiley Interscience Publication; 1975. Karnopp D. Bond graph models for eletromagnetic actuators. Journal of The Franklin Institute. 1985; 319(1-2):173-81. http://dx.doi.org/10.1016/0016-0032(85)90072-9

Rodrigues SS. Modelagem dinâmica para controle de uma serra automática utilizada em cirurgias ortopédicas [dissertação]. São José dos Campos: Instituto Tecnológico de Aeronáutica; 2005. 192 p.

Rodrigues SS, Simões TS, Kienitz KH, Trabasso LG. Modelagem e controle do suporte das lâminas da serra inteligente guiada por um sistema robótico para assistência em cirurgias de osteotomia. In: Congresso Temático de Dinâmica e Controle da SBMAC: Anais do 3. Congresso Temático de Dinâmica e Controle da SBMAC; 2004, Ilha Solteira. Ilha Solteira: UNESP; 2004. (CTA/ITA-IEE/ AE-055/2004).

Miller KS, Ross B. An Introduction to the Fractional Calculusand Fractional Differential Equations. Willey-Interscience: John-Wiley & Sons, 1993.

Podlubny I. Fractional Differential Equations. Academic Press, v. 198, 1999.

Camargo RF, Chiacchio AO, Oliveira EC, Differentiantion to Fractional Tlegraph Equation. Journal of Mathematical Physics, v. 49, n.033505, 2008.

Gorenflo R, Mainardi F. Fractional Calculus: Integral and Differential Equations of Fractional Order. CISM Lecture Notes, p.223-276, 2000.