ME 495 proposals for term 222

Ser.#	Advisor Name	email	Research Title	Research Description	Area of research
1	Dr. Jafar Albinmousa	binmousa@kfupm.edu.sa	Mechanical characterization of dissolvable structural alloys	Dissolvable structural alloys are used to carry mechanical loading. Yet, they are expected to dissolve after they successfully complete their function. These materials must withstand mechanical loading in the presence of stress concentration. Therefore, mechanical analysis is required to design mechanical components from these materials.	Mechanics
2	Dr. Abba Abubakar	abba.abubakar@kfupm.edu.sa	Cold Spray Deposition of Composite Coatings	Cold spray (CS) is a cold-state additive manufacturing technology for metallic parts in which micron-size powder particles are deposited onto a substrate surface via the high-velocity flow of supersonic gas. Composite coatings with tailored properties can be effectively deposited with the cold spray process via careful control of the deposition parameters. To avoid repetitive experiments involving trial and error, numerical models can be used to optimize the process. The present study proposes using a physics-based hybrid computational approach to optimize the cold spray deposition parameters. The software code development or implementation of the method is already done; however, the student is expected to carry out wide range of simulations for cold spray parameters for Ni/Al_2O_3 wear resistant coating layer. The results from the numerical simulations will be analyzed and validated by comparing them with that of experiments using real cold spray set up at KFUPM. The coatings microstructure will be characterized, and the effective properties will be measured with the aid of several experimental/analytical tools.	Mechanics
3	Dr. Abba Abubakar	abba.abubakar@kfupm.edu.sa	Addtive Manufacturing Simulations for Composite Parts	Composite parts are commonly made via a multi-material powder bed fusion (PBF) process. However, several problems arising from high porosity, grain anisotropy, phase transformations/precipitation, cracking, etc. need to be tackled for the successful disposition of the process in making composite parts. This work deals with using sequentially coupled multi-scale models to optimize the microstructure of composite parts made from PBF process. The software code has been developed to completion; however, the students need to investigate the influence of the reinforcement particle size and on microstructure morphology. Several composite samples fabricated from PBF process will be analyzed and characterized. The study aims to establish a procedure for designing and optimizing the laser PBF when used to fabricate metal-matrix composites.	Mechanics

4	Dr. Salem Bashmal	bashmal@kfupm.edu.sa	Kinematical design of a robotic arm	The student will perform a kinematical analysis on a robotic arm to calculate the displacemnt, velocity and acceleration of the end effector.	Dynamics and Design
5	Dr. Fadi Al-Badour	fbadour@kfupm.edu.sa	Friction Stir Welding of hybrid Structures; light Alloy to Polymer	The higher demand on fuel-efficient transportation increased the need for lightweight hybrid structures in subassemblies. The challenge is to weld thermoplastics and their composites with light materials such as Al, Mg to form useful complex and sturdy structures. Challenges arise from wide gap between thermal, physical, and chemical properties of metals and thermoplastics.	
6	Dr. Ravishankar Sathyamurthy	r.sathyamurthy@kfupm.edu.sa	Improving the absorptivity of absorber plate of solar still with nanoparticles	Desalination using renewable energy has several advantages over existing traditional methods of getting fresh water. Cost of water produced, maintenance, cost of electrical energy, and construction design features are the major advantages of the solar desalination technique. However, the operational viability under lower solar flux under cloudy conditions and seasonal climatic changes produces a lower yield, which appears to be a major disadvantage. It is an ideal combination since the solar heat, which in dry locations causes difficulties with fresh water shortages, is utilized to alleviate the problem by desalinating water. When it comes to desalination, water distillation is one of the methods that may be employed.	Thermofluids, and heat transfer
7	Dr. Abdullah Al-Sharafi	alsharafi@kfupm.edu.sa	Hybrid solar/wind power generation system for combined heat, power, and hydrogen productions	In this research, hybrid solar/wind renewable energy systems will be considered. Techno-economic assessment will be performed via HOMER software under different weather conditions at various locations in the Kingdom of Saudi Arabia for electricity, heat and hydrogen productions.	Renewable energy, Thermofluid
8	Dr. Atia Khalifa	akhalifa@kfupm.edu.sa	Cavitated Membrane Distillation- A novel process for water desalination	Water desalination using membrane distillation (MD) process is receiving a great attention as one of the emerging desalination techniques. In MD, water vapor is being separated from the seawater using a hydrophobic membrane. The research idea includes the creation of cavitation and investigate its effects on the distillation process and the system design.	Thermofluids, water desalination
9	Dr. Atia Khalifa	akhalifa@kfupm.edu.sa	Multistage bubble column dehumidification for desalination using membrane distillation	In this experimental research, water vapor is being seprated from seawater using a membrane. Water vapoer is then carried by an air stream. We are looking for air dehumidifcation using multistage bubble column dehumidifier to extract the freshwater and also to cool the air in order to co-generate freshwater and space cooling. the student is expected to help in the design, fabrication and testing of the system to evaluate its performance	Thermofluids, water desalination

10	Zuhair M Gasem	zuhair@kfupm.edu.sa	The effect of water absorption on interlaminar shear stress on glass-fiber reinforced plastic (GFRP) pipes.	Water absorption in GFRP pipes results in degradation of interlaminar shear strength and consequently leads to drop in flexural properties of buried pipes. A testing program will be carried out to measure the interlaminar shear strength (ISS) of samples of GFRP pipes after exposure in water at different temperature and exposure times.	Materials/manufacturing
11	Ammar Alzaydi	ammar.alzaydi@kfupm.edu.sa	UAV Light Weight Robotic Arm Design	Attaching a traditional robotic arm with motorized joint will require to constantly monitor the balancing of the combined structure via the centre of mass. Instead, a “snake” like flexible robotic arm can be used on the drone instead, which means that the robotic arm heavy mechanism is at a single point attached to the drone. This will reduce the centre of mass shift control and reduce the overall robotic arm weight as it does not need counter weights to be balance (Ex. At different points of the robot arm), but rather, the thrust from the drone motors should be enough to handle such centre of mass weight shift. An ME 495 student will be required to design and analyse the outer/inner structure and working mechatronic mechanism of this flexible robotic arm (snake robot like mechanism). The flexible mechanism dynamically changing centre of mass needs to be defined as well, and the robotic arm having the advantage to configure instantly to achieve a stable and balanced position allowed by the snake configuration.	Mechatronics/Robotics
12	Ammar Alzaydi	ammar.alzaydi@kfupm.edu.sa	Zero Netforce Spraying Mechanis for Aerial Systems	Complete the design of a zero net force spraying system to be used with aerial systems. the device is to consider action forces and consider reaction forces for balance purposes. This system to be applied for fire fighting purposes as a first application.	Mechatronics/Robotics
13	Pieter Boom	pieter.boom@kfupm.edu.sa	Generalised summation-by-parts for solid mechanics	Finite-difference (FD) are known to be highly efficient numerical methods when the domain and solution are smooth. On the other hand, finite-elements (FE) are often preferred for modelling complex geometries. The generalized summation-by-parts (gSBP) framework provides a unified description of many FD and collocated FE methods that have an SBP property: the discrete analogue of integration by parts. This project will implement 2D linear elasticity using the gSBP framework to exploit the combined advantages of FD and FE methods. Students will require strong mathematical and programming skills.	Mechanics

14	Pieter Boom	pieter.boom@kfupm.edu.sa	Generalised summation-by-parts for fluid-structure-interaction	Finite-difference (FD) are known to be highly efficient numerical methods often applied in fluid mechanics. On the other hand, finite-elements (FE) are often preferred in solid mechanics to represent complex geometries. The generalized summation-by-parts (gSBP) framework provides a unified description of many FD and collocated FE methods that have an SBP property: the discrete analogue of integration by parts. This project will implement the coupled quasi-1D Euler fluid and linear elastic solid equations using the gSBP framework to develop a monolithic implementation of fluid-structure interaction. Students will require strong mathematical and programming skills.	Mechanics
15	Afaque Shams	afaque.shams@kfupm.edu.sa	Advanced Numerical Methods to Accurately Predict Flow and Heat Transfer in Nuclear and Petrochemical Industries	In this project, efforts will be put forward to develop advanced numerical methods to accurately predict complex flows and heat transfer in non-unity Prandtl number (Pr) fluids. These fluids are commonly used in nuclear and petrochemical industries. This research will be performed using the Reynolds-Averaged Navier-Stokes (RANS) turbulence modelling approach. The non-unity Pr of fluids makes it extremely challenging for RANS models to accurately predict the heat transfer phenomena. In this regard, efforts will be put forward to develop and/or utilize the advanced numerical methods to study these non-unity Pr fluids in different flow regimes, i.e., natural, mixed, and forced convection.	Nuclear
16	Afaque Shams	afaque.shams@kfupm.edu.sa	Numerical Study of Flow-Induced Vibration in Nuclear Fuel Rods	Light Water reactors (LWR) are the most common worldwide operating reactors because of their safety and technical maturity. One of the key factors in the safe operation of nuclear reactors is the efficient heat removal from the reactor core. There are various fuel assembly configurations. The cooling through these assemblies is accomplished by external forced convection between the fuel rod surface and the primary coolant. To enhance convection, the primary coolant flows at high flow rates to cause turbulence mixing. However, the high flow rate imposes several challenges to the reactor operation. Among those is the Flow Induced Vibration (FIV) of the rod bundles, which could affect the heat transfer efficiency and sometimes leads to a component failure by mechanical stresses. In this project, numerical efforts will be put forward to study the FIV in nuclear fuel rods to ensure the safe operation of nuclear power plants.	Nuclear

17	Afaque Shams	afaque.shams@kfupm.edu.sa	CFD Analyses of a T-Junction in the primary piping of a nuclear power plant	Thermal fatigue is a degradation mechanism that can occur in a wide range of industrial applications. One such application is the primary piping system of a nuclear power plant due to the mixing of flows with different temperature. The consequences of thermal fatigue can be serious and can cause sufficient structural damage to a power plant and lead to a complete shutdown. Therefore, it is highly relevant in the context of aging and the life management of a nuclear power plant. In this project, CFD analyses will be performed to study the thermal fatigue phenomenon.	Nuclear
18	Sohail Akhtar	ssakhtar@kfupm.edu.sa	Design and fabrication of hybrid cermet composites for cutting tool inserts	The proposed project is aimed to develop a protocol for the material design and production of SPSed hybrid cermet-based cutting inserts in standard near-net geometries with improved mechanical, thermal, and tribological performance.	
19	Sohail Akhtar	ssakhtar@kfupm.edu.sa	A material-by-design approach to develop Functionally-graded biocompatible HA/SS composites	The purpose of the proposed project is to develop novel functionally graded hydroxyapatite-based composites. A mean-field homogenization and effective medium approximation approach s will be used to design FG composite followed by synthesis using SPS and characterization.	
20	Sohail Akhtar	ssakhtar@kfupm.edu.sa	Computational design and development of novel metal-matrix composites for improved machinability	To computationally design and develop new class of metal matrix composites.	
21	Sohail Akhtar	ssakhtar@kfupm.edu.sa	Machinability Optimization of metal-matrix composites using finite element simulation	Machinability Optimization of metal-matrix composites using finite element simulation	
22	Sohail Akhtar	ssakhtar@kfupm.edu.sa	An integrated approach to design and develop polymer composites for finned heat sinks as an alternative thermal solution	An integrated approach to design and develop polymer composites for finned heat sinks as an alternative thermal solution	
23	Usman Ali	usman.ali@kfupm.edu.sa	Metal based 3D printing additive manufacturing simulations	Approaches and tools for simulation will be taught and then applied on industrial additive manufacturing 3D printing systems.	
24	Sulaiman Alturaifi	sulaiman.alturaifi@kfupm.edu.sa	Design of high-pressure/high-temperature optical cell for laser spectroscopy	Laser absorption spectroscopy is a non-intrusive method used for gas detection. In this method, lasers are used to infer the amount of a targeted gas (e.g. CH4, NOx, H2S) using the science of spectroscopy (light-matter interaction). This research project aims to design and develop a cell that can withstand high pressure and high temperature, and allow laser light to pass through the cell. The cell will then be used to characterize the spectroscopy of several gases such as methane and pollutants. The results will then be published in a conference or journal paper.	Thermofluids

25	Sulaiman Alturaifi	sulaiman.alturaifi@kfupm.edu.sa	Characterization of ignition properties of blended-hydrogen fuels	A new shock tube facility will be used to test the ignition properties of several types of fuels. The shock tube creates a high-temperature environment similar to the combustion environment where one can observe the behavior of different fuels. In this project, we would like to measure the ignition event from a very-well known fuel (methane) to ensure that the new facility is producing repeatable measurements. Then, we would like to test the ignition properties of blended-hydrogen fuels. The results will be used to improve the models for better simulation of hydrogen-operated engines. The results will then be published in a conference or journal paper.	Thermofluids