To: The Faculty of the College of Engineering

From: The Faculty of the School of Mechanical Engineering

RE: Approval of Motorsports Engineering (MSPE) Courses

The faculty of the School of Mechanical Engineering has approved the adoption of the following Motorsports Engineering (MSPE) Courses. This action is now submitted to the Engineering Faculty with a recommendation for approval.

As part of the IUPUI Realignment, the Motorsports Engineering Program will now be a second-degree program (BS in MSPE) offered within the School of Mechanical Engineering. While this program will only be offered in Indianapolis, it will be managed by the School of Mechanical Engineering in West Lafayette.

Reason: The purpose of this EFD is to formally adopt the MSPE courses so they can be included in the West Lafayette Course Catalog. On the following pages, the existing MSPE courses are listed. These courses are currently listed with the MSTE prefix, but will be converted to MSPE courses with this EFD. Also, some prerequisite courses will also be updated with this EFD. A proposed MSPE course listing with the changes shown in red is appended after the existing course list.

James D. Jones
Associate Professor and Associate Head
School of Mechanical Engineering

Motorsports Engineering (Original Course Listing)

- **MSTE 27200 Introduction to Motorsports (3 cr.)** P: None Class 3. This course provides an introduction to the Motorsports Industry, including careers available, the organization and history of the industry, and technology development that has occurred due to the industry. A student project is required.

- **MSTE 29701 Computer Modeling for Motorsports (2 cr.)** P: None An Introductory course detailing methods for designing & modeling motorsports components using computer aided design (CAD) software.

- **MSTE 29800 Programming & Computer Modeling for Motorsports (2 cr.)** P: MSTE 27200 & admission to MSTE program. Introductory course detailing methods for creating virtual models of objects and systems for design, analysis, and optimization of motorsports components. Virtualization methods include object-oriented programming techniques for creating mathematical models, and solid modeling techniques for visualizing objects as three-dimensional representations. The methods introduced through this course lay the foundation for advanced courses in vehicle design, simulation, and analysis.

- **MSTE 29900 Motorsports Engineering Directed Study (1-3 cr.)** P: Permission of Instructor. This is a directed study course for students wishing to pursue additional motorsports studies under the direction of a faculty advisor.

- **MSTE 31201 Business of Motorsports (4 cr.)** P: MSTE 27200 and ENG W131. This course covers the unique aspects of the motorsports industry, especially race teams, including organizations, budgeting, marketing, & sponsorships through an examination of literature & guest speakers.

- **MSTE 31700 Motorsports Practicum II (1 cr.)** P: MSTE 35000 and junior standing. This course engages students in a hands-on experiential learning opportunity in which they participate in the design, fabrication, assembly, and preparation of a race vehicle just as they might when engaged with a professional motorsports organization.

- **MSTE 32000 Motorsports Design I (3 cr.)** P: MSTE 35000, MSTE 47200 or permission of instructor. This course explores the design concepts and approaches of the Motorsports Industry, creating connectivity between the courses of the first two years of the Motorsports Engineering BS Program and preparing students for internships in industry.

- **MSTE 33001 Data Acquisition in Motorsports I (2 cr.)** C: ECE 20400 This course introduces students to motorsports data acquisition systems and the associated hardware and software that are comprised therein. A hands-on lab component is included in the class where in students learn how to specify a motorsports data system, understand vehicle network communication and build a motorsport industry standard data acquisition wiring harness.

- **MSTE 33100 Race Engineering (3 cr.)** P: MSTE 33001 and MSTE 47200. This course explores the application of vehicle dynamics principles to motorsport vehicles. Students will utilize engineering software tools to develop motorsport engineering workbooks for vehicle performance analysis. Driver performance analysis and race strategy topics are introduced to provide the student with the full fundamentals of race engineering.

- **MSTE 34000 Dynamic Systems and Signals (3 cr.)** P: MATH 26600, ME 27000 and ME 27400. Introduction to dynamic engineering systems and continuous-time and discrete-time signals, mechanical electromechanical components, linear system response, Fourier and Laplace Transforms. The course is designed to teach the student the basic concept for modeling the behavior of dynamic systems.

- **MSTE 35000 Computer Aided Design & Manufacturing (3 cr.)** P: MSTE 29701. C: ME 27000. This course provides the basis for the computer aided engineering and analysis skills needed in the Motorsports Industry. The ability to visualize and conceptualize a real part in the physical world and produce graphical representations of it in 2D and 3D in Solidworks or an equivalent is a primary objective. Further skills to be developed include the ability to produce large assemblies of such parts with appropriate tolerancing, free form surfacing, casting shapes and casting machining, 2D drawings

for use in 3D sheet metal fabrication including shrink and stretch, use of 3D models to facilitate Finite Element Analysis, Conversion of CAD model to programming of CAM machining.

- **MSTE 41400 Motorsports Design II (3 cr.)** P: MSTE 32000 and MSTE 47200. C: MSTE 48200 This is the culminating course in the Motorsports Engineering Plan of Study, typing together concepts from all the other courses in the curriculum, and requires a capstone design project representative of a real world project within the Motorsports Industry.

- **MSTE 41700 Motorsports Practicum III (1 cr.)** P: MSTE 31700 This course engages students in a hands-on experiential learning opportunity in which they participate in the design, fabrication, assembly, and preparation of a race vehicle just as they might when engaged with a race team in the motorsports industry. Students will be expected to show mastery of 12 of the 12 skills outlined in the Course Objectives.

- **MSTE 41800 Advanced Motorsports Practicum (1 cr.)** P: Permission of Instructor. This course engages students in a hands-on experiential learning opportunity in which they participate in the design, fabrication, assembly, and preparation of a race vehicle just as they might when engaged with a race team in the motorsports industry. Students will be expected to show mastery beyond the 12 skills outlined in the Course Objectives.

- **MSTE 42600 Internal Combustion Engines (3 cr.)** P: ME 20000. This course covers the fundamentals of internal combustion engine design and operation, with a focus on high performance.

- **MSTE 47200 Vehicle Dynamics (3 cr.)** P: ME 27000 and ME 27400. This course develops students understanding in the mathematical model development of the motorsports vehicle. Students will utilize these models to understand how key vehicle parameters influence vehicle performance in the longitudinal and lateral direction.

- **MSTE 48200 Motorsports Aerodynamics (3 cr.)** P: ME 31002 and MSTE 35000. Study of fluid flow and aerodynamics as applied to race car design and Computational Fluid Dynamic (CFD) Analysis.

- **MSTE 49000 Motorsports Engineering Independent Study (1-3 cr.)** P: Permission of Instructor. This is an independent study course for students wishing to pursue advanced studies under the direction of a faculty advisor.

- **MSTE 49700 Motorsports Design Project (3 cr.)** P: Permission of instructor. This is an independent study version of the MSTE 41400 culminating course in the Motorsports Engineering Plan of Study, tying together concepts from all the other courses in the curriculum, and requires a capstone design project representative of a real world project within the Motorsports Industry.

- **MSTE 49900 Motorsports Engineering Special Topics (1 cr.)** P: MSTE 27000 and ENG-W 131 and Permission of Instructor. This is a special topics course for students wishing to pursue advanced studies under the direction of a faculty advisor.

- **MSTE 57200 Vehicle Dynamics (3 cr.)** P: Graduate standing or MSTE 21000 and ME 27000. Vehicle dynamics is the study of behavior of vehicles in motion. The study is one of the most important activities in the Vehicle design and development cycle to design vehicles which drive well and are comfortable to ride in. The course focuses on the development of advanced mathematical engineering models that represent the behavior of automotive vehicles and vehicle subsystems. Topical emphasis is focused on rectilinear performance, steady state handling behavior, tire models and suspension models.

- **MSTE 57400 Advanced Vehicle Dynamics (3 cr.)** P: MSTE 57200. An investigation into advanced topics in the field of vehicle dynamics. This course covers the principles and applications of vehicle handling dynamics from an advanced perspective in depth. The methods required to analyze and optimize vehicle handling dynamics are presented, including tire compound dynamics, vehicle planar dynamics, vehicle roll dynamics, full vehicle dynamics, and in-wheel motor vehicle dynamics. The provided vehicle dynamic model is capable of investigating drift, sliding, and other over-limit vehicle maneuvers. This is an ideal course for postgraduate and research students and engineers in motorsports, mechanical, automotive, transportation, and ground vehicle engineering.

- **MSTE 57800 Composite Materials for Automotive Applications (3 cr.)** This course focuses on Development of Low-Cost Carbon Fiber for Automotive Applications, Mechanical Properties of Advanced Composites, Automotive Composite Structures for Crashworthiness, Crashworthiness Analysis of Composite, Hybrid Structures Consisting of Sheet Metal and Fiber Reinforced Plastics for Structural Automotive and Design Solutions to Improve Crash-Box Impact Efficiency for Racing Applications.

- **MSTE 57900 Design and Analysis of Materials and Structures in Lightweight Vehicles (3 cr.)** P: Graduate standing or ME 27200. The materials for the construction of automobiles are changing from mostly low carbon steels to a combination of steels, light alloys, such as aluminum and magnesium alloys, and polymer matrix composites. Many of these materials are already used in today's vehicles, albeit in smaller volumes. Future vehicles, which will have to be much lighter in weight for improved fuel economy and reduced environmental pollution, will contain much larger volumes of these materials. The selection of materials will not only be influenced by their weight reduction potential, but also by factors such as safety, durability, processing, joining, recycling and cost. This course focuses on materials, their properties,processing technology and design and materials selection issues pertinent to designing lightweight vehicles. it will provide first-hand knowledge and experience of working with these advanced materials. it starts with a broad review of the materials scenario and design considerations for lightweight automotive structures. it is then divided into two major parts: materials, and design and manufacturing. The materials part contain topics on advanced steels, aluminum alloys, magnesium alloys and polymer matrix composites. it will provide information on material properties, processing characteristics and application examples. The design and manufacturing part contains information on manufacturing processes for light alloys, joining, crashworthiness considerations, recycling and life-cycle issues.

- **MSTE 58200 Motorsports Aerodynamics (3 cr.)** P: Graduate standing or ME 20000, 31000 and MSTE 35000. A study and adaptation of fluid flow and aerodynamics as applied to motorsports design and performance optimization. This course is designed to reinforce student's understanding of aerodynamics as it pertains to a race car. This course breaks down the differences between actual air flow while driving/racing versus air flow within a wind tunnel, and how these flows are different. It discusses how to evaluate those flows, and determine if they need to be improved. it discusses ways to improve the aero on race cars.

- **MSTE 58400 Advanced Motorsports Aerodynamics (3 cr.)** P: MSTE 58200. This advanced course is designed to adapt the secrets of the rapidly developing field of high-speed vehicle design. From F1 to Indy Car, advanced drag simulation and Sedan racing, this course provides clear advanced explanations for students and engineers who want to improve their design skills and to interpret how their favorite race cars aerodynamics is designed. it differentiates how aerodynamics win races, why downforce is more important than streamlining and drag reduction, designing wings and venturis, plus wind tunnel designs and more. Appraises the development process of advanced motorsports aerodynamics engineering. Extensive use of CFD in the development of race ar aerodynamics.

- **MSTE 59200 Motorsports Simulations (3 cr.)** P: Graduate standing or MSTE 29800 and MSTE 47200. A course on mathematical modeling and computer simulation of mechanical systems offering a complete tool for modeling and simulation of integrated and complex systems for use within automotive and motorsports applications. Complex multi-disciplinary systems modeling and analysis problems will be solved, using a modeling and simulation environment for complex systems analysis such as Dymola's Modelica simulation technology. Dymola is a complete environment for model creation, testing, simulation and post-processing. Equal emphasis is placed on model development and simulation via Dymola GUI interface. Models range from simple spring-mass-damper system to whole vehicle models will be covered.

- **MSTE 59700 Selected Topics in Motorsports Engineering (1-3 cr.)** Topics of contemporary importance or of special interest that are outside the scope of the standard graduate curriculum can be offered temporarily under the selected topics category until the course receives a permanent number.

- **MSTE 59800 Motorsports Engineering Projects (1-3 cr.)** Individual research projects of contemporary importance or of special interest that are outside the scope of the standard graduate curriculum can be studied under the Motorsports Engineering Projects course.

- **MSTE 59900 Motorsports Advanced Internship (1-3 cr.)** Graduate-level based course, in an off-campus internship position.

- **MSTE 69800 Research MS Thesis (1-6 cr.)** Research credit for students in thesis option.

- **MSTE-I 41000 Motorsports Internship (1-3 cr.)** P: Sophomore standing and program advisor approval

Motorsports Engineering (Proposed Course Listing)

- **MSPE 27200 Introduction to Motorsports (3 cr.)** P: None Class 3. This course provides an introduction to the Motorsports Industry, including careers available, the organization and history of the industry, and technology development that has occurred due to the industry. A student project is required.

- **MSPE 29701 Computer Modeling for Motorsports (2 cr.)** P: None An Introductory course detailing methods for designing & modeling motorsports components using computer aided design (CAD) software.

- **MSPE 29800 Programming & Computer Modeling for Motorsports (2 cr.)** P: MSPE 27200 & admission to MSPE program. Introductory course detailing methods for creating virtual models of objects and systems for design, analysis, and optimization of motorsports components. Virtualization methods include object-oriented programming techniques for creating mathematical models, and solid modeling techniques for visualizing objects as three-dimensional representations. The methods introduced through this course lay the foundation for advanced courses in vehicle design, simulation, and analysis.

- **MSPE 29900 Motorsports Engineering Directed Study (1-3 cr.)** P: Permission of Instructor. This is a directed study course for students wishing to pursue additional motorsports studies under the direction of a faculty advisor.

- **MSPE 31201 Business of Motorsports (4 cr.)** P: MSPE 27200 and Written Communication. This course covers the unique aspects of the motorsports industry, especially race teams, including organizations, budgeting, marketing, & sponsorships through an examination of literature & guest speakers.

- **MSPE 31700 Motorsports Practicum II (1 cr.)** P: MSPE 35000 and junior standing. This course engages students in a hands-on experiential learning opportunity in which they participate in the design, fabrication, assembly, and preparation of a race vehicle just as they might when engaged with a professional motorsports organization.

- **MSPE 32000 Motorsports Design I (3 cr.)** P: MSPE 35000, MSPE 47200 or permission of instructor. This course explores the design concepts and approaches of the Motorsports Industry, creating connectivity between the courses of the first two years of the Motorsports Engineering BS Program and preparing students for internships in industry.

- **MSPE 33001 Data Acquisition in Motorsports I (2 cr.)** C: ECE 20400 This course introduces students to motorsports data acquisition systems and the associated hardware and software that are comprised therein. A hands-on lab component is included in the class where in students learn how to specify a motorsports data system, understand vehicle network communication and build a motorsport industry standard data acquisition wiring harness.

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- **MSPE 41800 Advanced Motorsports Practicum (1 cr.)** P: Permission of Instructor. This course engages students in a hands-on experiential learning opportunity in which they participate in the design, fabrication, assembly, and preparation of a race vehicle just as they might when engaged with a race team in the motorsports industry. Students will be expected to show mastery beyond the 12 skills outlined in the Course Objectives.

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- **MSPE 57900 Design and Analysis of Materials and Structures in Lightweight Vehicles (3 cr.)** P: Graduate standing or ME 32300. The materials for the construction of automobiles are changing from mostly low carbon steels to a combination of steels, light alloys, such as aluminum and magnesium alloys, and polymer matrix composites. Many of these materials are already used in today's vehicles, albeit in smaller volumes. Future vehicles, which will have to be much lighter in weight for improved fuel economy and reduced environmental pollution, will contain much larger volumes of these materials. The selection of materials will not only be influenced by their weight reduction potential, but also by factors such as safety, durability, processing, joining, recycling and cost. This course focuses on materials, their properties, processing technology and design and materials selection issues pertinent to designing lightweight vehicles. it will provide first-hand knowledge and experience of working with these advanced materials. it starts with a broad review of the materials scenario and design considerations for lightweight automotive structures. it is then divided into two major parts: materials, and design and manufacturing. The materials part contain topics on advanced steels, aluminum alloys, magnesium alloys and polymer matrix composites. it will provide information on material properties, processing characteristics and application examples. The design and manufacturing part contains information on manufacturing processes for light alloys, joining, crashworthiness considerations, recycling and life-cycle issues.

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- **MSPE-I 41000 Motorsports Internship (1-3 cr.)** P: Sophomore standing and program advisor approval