

## DEPARTMENT OF MECHANICAL ENGINEERING

Mechanical Engineering is a very broad field of science, engineering, and technology. It encompasses virtually all aspects of everyday life. To get some perspective, it can be broadly identified according to the foundation, role, and purpose of mechanical engineering as:

The science, engineering, and technology that are foundation to research and development, design and manufacturing, and installation and maintenance, of devices, machines or systems that transform, transmit, or utilize energy for the benefit of humankind. These devices, machines, or systems generally involve the transform of energy into motion and motion into energy;

People who study and practice mechanical engineering can therefore

- function in many different roles such as researchers, inventors, designers, practicing engineers, etc.;
- work in many different areas such as power generation, distribution and utilization; engine, vehicle and transportation; material, design and manufacturing; dynamics, control and robotics; machinery and maintenance; refrigeration, air conditioning and building technology; energy resource, management, utilization and conservation; environment technology; MEMS and nanotechnology, etc.;
- work in many different places, both public and private sectors, such as in industry, factory, hospital, large building and structure, consulting company, governmental office, university, etc.

## MISSION

The mission of the Department of Mechanical Engineering is to provide firm-founded and creative-minded mechanical engineers for the advancement of mechanical engineering and for the development of the country.

Its integrated educational programs emphasize

- fundamental knowledge of advanced mathematics, sciences, engineering, and mechanical engineering;
- general knowledge in social sciences and humanity;
- mathematical, scientific, and engineering methodologies;
- design and conduct of experiments, analysis of data, and meaningful physical interpretation of data;
- identification, formulation, and solving engineering problems;
  - o conceptualization of objectives and constraints,
  - o identification of governing physical principles,
  - o application of fundamental analytical tools as well as modern engineering tools, with sound appreciation of its capabilities and limitations and with sound understanding of the underlying physics and physical insights.
- open-ended problems, design projects, and research;

- effective written and verbal communication skills;
- independent study experiences as well as teamwork efforts;
- appreciation of engagement in life-long learning; and
- appreciation of the roles and responsibilities of mechanical engineers in society.

## DEGREES OFFERED

The Department of Mechanical Engineering offers three degreed programs (Bachelor of Engineering, B.Eng.) in Mechanical Engineering, Automotive Engineering, and Naval Architecture and Marine Engineering, at the undergraduate level. At the graduate level, the department offers a Master of Engineering (M.Eng.) and a Doctor of Philosophy (Ph.D.), in Mechanical Engineering. Details for each program are given in the following sections.

## HEAD:

Paired	Singhatanadgid	Ph.D. (Washington)
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## PROFESSORS :

Pramote	Dechaumphai	Ph.D. (Old Dominion)
Somsak	Chaiyapinunt	Ph.D. (Oregon State)
Viboon	Sangveraphunsiri	Ph.D. (Georgia Tech.)

## ASSOCIATE PROFESSORS :

Asi	Bunyajitradulya	Ph.D. (UC, Irvine)
Angkee	Sripakagorn	Ph.D. (Washington)
Boonchai	Lertnuwat	D.Eng. (Tokyo)
Chairote	Kunpanitchakit	Ph.D. (Wisconsin-Madison)
Chittin	Tangthiang	Ph.D. (Penn State)
Kanit	Wattanavichien	Ph.D. (University of Melbourne)
Kuntinee	Maneeratana	Ph.D. (London)
Paired	Singhatanadgid	Ph.D. (Washington)
Pongtorn	Charunyakorn	Ph.D. (Miami)
Phongsaen	Pitakwatchara	Ph.D. (Tokyo)
Ratchatin	Chancharoon	D.Eng. (Chula)
Thitima	Jintanawan	Ph.D. (Washington)
Thanyarat	Singhanart	Ph.D. (Tokyo)
Nopdanai	Ajavakom	D. Eng (California)

**ASSISTANT PROFESSORS :**

Alongkorn	Pimpin	D.Eng. (Tokyo)
Chatchai	Hongsa-Utain	Dipl.Ing. (Braunschweig)
Chanat	Ratanasumawong	D.Eng. (Tokyo Tech.)
Chanyaphan	Virulsri	D.Eng. (Tokyo)
Jirapong	Kasivitamnuay	D.Eng. (Tokyo)
Niphon	Wansophark	D.Eng. (Chula)
Nuksit	Noomwong	Ph.D. (TUAT)
Pairat	Tangpornprasert	D.Eng. (Tokyo)
Sompong	Putivisutisak	Ph.D. (London)
Sunhapos	Chatranuwathana	Ph.D. (Michigan)
Tul	Manwattana	Ph.D. (Stevens Inst.Of Tech.)
Thanyaatorn	Mekumpornpong	M.Eng.(Canterbury)
Witaya	Wannasuphprasit	Ph.D. (Northwestern)
Werayut	Srituravanich	Ph.D. (UCLA)

**LECTURERS :**

Chirdpun	Vitooraporn	Ph.D. (M.I.T.)
Tawan	Paphapote	M.S. (Illinois)
Saran	Salakit	Ph.D. (Oregon)
Gridsada	Phahomcheng	Ph.D. (Minnesota)
Surat	Kwanmuang	Ph.D. (Michigan)

**MECHANICAL ENGINEERING UNDERGRADUATE PROGRAMS**

The general aim of the Department of Mechanical Engineering is to give the student an understanding of theoretical principles and also, through experiment and design work, to provide him/her with confidence in solving practical problems. In accordance with the credit system of study, the Department provides an undergraduate curriculum for three programs: Mechanical Engineering, Naval Architecture and Marine Engineering, and Automotive Engineering. Students who plan to further their study for higher degrees, as well as those who wish to specialize in any of the fields offered, are strongly urged to consult their advisors in order to select and prepare the required elective programs.

**NAME OF THE DEGREE**

: Bachelor of Engineering  
: B.Eng.

**COURSE REQUIREMENTS****Mechanical Engineering Program**

Total credits for graduation 147 credits

1. General Education 30 credits
2. Basic Science 27 credits
3. Basic Engineering Science 26 credits
4. Program Core Courses 46 credits
5. Elective Courses 12 credits
6. Free Electives 6 credits

**Automotive Engineering Program**

Total credits for graduation 147 credits

1. General Education 30 credits
2. Basic Science 27 credits
3. Basic Engineering Science 26 credits
4. Program Core Courses 52 credits
5. Elective Courses 6 credits
6. Free Electives 6 credits

**Naval Architecture and Marine Engineering Program**

Total credits for graduation 148 credits

1. General Education 30 credits
2. Basic Science 27 credits
3. Basic Engineering Science 26 credits
4. Program Core Courses 53 credits
5. Elective Courses 6 credits
6. Free Electives 6 credits

**STUDY PROGRAM:  
MECHANICAL ENGINEERING  
FIRST YEAR CURRICULUM  
COMMON TO ALL ENGINEERING STUDENTS**

<b>COURSE NO.</b>	<b>SUBJECT</b>	<b>CREDITS</b>	<b>COURSE NO.</b>	<b>SUBJECT</b>	<b>CREDITS</b>
<b>THIRD SEMESTER</b>			<b>SIXTH SEMESTER</b>		
2103211	STATICS	3	2100311	ENG ESSENTIALS	3
2103241	THERMODYNAMICS I	3	2102391	ELEC ENG I	3
2301215	MULTIVARIABLE CALCULUS	3	2102392	ELEC ENG LAB I	1
2301216	LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS	3	2103320	DES MECH ELEM	3
2603284	STAT PHYS SCIENCE	3	2103361	EN THERM DESIGN I	3
xxxxxxx	GENERAL EDUCATION	<u>3</u>	2103433	INTRO MECH VIBRAT	3
		<b>18</b>	2103460	ME EXP LAB III	<u>2</u>
			<b>SUMMER SEMESTER</b>		
<b>FOURTH SEMESTER</b>			2100301	ENG PRACTICE	2
2103212	DYNAMICS	3	<b>SEVENTH SEMESTER</b>		
2103231	MECH OF MAT I	3	2103325	ME DES PROJ	2
2103260	ME EXP LAB I	2	2103409	INTRO MECHATRONICS	3
2103305	MFR PROC ME	3	2103489	MECH ENG PRE-PROJECT	1
2103351	FLUID MECHANICS I	3	5500308	TECH WRIT ENG	3
5500208	COM PRES SKIL	3	XXXXXXX	ELECTIVE COURSES	6
xxxxxxx	GENERAL EDUCATION	<u>3</u>	XXXXXXX	GENERAL EDUCATION	<u>3</u>
		<b>20</b>	<b>18</b>		
<b>FIFTH SEMESTER</b>			<b>EIGHTH SEMESTER</b>		
2103301	DES MTHD ME	3	2103499	MECH ENG PROJECT	3
2103304	AUTO CONTROL I	3	<u>OR</u> 2100499	ENG PROJECT	
2103306	COM-AIDED ME DES	3	XXXXXXX	ELECTIVES COURSES	6
2103322	MECH MACHINERY	3	XXXXXXX	GENERAL EDUCATION	3
2103360	ME EXP LAB II	2	XXXXXXX	FREE ELECTIVES	<u>3</u>
2103463	HEAT TRANSFER	<u>3</u>			<b>18</b>
		<b>17</b>			

**TOTAL CREDITS FOR GRADUATION = 147**

**STUDY PROGRAM :  
AUTOMOTIVE ENGINEERING  
FIRST YEAR CURRICULUM  
COMMON TO ALL ENGINEERING STUDENTS**

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
<b>THIRD SEMESTER</b>			<b>SIXTH SEMESTER</b>		
2103211	STATICS	3	2100311	ENG ESSENTIALS	3
2103241	THERMODYNAMICS I	3	2102391	ELEC ENG I	3
2301215	MULTIVARIABLE CALCULUS	3	2102392	ELEC ENG LAB I	1
2301216	LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS	3	2103320	DES MECH ELEM	3
2603284	STAT PHYS SCIENCE	3	2103482	MECH VEHICLES II	3
XXXXXXX	GENERAL EDUCATION	<u>3</u>	2103393	ME LAB NON ME	1
		<b>18</b>	2103433	INTRO MECH VIBRAT	3
			2103471	INTER COMB ENGIN	<u>3</u>
					<b>20</b>
<b>FOURTH SEMESTER</b>			<b>SUMMER SEMESTER</b>		
2103212	DYNAMICS	3	2100301	ENG PRACTICE	2
2103231	MECH OF MAT I	3			
2104257	MFR PROC	3			
2104258	MFR PROC LAB	1			
2103351	FLUID MECHANICS I	3			
2103481	AUTOMOTIVE ENG	4	2103483	AUTOMOTIVE SYS DES	3
5500208	COM PRES SKIL	3	2103461	AE ENG LAB	2
		<b>20</b>	2103555	ENGINE EMIS & CONT	3
			2103489	MECH ENG PRE- PROJECT	1
			5500308	TECH WRIT ENG	3
			XXXXXXX	ELECTIVES COURSES	3
			XXXXXXX	GENERAL EDUCATION	<u>3</u>
					<b>18</b>
<b>FIFTH SEMESTER</b>			<b>EIGHTH SEMESTER</b>		
2103382	MECH VEHICLES I	3	2103499	MECH ENG PROJECT	3
2103408	AUTOMOTIVE CONTROL	3	XXXXXXX	ELECTIVES COURSES	3
2103335	VEH STRUC ANAL I	3	XXXXXXX	GENERAL EDUCATION	3
2103322	MECH MACHINERY	3	XXXXXXX	FREE ELECTIVES	<u>6</u>
2103463	HEAT TRANSFER	3			
XXXXXXX	GENERAL EDUCATION	<u>3</u>			
		<b>18</b>			<b>15</b>

**TOTAL CREDITS FOR GRADUATION = 147**

**STUDY PROGRAM:  
NAVAL ARCHITECTURE AND MARINE ENGINEERING  
FIRST YEAR CURRICULUM  
COMMON TO ALL ENGINEERING STUDENTS**

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
<b>THIRD SEMESTER</b>			<b>SIXTH SEMESTER</b>		
2103211	STATICS	3	2100311	ENG ESSENTIALS	3
2103241	THERMODYNAMICS I	3	2102391	ELEC ENG I	3
2301215	MULTIVARIABLE CALCULUS	3	2102392	ELEC ENG LAB I	1
2301216	LINEAR ALGEBRA AND DIFFERENTIAL EQUATIONS	3	2103320	DES MECH ELEM	3
2603284	STAT PHYS SCIENCE	3	2103332	SHIP BUILDING ENG	3
XXXXXXX	GENERAL EDUCATION	<u>3</u>	2103352	SHIP BUOY & STAB	3
		<b>18</b>	2103361	EN THERM DESIGN	<u>3</u>
					<b>19</b>
<b>FOURTH SEMESTER</b>			<b>SUMMER SEMESTER</b>		
			2100301	ENG PRACTICE	2
2103212	DYNAMICS	3			
2103231	MECH OF MAT I	3	<b>SEVENTH SEMESTER</b>		
2103260	ME EXP LAB I	2	2103437	SHIP DESIGN I	3
2103305	MFR PROC ME	3	2103473	SHIP RESIS & POWER	3
2103351	FLUID MECHANICS I	3	2103443	REFRIGERATION	3
5500208	COM PRES SKIL	3	2103489	MECH ENG PRE- PROJECT	1
XXXXXXX	GENERAL EDUCATION	<u>3</u>	XXXXXXX	ELECTIVES COURSES	3
		<b>20</b>	XXXXXXX	GENERAL EDUCATION	3
			XXXXXXX	FREE ELECTIVES	<u>3</u>
					<b>19</b>
<b>FIFTH SEMESTER</b>			<b>EIGHTH SEMESTER</b>		
2103304	AUTO CONTROL I	3	2103471	INTER COMB ENG	3
2103322	MECH MACHINERY	3	2103433	INTRO MECH VIBRAT	3
2103462	FLUID MECHANICS II	3	2103499	MECH ENG PROJECT	3
2103463	HEAT TRANSFER	3	OR 2100499	ENG PROJECT	
5500308	TECH WRIT ENG	3	2103393	ME LAB NON ME	1
XXXXXXX	GENERAL EDUCATION	<u>3</u>	XXXXXXX	ELECTIVES COURSES	3
		<b>18</b>	XXXXXXX	FREE ELECTIVES	<u>3</u>
					<b>16</b>

**TOTAL CREDITS FOR GRADUATION = 148**

**APPROVED ELECTIVES FOR UNDERGRADUATE PROGRAMS FOR 2016**

<b>Mechanical Engineering</b>				<b>Naval Architecture and Marine Engineering</b>	<b>Automotive Engineering</b>
2102505	2103302	2103404	2103510	2103304	2103302
2102532	2103382	2103405	2103530	2103314	2103303
2102537		2103406	2103532	2103362	2103314
2103204		2103407	2103533	2103421	2103362
2104303		2103421	2103535	2103432	2103382
		2103432	2103540	2103433	2103421
		2103433	2103541	2103443	2103433
		2103443	2103552	2103454	2103465
		2103454	2103555	2103463	2103467
		2103462	2103560	2103472	2103472
		2103465	2103567	2103484	2103479
		2103467	2103570	2103495	2103483
		2103471	2103571	2103496	2103495
		2103472		2103560	2103496
		2103475		2104200	2109418
		2103477			2103510
		2103478			2103532
		2103479			2103540
		2103481			2103541
		2103485			2103555
		2103491			2103556
		2103495			2103558
		2103496			

**Remark :** Approved electives are subjected to change and will be announced by the department.

## MECHANICAL ENGINEERING GRADUATE PROGRAMS

The mechanical engineering department offers a graduate program leading to the degrees of Master of Engineering and Doctor of Philosophy in Mechanical Engineering. The program is housed in the Mechanical Engineering Department which offers three different majors: Solid Mechanics, Heat transfer/Thermodynamics/Fluids, and Control/Dynamics/Manufacturing. Approximately one hundred and thirty graduate students are full-time students in the department. Students who have demonstrated record of high academic achievement normally receive a kind of financial support which may be in a form of educational grant from different supporting organizations, or as teaching or research assistants, as well as the eligibility for waiving the tuition fee.

Presently, there are approximately 30 faculty members who are associated with the graduate program in the mechanical engineering department. The department is involved in research activities in a number of different fields. Several faculty members are associate technical editors for journals. A large number of technical papers resulted from faculty research and student theses have been published annually.

### MASTER DEGREE PROGRAM

#### NAME OF THE DEGREE

: Master of Engineering  
: M.Eng.

#### ADMISSION

The applicant must hold a Bachelor's Degree in Mechanical Engineering or related fields and meet the Graduate School requirements.

#### DEGREE REQUIREMENTS

There are two programs in the degree of Master of Engineering in Mechanical Engineering.

##### Program A1

This program is for students who have demonstrated high academic achievement and are approved from the graduate program committee. Students do not need to study course work. 36 credits for thesis are required in the program A1.

##### Program A2

Each of the following area of study consists of 18 credits for course work, one credit for engineering seminar, and 18 credits for thesis. One of the three programs below must be chosen:

1. Solid Mechanics area of study
2. Heat Transfer/Thermodynamics/Fluids area of study
3. Control/Dynamics/Manufacturing area of study

A small successful candidate must obtain an overall grade point average of at least 3.00.

For both programs, a period of study is not more than 8 regular semesters. The student must also demonstrate

his or her power of the original thought and ability to organize his or her finding by presenting an acceptable thesis accompanied by an oral examination. Students are also required to pass the thesis proposal within 4 regular semesters otherwise they will be dismissed from the Department according to the Graduate School Regulation.

### COURSE REQUIREMENTS

(For Program A2)

#### COURSE REQUIREMENTS

##### 1) Required Courses for all area of study

2103790 Seminar in Mechanical Engineering 1(0-3-1)

##### 2) Additional Required Courses for each area of study

<i>2.1) Solid Mechanics:</i>		
2103601	Advanced Engineering Mathematics	3(3-0-9)
3 credits are to be chosen from the		
2103612	Elasticity	3(3-0-9)
2103614	Continuum Mechanics	3(3-0-9)
<i>2.2) Heat Transfer/Thermodynamics/Fluid:</i>		
2103601	Advanced Engineering Mathematics	3(3-0-9)
6 credits are to be chosen from the		
2103602	Measurement and Instrumentation	3(2-3-7)
2103650	Advanced Engineering Thermodynamics	3(3-0-9)
2103651	Advanced Fluid Mechanics	3(3-0-9)
2103652	Combustion Theory	3(3-0-9)
2103655	Convection Heat Transfer	3(3-0-9)

<i>2.3) Control/Dynamics/Manufacturing:</i>		
2103603	Mathematic for Control Engineers	3(3-0-9)
2103631	Control of Dynamic Systems	3(3-0-9)

##### 3) Approved Elective Courses for each area of study

<i>3.1) Solid Mechanics:</i>		
9 credits are to be chosen from the		
2103510	Mechanics of Composite Materials	3(3-0-9)
2103511	Introduction to Continuum Mechanics	3(3-0-9)
2103540	Failure Analysis and Non-destructive Testing	3(2-3-4)
2103541	Vibration Monitoring and Analysis	3(2-3-4)
2103570	Micro Fabrication Technology	3(3-0-9)
2103571	Micro and Nano Electromechanical Systems (MEMS-NEMS)	3(3-0-9)
2103602	Measurement and Instrumentation	3(2-3-7)
2103612	Elasticity	3(2-3-4)
2103613	Plasticity	3(3-0-9)
2103614	Continuum Mechanics	3(3-0-9)
2103615	Mechanical Vibrations	3(3-0-9)
2103616	Optimum Design of Complex Mechanical Elements	3(3-0-9)
2103620	Theory of Elastic Stability I	3(3-0-9)
2103621	Energy Principles in Solid Mechanics	3(3-0-9)
2103622	Analysis of Composite Structure	3(3-0-9)
2103623	Fatigue of Metals	3(3-0-9)

2103625	Advanced Finite Element Method	3(3-0-9)
2103626	Thermal Stress Analysis	3(3-0-9)
2103701	Selected Topics in Mechanical Engineering	3(3-0-9)
2103721	Fracture Mechanics	3(3-0-9)

*3.2) Heat Transfer/Thermodynamics/Fluid:*

9 credits are to be chosen from the

2103552	An Introduction to Computational Fluid Mechanics	3(3-0-9)
2103555	Engine Emissions and Control	3(3-0-9)
2103556	Fundamental of Engine Fuel Control Systems	3(3-0-9)
2103558	Intake Manifold and Induction System Design	3(3-0-9)
2103560	Gas Turbine Performance	3(3-0-9)
2103566	Compressible Fluid Dynamics	3(3-0-9)
2103567	Turbulent Shear Flows	3(3-0-9)
2103602	Measurement and Instrumentation	3(2-3-7)
2103604	Advanced Numerical Methods	3(3-0-9)
2103605	Advanced Finite Element Method	3(3-0-9)
2103650	Advanced Engineering Thermodynamics	3(3-0-9)
2103651	Advanced Fluid Mechanics	3(3-0-9)
2103652	Combustion Theory	3(3-0-9)
2103653	Fluid Dynamics Aspects of Wind Turbines	3(3-0-9)
2103654	Conduction Heat Transfer	3(3-0-9)
2103655	Convection Heat Transfer	3(3-0-9)
2103656	Radiation Heat Transfer	3(3-0-9)
2103658	Advanced Internal Combustion Engine	3(3-0-9)
2103659	Utilization of Alternative Fuels	3(3-0-9)
2103663	Advanced Refrigeration and Air Conditioning	3(3-0-9)
2103664	Design of Thermal Systems	3(3-0-9)
2103665	Advanced Computational Fluid Dynamics	3(3-0-9)
2103666	Finite Element Method for Computational Fluid Dynamics	3(3-0-9)

*3.3) Control/Dynamics/Manufacturing:*

9 credits are to be chosen from the

2103510	Mechanics of Composite Materials	3(3-0-9)
2103530	Industrial Robots I	3(3-0-9)
2103532	Computer-Aided Design and Computer-Aided Manufacturing	3(2-3-7)
2103535	Mechatronics	3(3-0-9)
2103602	Measurement and Instrumentation	3(2-3-7)
2103604	Advanced Numerical Methods	3(3-0-9)
2103615	Mechanical Vibrations	3(3-0-9)
2103616	Optimum Design of Complex Mechanical Elements	3(3-0-9)
2103617	Advanced Dynamics	3(3-0-9)
2103625	Advanced Finite Element Method	3(3-0-9)
2103630	Industrial Robots II	3(3-0-9)
2103632	Applied Nonlinear Control	3(3-0-9)
2103633	Applied Optimal Control	3(3-0-9)
2103634	Dynamics System Modeling and Simulation	3(3-0-9)

**4) Elective Courses**

*4.1) Solid Mechanics: 3 credits*

*4.2) Heat Transfer/Thermodynamics/Fluid:*

**none**

*4.3) Control/Dynamics/Manufacturing : 3 credits*

Elective courses are to be chosen from the following list:

2103510	Mechanics of Composite Materials	3(3-0-9)
2103511	Introduction to Continuum Mechanics	3(3-0-9)
2103530	Industrial Robots I	3(3-0-9)
2103532	Computer-Aided Design and Computer-Aided Manufacturing	3(2-3-7)
2103535	Mechatronics	3(3-0-9)
2103540	Failure Analysis and Non-destructive Testing	3(2-3-4)
2103541	Vibration Monitoring and Analysis	3(2-3-4)
2103552	An Introduction to Computational Fluid Mechanics	3(3-0-9)
2103555	Engine Emissions and Control	3(3-0-9)
2103556	Fundamental of Engine Fuel Control Systems	3(3-0-9)
2103558	Intake Manifold and Induction System Design	3(3-0-9)
2103560	Gas Turbine Performance	3(3-0-9)
2103566	Compressible Fluid Dynamics	3(3-0-9)
2103567	Turbulent Shear Flows	3(3-0-9)
2103570	Micro Fabrication Technology	3(3-0-9)
2103571	Micro and Nano Electromechanical Systems (MEMS-NEMS)	3(3-0-9)
2103602	Measurement and Instrumentation	3(2-3-7)
2103604	Advanced Numerical Methods	3(3-0-9)
2103612	Elasticity	3(2-3-4)
2103613	Plasticity	3(3-0-9)
2103614	Continuum Mechanics	3(3-0-9)
2103615	Mechanical Vibrations	3(3-0-9)
2103616	Optimum Design of Complex Mechanical Elements	3(3-0-9)
2103617	Advanced Dynamics	3(3-0-9)
2103620	Theory of Elastic Stability I	3(3-0-9)
2103621	Energy Principles in Solid Mechanics	3(3-0-9)
2103622	Analysis of Composite Structure	3(3-0-9)
2103623	Fatigue of Metals	3(3-0-9)
2103625	Advanced Finite Element Method	3(3-0-9)
2103626	Thermal Stress Analysis	3(3-0-9)
2103630	Industrial Robots II	3(3-0-9)
2103631	Control of Dynamic Systems	3(3-0-9)
2103632	Applied Nonlinear Control	3(3-0-9)
2103633	Applied Optimal Control	3(3-0-9)
2103634	Dynamics System Modeling and Simulation	3(3-0-9)
2103650	Advanced Engineering Thermodynamics	3(3-0-9)
2103651	Advanced Fluid Mechanics	3(3-0-9)
2103652	Combustion Theory	3(3-0-9)
2103653	Fluid Dynamics Aspects of Wind Turbines	3(3-0-9)
2103654	Conduction Heat Transfer	3(3-0-9)
2103655	Convection Heat Transfer	3(3-0-9)
2103656	Radiation Heat Transfer	3(3-0-9)
2103658	Advanced Internal Combustion Engine	3(3-0-9)
2103659	Utilization of Alternative Fuels	3(3-0-9)
2103663	Advanced Refrigeration and Air Conditioning	3(3-0-9)



2103664	Design of Thermal Systems	3(3-0-9)	
2103665	Advanced Computational Fluid Dynamics	3(3-0-9)	
2103666	Finite Element Method for Computational Fluid Dynamics	3(3-0-9)	
2103701	Selected Topics in Mechanical Engineering	3(3-0-9)	
2103721	Fracture Mechanics	3(3-0-9)	
<b>5) Thesis</b>			
2103813	Thesis	18	credits
2103816	Thesis	36	credits

**Ph.D. DEGREE PROGRAM**

**NAME OF THE DEGREE**

: Doctor of Philosophy  
: Ph.D.

**ADMISSION**

1. The applicant must have bachelor degree in mechanical engineering or master degree in mechanical engineering/related fields. The applicant with bachelor degree must have average grade point of not less than 3.25 based on a 4 point grading system or receiving second class honor degree. The applicant with master degree must earn the thesis qualification at the good or excellent level. Both the bachelor and master degree applicants must possess other qualifications which the Doctor of Philosophy Program Committee considers sufficient to enter the programme.

2. The applicant must present three letters of recommendation written by persons who are engaging in teaching the graduate study and/or his or her academic advisors.

3. The applicant must possess other qualifications which fulfill the regulations governing the study in Chulalongkorn University's Graduate School and the standard of study for the Doctor of Engineering Degree, 1981.

**DEGREE REQUIREMENTS**

The applicant with bachelor degree must take 24 credits of the listed elective courses. The applicant with master degree may take 0-12 credits of the listed elective courses depending on the consideration of the Program Committee. Both the bachelor and master degree applicants are required to submit a dissertation of 48 credits and satisfactory pass an oral examination. In addition, the applicant must fulfill the requirements of the graduate school by passing the English examination and publishing technical paper in an international journal.

**COURSE REQUIREMENTS**

<i>1) Elective Courses</i>			
2103601	Advanced Engineering	3(3-0-9)	Mathematics
2103602	Measurement and Instrumentation	3(2-3-7)	
2103603	Mathematics for Control Engineers	3(3-0-9)	
2103604	Advanced Numerical Methods	3(3-0-9)	
2103612	Elasticity	3(3-0-9)	
2103613	Plasticity	3(3-0-9)	
2103614	Continuum Mechanics	3(3-0-9)	
2103615	Mechanical Vibrations	3(3-0-9)	
2103616	Optimum Design of Complex Mechanical Elements	3(3-0-9)	
2103617	Advanced Dynamics	3(3-0-9)	
2103620	Theory of Elastic Stability I	3(3-0-9)	
2103621	Energy Principles in Solid Mechanics	3(3-0-9)	
2103622	Analysis of Composite Structures	3(3-0-9)	
2103623	Fatigue of Metals	3(3-0-9)	
2103625	Advanced Finite Element Method	3(3-0-9)	
2103626	Thermal Stress Analysis	3(3-0-9)	
2103630	Industrial Robots II	3(3-0-9)	
2103631	Control of Dynamic Systems	3(3-0-9)	
2103632	Applied Nonlinear Control	3(3-0-9)	
2103633	Applied Optimal Control	3(3-0-9)	
2103634	Dynamic System Modeling and Simulation	3(3-0-9)	
2103650	Advanced Engineering Thermodynamics	3(3-0-9)	
2103651	Advanced Fluid Mechanics	3(3-0-9)	
2103652	Combustion Theory	3(3-0-9)	
2103653	Fluid Dynamic Aspects of Wind Turbines	3(3-0-9)	
2103654	Conduction Heat Transfer	3(3-0-9)	
2103655	Convection Heat Transfer	3(3-0-9)	
2103656	Radiation Heat Transfer	3(3-0-9)	
2103658	Advanced Internal Combustion Engine	3(3-0-9)	
2103659	Utilization of Alternative Fuels	3(3-0-9)	
2103663	Advanced Refrigeration and Air Conditioning	3(3-0-9)	
2103664	Design of Thermal Systems	3(3-0-9)	
2103665	Advanced Computational Fluid Dynamics	3(3-0-9)	
2103666	Finite Element Method for Computational Fluid Dynamics	3(3-0-9)	
2103701	Selected Topics in Mechanical Engineering	3(3-0-9)	
2103721	Fracture Mechanics	3(3-0-9)	
<i>2) Dissertation</i>			
2103828	Dissertation	48	credits
2103829	Dissertation	60	credits
2103894	Doctoral Dissertation Seminar	0(0-0-0)	
2103897	Qualifying Examination	0(0-0-0)	

**COURSES DESCRIPTIONS  
IN MECHANICAL ENGINEERING  
(UNDERGRADUATE LEVEL)**

- 2103106 Engineering Drawing 3(1-4-4)**  
Introduction, Lettering, Apply geometry, Orthographic projection principle, Orthographic writing, Pictorial sketching, Orthographic reading, Dimensioning, Threaded fastener, Assembly drawing, Introduction to computer-aid drafting.
- 2103211 Statics 3(3-0-6)**  
Force system; resultants; equilibrium; structures and machines; distributed forces; friction, friction in machines; principle of virtual work; stability.
- 2103212 Dynamics 3(3-0-6)**  
*Condition: Corequisite 2103211 or 2103213*  
Kinematics and kinetics of particles and planar rigid body; Newton's second law; equations of motion; work and energy; impulse and momentum of particles and planar rigid body; fundamental theory of vibration; free vibration and natural frequency.
- 2103231 Mechanics of Materials I 3(3-0-6)**  
*Condition: Corequisite 2103211 or 2103213*  
Concept of stress and strain; stress and strain components; plane stress and plane strain; Mohr's circle of plane stress; Hooke's law and modulus of elasticity; engineering stress-strain diagrams; working stress; factor of safety; problems in axial loading including statically indeterminate problems and temperature changes; thin-walled pressure vessel; torsion of circular shaft; statically indeterminate shaft; beam; stress in beam; deflection of beam; statically indeterminate beam; Euler's formula; combined stress.
- 2103241 Thermodynamics I 3(3-0-6)**  
Some introductory comments, some concepts and definitions, properties of pure substances, work and heat, the first law of thermodynamics, the first law analysis for a control volume, the second law of thermodynamics, entropy, second law analysis for a control volume, power and refrigeration system.
- 2103260 Mechanical Engineering Experimentation and Laboratory I 2(1-3-2)**  
Understanding the configuration and underlying principles/theories of mechanical engineering devices or systems; basic knowledge in measurement and instrumentation; basic concept in experimentation; conducting simple experiments using simple devices or systems.
- 2103301 Design Methodology for Mechanical Engineering 3 (2-2-5)**  
Design process; defining design problems, conceptual design, evaluating conceptual design; configuration design; introduction to simple mechanisms and mechanical devices; standard parts in mechanical works; conceptual design project.

- 2103303 Numerical Methods for Mechanical Engineering 3(3-0-6)**  
Digital computer principles and computer languages; root of algebraic and transcendental equations; solution of simultaneous algebraic equations; curve fitting; numerical integration and differentiation; numerical integration of ordinary differential equations: initial-value problems, ordinary differential equations: boundary-value problems.
- 2103302 Engineering Measurements 3(2-2-5)**  
*Condition: Consent of Faculty*  
Engineering measurement systems, basic measurement standards; fundamentals of selection and operation of instrumentation components of measuring systems; error analysis, and propagation of error.
- 2103304 Automatic Control I 3(3-0-6)**  
Introduction to control system; mathematical models of systems; state-space description; dynamics simulation; feedback control system characteristics; the performance of feedback control systems; the stability of linear feedback systems; essential principles of feedback, the root-locus method; frequency response methods; stability of the frequency domain, time-domain analysis of control systems; the design and compensation of feedback control systems.
- 2103305 Manufacturing Process for Mechanical Engineering 3(2-2-5)**  
Manufacturing process: casting, turning, milling, welding, heat treatment; manufacturing process selection for materials and shapes; manufacturing process selection for linear tolerance and geometric tolerance; surface roughness; metrology and examination techniques.
- 2103306 Computer-Aided Mechanical Engineering Design 3(3-0-6)**  
Use of computer-aided engineering for design and analysis of mechanical engineering problems. Physical modeling and simulations of mechanical engineering problems and related applications. Numerical methods for analysis, modeling and design of mechanical engineering problems
- 2103320 Design of Mechanical Elements 3(3-0-6)**  
*Condition: Prerequisite 2103231*  
Properties of materials, theory of failure; fatigue analysis for mechanical design, design of various interesting mechanical elements.
- 2103322 Mechanics of Machinery 3(3-0-6)**  
*Condition: Prerequisite 2103212*  
Basic Mechanisms; Position, velocity and acceleration of Linkages, Graphical linkage synthesis; Linkage synthesis; Static and dynamic force analysis; Static and dynamic balancing of a simple rotating and reciprocating machine.

**2103325 Mechanical Engineering Design Project** **2(0-4-2)**  
*Condition : Corequisite 2103320,2103322 and 2103361*

Conducting a practical interesting design; project presentation and complete report writing.

**2103332 Shipbuilding Engineering** **3(3-0-6)**

Ship types; shipbuilding materials and material testing; classification societies and related regulation; welding and cutting processes in shipbuilding; classification society weld testing; fabrication of main ship structural items; keel and bottom construction; shell plating, framing systems and decks; bulkheads and pillars; superstructures, etc.; fabrication of minor ship structural items; pumping and piping system; ventilation, refrigeration and insulation; shipbuilding process; shipyard layout and facilities; shipbuilding quality control; shipyard management and organization; industrial relations and psychology.

**2103335 Vehicle Structural Analysis 1** **3(3-0-6)**

*Condition: Prerequisite 2103231*

Types and functions of vehicle body and chassis, layout of driving system, and chassis's load; factors affecting the structural design : safety; analysis of stress and deformation in beam and frame under axial load, bending moment, torque, transverse load and thermal load, respectively. The analysis involves both analytical method and finite element method, use of software in solving structural problems.

**2103342 Thermodynamics II** **3(3-0-6)**

*Condition: Prerequisite 2103241*

Gaseous mixture; thermodynamic relations; fuel and chemical reactions; irreversibility, availability or exergy and second law efficiency; compressible flow.

**2103351 Fluid Mechanics I** **3(3-0-6)**

*Condition: Prerequisite 2103241 or 2103295*

Introduction and fundamental concepts: fluid as a continuum, velocity field, nature of forces in fluid; fluid statics: fluid in rigid-body motion; Reynolds' transport theorem; governing equations for fluid motion in integral form: conservation of mass, linear momentum, angular momentum, and energy; introduction to kinematics of fluid motion: Eulerian and Lagrangian description of fluid motion, substantial derivative, translation, rotation, vorticity and circulation, deformation; introduction to governing equations for fluid motion in differential form: conservation of mass, stress in fluid motion, resultant force due to stress, the Navier-Stokes equation; introduction to inviscid flow: Euler's equation, Bernoulli's equation; dimensional analysis and similarity; introduction to internal viscous flow: fully-developed laminar flow, flow in pipes and ducts, flow measurements; introduction to external viscous flow: boundary layer flow, flow about immersed bodies.

**2103352 Ship's Buoyancy and Stability** **3(2-3-4)**

*Condition: Corequisite 2103351*

Ship geometry; ship's lines, nomenclature of form floatation; buoyancy; computations of areas, volumes and moments, the properties of floating bodies, hydrostatic curves; equilibrium and initial stability: equilibrium of floating objects, initial stability, metacentric radius, the inclining experiment, trim, stability curves; cross curves, stability characteristics; weight effects of stability; weight effects of stability; weight addition weight removal, grounding and docking; impaired stability and control of damage, free surface, flooding, permeability, estimate of the damaged ship's condition.

**2103360 Mechanical Engineering Experimentation and Laboratory II** **2(1-3-2)**

*Condition : Prerequisite 2103260*

Basic concepts and framework of experimentation; uncertainty analysis; analysis of data; interpretation of experimental results; analysis of characteristics and physical behavior of the system from experimental results via the use of physical observation and knowledge of basic physical principles; practices in applying principles and theories and evaluating the results of the application of such principles and theories in thermodynamics, fluid or solid mechanics systems.

**2103361 Energy and Thermal-Fluid System Design I** **3(3-0-6)**

*Condition : Prerequisite 2103241 and 2103351*

Characteristics and performance of energy thermal-fluid systems; analysis; modeling; energy transformation; design constraints; economic concept in engineering design; parametric study; introduction to optimization.

**2103382 Mechanics of Vehicles I** **3(3-0-6)**

*Condition: Prerequisite 2103211*

Dynamics of wheels; vehicle's resistance forces and power requirement; performance & fuel consumption; dynamics of breaking.

**2103393 Mechanical Engineering Laboratory For NoN-ME** **1(0-3-0)**

*Condition: Prerequisite 2103241 or 2103295 or 2103261*

Experiments are designed to familiarize non mechanical students with experimental technique and instrumentations in the field of mechanical engineering. This course involves students working together in small groups on various experimental problems including gasoline and diesel engines, air compressor, hydraulic pump and turbine, friction loss in pipe and refrigeration cycle.

**2103404 Dynamic Systems Simulation** **3(3-0-6)**

*Condition: Prerequisite 2103304*

Introduction; multiport systems and bond graphs; basic component models; system models; state-space equations; analysis of linear systems; multiport fields and junction structures; transducers, amplifiers, and instruments.

**2103405 Automatic Control II 3(3-0-6)**

*Condition: Prerequisite 2103304*

Describing-function analysis of non-linear control systems, phase-plane analysis, state-space analysis of control system; linear dynamical equations and impulse- response matrices; controllability and observability of linear dynamical equations, irreducible realizations: strict system, equivalence and identification.

**2103406 Digital Control 3(3-0-6)**

*Condition: Prerequisite 2103304*

Introduction to discrete systems by time-domain representations of linear discrete systems; the analysis of discrete-time systems, z-transformation of linear discrete systems; state variable representation; analysis of linear discrete-time system: z-domain approach; the analytical design of discrete systems; engineering characteristics of computer control systems.

**2103407 Industrial Control 3(3-0-6)**

Basic control system; industrial control components: pneumatic electric, electronic and fluid devices; analysis and design of the complete control systems; special control applications; boiler control air condition control flight control; introduction to direct digital control and supervisory control.

**2103408 Automotive Control 3(3-0-6)**

Basic electronics; principle of feedback control system; digital control system; control device in automotive; sensors, controller, actuator; various control systems in automobile; system failure analysis.

**2103409 Introduction to Mechatronics 3(3-0-6)**

Introduction to Mechatronic Systems; Digital circuits; OP-AMP and analog circuits; Sensors and Measurement Systems; Actuators; Microprocessor; Programming, Project in Mechatronics.

**2103421 Introduction to Finite Element Method for Mechanical Engineering 3(3-0-6)**

*Condition: Prerequisite 2103303*

Mathematical preliminaries and matrices, general procedure of the finite element method, derivation of finite equations using; direct approach, variational approach and method of weighted residuals, finite element types in one, two and three dimensions, and their interpolation functions, applications to structural, heat transfer, and fluid flow problems.

**2103432 Mechanics of Materials II 3(3-0-6)**

*Condition: Prerequisite 2103231*

Analysis of stresses at a point; analysis of stresses at adjacent points; analysis of strain at a point; analysis of strain at adjacent points; introduction to theory of elasticity; applications to thick cylinders; compound cylinders: rotating disks: criteria of yielding: energy method.

**2103433 Introduction to Mechanical Vibration 3(3-0-6)**

*Condition: Prerequisite 2301312 or Concurrent 2103212*

Definitions; system with one degree of freedom; simple harmonic motion; torsional vibration; method of equivalent system; energy method; Rayleigh method; vibration with damping; viscous damping; coulomb damping; force vibration; system having several degree of freedom: dynamic absorber.

**2103437 Ship Design I 3(3-0-6)**

*Condition: Prerequisite 2103352*

Ship types and rules of construction, international convention, ship owner's requirement, choice of vehicles; tendering and specifications; general design characteristics; estimation of principal parameters and dimensions; mass equations and estimation of masses, capacities, stability and trim; body plan design, choice of form and modification; producing of line plan general arrangement, inboard, inboard profile, out board profile, transverse sections through engine room and others; engine foundations, sturttube, struts, propellers rudders; engine room layout, piping systems; electric and electronic system, refrigerating systems and others.

**2103443 Refrigeration 3(3-0-6)**

*Condition: Prerequisite 2103241, 2103351*

Various types of refrigerating system; refrigeration cycle: single stage, booster, multi-stage and cascade system; basic principles of cryogenic technique; properties of refrigerants; blast freezer and anteroom construction: refrigeration load estimation; cold storage construction; freezing preservation of foods; low temperature refrigeration system; introduction to cryogenic technique; control system and instrumentations.

**2103454 Ventilation and Air Conditioning 3(3-0-6)**

*Condition: Prerequisite 2103342, 2103351*

Psychrometric properties and process of air, criteria for thermal comfort; general ventilation; industrial ventilation; fume and dust removal; air conditioning load calculation; various types of air conditioning system and equipment; air distribution and duct system design; air conditioning piping design; noise and vibration control: air.

**2103460 Mechanical Engineering Experimentation and Laboratory III (ME EXP LAB III) 2(1-3-2)**

*Condition: Prerequisite 2103360*

Concepts in experimentation and design of an experiment, setting up specifications and objectives of an experiment; systematic design of an experiment according to the specifications and objectives using tools such as data reduction diagram (DRD) and uncertainty analysis, and knowledge and application of basic physical principles, and knowledge of instruments and measurement; outlining the process of extracting experimental results and conclusions from the designed experiment; outlining of data collection and data analysis schemes; outlining of experimental project phases, tasks, and schedule; design documentation and review by oral and written presentation; practices in the design of an experiment in the project-based setting; introduction to

modern instrumentation and data acquisition through demonstration.

**2103461 Automotive Engineering Experimentation and Laboratory** 2(1-3-2)

Basic concepts and framework of experimentation; uncertainty analysis; analysis of data; interpretation of experimental results; analysis of characteristics and physical behavior of the system from experimental results via the use of physical observation and knowledge of basic physical principles; practices in applying principles and /theories in automotive systems.

**2103462 Fluid Mechanics II** 3(3-0-6)  
*Condition: Prerequisite 2103241 and 2103351*

Fundamental concepts in fluid mechanics: methods of description of fluid motion, kinematics of fluid motion, stress at a point, the Navier-Stokes equation; inviscid irrotational flows: vorticity and circulation, velocity potential, stream function, Euler's equation of motion, Bernoulli's equation, elementary plane flows, superposition of elementary plane flows, lift and circulation; laminar viscous flows: Poiseuille flow, Couette flow, flow between rotating concentric cylinders; laminar boundary layers: displacement and momentum thicknesses, thin shear layer assumption and laminar boundary layer equation, flat plate boundary layer, momentum integral equation; introduction to turbulent flows: mean flow and turbulence, the Reynolds-Average Navier-Stokes equation, turbulent flows in channel and pipe, turbulent boundary layers; lift and drag of immersed bodies; introduction to compressible flows: local isentropic reference states, steady one-dimensional compressible flows with area change, with friction, and with heat transfer, normal shock.

**2103463 Heat Transfer** 3(3-0-6)  
*Condition: Prerequisite 2103241 and 2103351*

Modes of heat transfer; heat conduction equation; steady, one-dimensional heat conduction; steady, two-dimensional heat conduction; unsteady, one-dimensional heat conduction; Introduction to convection heat transfer; velocity and thermal boundary layer; forced convection along external surfaces; forced convection inside tubes; free convection; introduction to thermal radiation; blackbody radiation; real surface emission; surface absorption, reflection and transmission; view factor; radiation exchanger between blackbody; radiation exchanger between real surface; heat exchanger design; boiling and condensation.

**2103465 Fluid Power System** 3(3-0-6)  
*Condition: Prerequisite 2103351, 2301312*

Fundamentals of fluid power system, basic components and circuits, standard symbols, definitions using steady-state characteristics, transmission system, logic components and circuits, electrical components and wiring diagrams definition using transient characteristic, dynamic of fluid power system.

**2103467 Combustion Technology** 3(3-0-6)  
*Condition: Prerequisite 2103342, 2103351*

Combustion phenomena; chemical kinetics, total collision frequency, equation of Arrhenius, activation energy, rates of reaction, ignition, quenching distance, flammability limits, fuel technology, stoichiometric combustion calculation, thermochemical analysis, theoretical flame temperature, performance of steam boilers, boiler's efficiency, boiler's heat balance sheet, boiler draught and fan power calculation, classification of industrial furnaces, heat source and heating method, operating method and material transfer equipment, furnace's radiative heat transfer, combustion apparatus, fuel-to-steam efficiency.

**2103471 Internal Combustion Engines** 3(3-0-6)  
*Condition: Prerequisite 2103241*

Fundamental of how the design and operation of internal combustion engine effect their performance and fuel requirements. Study of fluid flow, thermodynamics, combustion, heat transfer and friction phenomena, and fuel properties, relevant to engine power, efficiency, and emissions. Examination of design features and operating characteristics of different types of engine: spark-ignition, compression-ignition.

**2103472 Power Plant Engineering** 3(3-0-6)  
*Condition: Prerequisite 2103241*

Power plant and energy conversion systems: load calculation; power plant economics; fuel and combustion; steam turbines; steam and nuclear generators; condensers and auxiliary equipments; steam, internal combustion engine, gas turbine and hydroelectric plans.

**2103473 Ship Resistance and Powering** 3(3-0-6)  
*Condition: Prerequisite 2103351*

Frictional resistance, residuary resistance, wave making resistance, Froude's law of comparison; model tests; powering of ships; estimation of effective horse power; propulsion and propellers horsepower, wake thrust deduction, hull efficiency, propellers, geometry of the screw propeller, propellers and law of similarity, design procedure.

**2103475 Energy Management in Building** 3(3-0-6)  
*Condition : Senior project*

*Energy audit program for building and facilities, initiating energy management program, guidelines for methods of reducing energy usage in each area in buildings, conservation of the energy in the planning, design, installation, utilization, maintenancem and modernization of the mechanical systems in existing and new buildings, utilization of microcomputer in energy management and in automatic control of air conditioning and ventilatin systems in buildings.*

**2103477 Design of Industrial Piping** 3(3-0-6)  
*Condition: Prerequisite 2103351*

Boiler, principle of steam piping system, steam trapping, condensate recovery, flash steam, steam system design; principle of industrial compressed air piping system, air compressor and equipments, compressed air system design; air compressor and equipments, compressed air system design; principle of low pressure gas piping, pressure reducing station, calculation and sizing of gas pipes.

**2103478 Energy Management in Industry 3(3-0-6)**

*Condition: Prerequisite 2103351*

Energy balance studies for various equipment in industrial plants and options for improved efficiency, waste heat recovery techniques, cogeneration concepts in industry and management for efficient use of energy.

**2103479 Engine Cooling Systems 3(3-0-6)**

Function of engine cooling system; fundamental of engine heat transfer; engine cooling system components; engine temperature; engine cooling circuits; vehicle coolant circuits; heat rejection; failure mode of cooling system; system characteristics; design process and test methods.

**2103481 Automotive Engineering 4(3-3-6)**

Basic principles; suspension system ; body and chassis, brake system; steering system; front wheel geometry; transmission system, automotive equipment; performance factors.

**2103482 Mechanics of Vehicles 3 (3-0-6)**

PART I: Introduction, degree of freedom, mechanical replacement system, uneven road surface, one-mass system, impulse due to the unevenness of the road, spectral density, spectral density of uneven road surfaces, evaluation criteria of vibration and its calculation, evaluating the effect of the vibration on person, tyre, seat, vibration of motor vehicles and single point excitation, magnification factor (amplitude ratio), assessment criteria.

PART II: Single-track model, equation of motion, center of curvature and instantaneous center, tyre characteristics, aerodynamic characteristic values, linear differential equation of the single-track model, steady-state circular test at a constant speed, characteristic variable and its subjective assessment, effect of vehicle data, dynamic behavior, drive with large slip angles (in non-linearized range), effect of the height of center of mass.

**2103483 Automotive System Design 3(1-4-4)**

*Condition: Prerequisite 2103320*

A practical interesting automotive system design project assigned by the instructor; the project must be completed within one semester; a complete written design report is required.

**2103484 Marine Engineering 3(3-0-6)**

*Condition : Consent of Faculty*

Marine machinery; types and their layouts: pumps, fans, steering gear mechanism, anchoring device,

winches, and cranes; propulsion; propeller geometry and definitions; lift and drag; momentum and blade element theories; steering and design of rudders; ship auxiliary services; ventilation, refrigeration, air conditioning, pumping, flooding and draining, and waste heat utilization.

**2103485 Agricultural Tractor Systems and Design 3(3-0-6)**

*Condition : Senior Standing*

Principles of design, constructional features, and operation of farm tractors, with emphasis on mechanics of tractor chassis, tractor transmission systems, hydraulic control systems, tractor-implement relationship, tractor-soil relationship, and tractor steering.

**2103489 Mechanical Engineering Pre-Project 1(0-2-1)**

*Condition : Senior Standing or Consent of Faculty*

Conduct and complete design processes for a mechanical engineering project in a team as well as documenting and presenting the processes in a professional manner.

**2103491 Rolling Stock Engineering 3(3-0-6)**

Fundamentals of railway rolling stock engineering railway stock components; introduction to railway vehicle dynamics; stability analysis; bogie, suspension, propulsion and brake system; fundamentals of bogie forms and design concept ; principle of railway rolling stock maintenance.

**2103495 Advanced Topics in Mechanical Engineering I 3(3-0-6)**

*Condition : Consent of Faculty*

Topics of current interest and new developments in various fields of mechanical engineering.

**2103496 Advanced Topics in Mechanical Engineering II 3(3-0-6)**

*Condition : Consent of Faculty*

Topics of current interest and new developments in various fields of mechanical engineering.

**2103499 Mechanical Engineering Project 3(0-6-3)**

*Condition : Senior Standing or Consent of Faculty*

Conduct and complete a mechanical engineering project in a team such that the processes comply with prescribed design processes as well as documenting and presenting the project in a professional manner.

**COURSES DESCRIPTIONS  
IN MECHANICAL ENGINEERING  
(GRADUATE LEVEL)**

**2103510 Mechanics of Composite Materials 3(3-0-9)**

Basic concepts of fiber reinforced composite materials and their application, stress and strain analysis of continuous fiber composite materials; Hooke' law and hygrothermal behavior of orthotropic lamina; classical lamination theory, failure criterion, and design concepts, as applied to composite structures; analysis of composite beams and plates; introduction to material fabrication and testing.

**2103511 Introduction to Continuum Mechanics 3(3-0-9)**

*Condition : Consent of Faculty*

Introduction to continuum mechanics; essential mathematics: notations, tensor and operations, transformation, equation and symbol presentation; Kinematics of motion and small deformation; engineering stress; governing equations; constitutive equations; applications: setting and interpretation of heat conduction, solid mechanics and fluid mechanics.

**2103530 Industrial Robots I 3(3-0-9)**

Introduction Industrial Robots; robot reference frames; manipulator kinematics; inverse manipulator kinematics; Jacobian; manipulator dynamics; introduction to robot controls; trajectory generation; mechanism design; introduction to hybrid force/position control; summary.

**2103532 Computer Aided Design and Computer Aided Manufacturing 3(2-3-7)**

Introduction to CAD/CAM; basic concept of CAD/CAM/CAE; product design and strategy; 3D modeling concept; techniques for geometry modeling; surface design; computer aided manufacturing concept; the design and manufacturing interface; NC programming & verification; link to manufacture; CAD/CAM standard and data exchange; rapid-prototyping concept; total approach to product development.

**2103535 Mechatronics 3(3-0-9)**

Introduction to mechanical system interfacing; combinational digital logic; industrial electronic components; industrial sensors; simple computer structure; low level programming techniques; embedded control computers; microcontroller; stepping motors; DC motors; analog/digital conversion; position and velocity measurement; amplifiers; projects related to mechatronics.

**2103540 Failure Analysis and Non-destructive Testing 3(2-3-7)**

*Condition : Consent of Faculty*

Stress at crack tip and concerning parameters; failure phenomena: crack propagation, creep, corrosion, failure surface; life assessment; case studies; nondestructive testing; practice on NDT techniques.

**2103541 Vibration Monitoring and Analysis 3(2-3-7)**

*Condition : Consent of Faculty*

Predictive maintenance; mechanical vibration; Fourier series and Fast Fourier Transform; measurement and instrumentation; symptoms of vibration signals; diagnosis; setup of alarm band; case studies; and projects.

**2103552 An Introduction to Computational Fluid Mechanics 3(3-0-9)**

Dynamics of body moving through a fluid medium; numerical solution of ordinary differential equations. Inviscid fluid flows. Numerical method for solving elliptic partial differential equations. Viscous fluid flows: explicit and implicit methods for solving parabolic partial differential equations. Artificial viscosity. Mathematical behavior of partial differential equations. Boundary condition and Grid transformation.

**2103555 Engine Emissions and Control 3(3-0-9)**

Air pollution system, effects of pollutants; engine fundamentals, engine emissions; emission control techniques; instrumentation and techniques for measuring emissions.

**2103556 Fundamental of Engine Fuel Control System 3(3-0-9)**

Fuel properties; fuel tank; carburetor; fuel injection system; injector; injection timing and control strategies; injector quality evaluation and testing; throttle body analysis and design; idle air control; fuel rail; fuel pumps and pressure regulator; fuel control systems for alternative fuels.

**2103558 Intake Manifold and Induction System Design 3(3-0-9)**

Engine intake manifold design; primary design parameters and tuning, analysis methods; multicylinder wave dynamics; flow losses in induction systems; testing method for performance evaluation; noise in induction system, silencers.

**2103560 Gas Turbine Performance 3(3-0-9)**

*Condition : Prerequisite 2103342 and 2103351 or Consent of Faculty*

Introduction, thermodynamics of gas turbine cycle: efficiency and output of hypothetical cycle of intercooling, reheat and regenerative separately and in combination: the aeroturbo-propeller engine; the turbojet engine, the bypass jet engine, the supersonic turbojet engine; component matching problem.

**2103566 Compressible Fluid Dynamics 3(3-0-9)**

*Condition : Consent of Faculty*

Thermodynamics of motion; physical acoustics; wave equation; speed of sound; quasi-one-dimensional flow with friction and heat addition; shock waves and related discontinuities; one-dimensional unsteady flow; two-dimensional steady flow; method of characteristics; nozzle design; linearized flow; flow visualization using optical techniques.

**2103567 Turbulent Shear Flows 3(3-0-9)**  
Characteristics of turbulent flows; Reynolds equations; dynamics of turbulence; free turbulent shear flows; jets, wakes, mixing layers, channel and pipe flows; turbulent transport of scalar quantities.

**2103570 Micro Fabrication Technology 3(3-0-9)**  
Photo-lithography, etching, deposition, thermal oxidation, diffusion, ion implantation, bulk and surface micromachining, metrology, packaging, advanced lithography and the applications of micro and nanofabrication.

**2103571 Micro and Nano Electromechanical Systems (MEMS-NEMS) 3(3-0-9)**  
Overview of MEMS, review of engineering mechanics and thermo-fluid engineering, electromechanics and light phenomena, micro system design of micromechanical devices, MEMS materials, review of micro fabrication, applications of MEMS, micro sensor, micro actuator, micro fluidic systems, display technologies, future trends.

**2103601 Advanced Engineering Mathematics 3(3-0-9)**  
Numerical and graphical methods of approximate solution; finite difference method; calculus of variations, solution of classical partial differential equations of mathematical physics including application of conformal mapping and the Laplace transformation.

**2103602 Measurement and Instrumentation 3(2-3-7)**  
Generalized performance characteristic of instruments; static and dynamic characteristics, study of measurement method for temperature, pressure, mass flow, stress-strain and vibration; experimental design and data analysis.

**2103603 Mathematics for Control Engineers 3(3-0-9)**  
System representation; linear system analysis; state-space solutions and realizations; stability; controllability and observability; minimal realization; nonlinear systems analysis; phase plane analysis; Lyapunov theory for autonomous system; introduction to Lyapunov theory for non-autonomous systems; differential geometry; Lie derivative and Lie bracket; the Frobenius theorem; describing function analysis; Fourier series; Fourier integral; discrete-time mathematic; digital signal processing and fast Fourier transform (FFT).

**2103604 Advanced Numerical Methods 3(3-0-9)**  
*Condition : Consent of Faculty*  
Solution of equation; numerical instabilities and their cure; simultaneous linear algebraic equations; numerical differentiation and integration; least squares approximations; ordinary differential equations; boundary value problems; partial differential equations.

**2103612 Elasticity 3(3-0-9)**  
Two and three dimensional stress and strain analysis, theory of elasticity, Hooke's law for two and three dimensional problems, equilibrium conditions, compatibility conditions; stress function: two and three dimensional problems in Cartesian, polar and curvilinear coordinate systems; introduction to three dimensional elasticity.

**2103613 Plasticity 3(3-0-9)**  
*Condition: Prerequisite 2103612 or Consent of Faculty*  
Stress tensors and tensor notations, yield criteria, stress-strain relations, plastic-elastic problems, introduction to incremental plasticity theory, plane strain compression, slip-line fields, friction effects, extrusion, deep drawing, rolling, limit analysis, upper bound and lower bound solutions.

**2103614 Continuum Mechanics 3(3-0-9)**  
*Condition : Consent of Faculty*  
Introduction to continuum mechanics; Essential mathematics: notations, tensor and operations, transformation, integral theorems of Gauss and Stokes; Kinematics of deformation and motion; Stress principles; Governing equations; Constitutive equations; Applications (heat conduction, solid mechanics, fluid mechanics); Introduction to computational modelling.

**2103615 Mechanical Vibrations 3(3-0-9)**  
One degree of freedom systems; applications of vibration principles to various types of practical problems; multi-degrees of freedom systems, formulation of equation, numerical solving methods, continuous system, non-linear vibration.

**2103616 Optimum Design of Complex Mechanical Elements 3(3-0-9)**  
Techniques for optimum design with application to simple mechanical elements in problem with practical constraints.

**2103617 Advanced Dynamics 3(3-0-9)**  
Kinematics and kinetics of particles; variable mass problems; rigid body dynamics; Lagrange's equation; Hamilton's principle; Hamilton's canonical equations; Hamilton-Jacobi theory.

**2103620 Theory of Elastic Stability I 3(3-0-9)**  
*Condition: Prerequisite 2103432 or Consent of Faculty*  
Stability of mechanical models and elastic beams by classical, kinetic, and energy approaches; snapthrough and bifurcation buckling; buckling of beams on elastic foundation; approximate methods for critical loads, buckling of rings and arches.



**2103621 Energy Principles in Solid Mechanics 3(3-0-9)**

Variational calculus; energy principles of structural mechanics; Hamilton's principle and Lagrange's equations; formulation and solution of engineering problems by direct variational methods.

**2103622 Analysis of Composite Structures 3(3-0-9)**

Concept and analysis structural response of laminated composite components; bending, vibration and stability of laminated composite structures; interlaminar stresses; effect of shear deformation on structural response; numerical modeling of laminated plates.

**2103623 Fatigue of Metals 3(3-0-9)**

Fatigue damage process; analysis and design against fatigue failure through stress-based, strain-based and fracture mechanics-based approaches; problems of high temperature fatigue.

**2103625 Advanced Finite Element Method 3(3-0-9)**

Procedures of the finite element method for structural, thermal and fluid differential equations; nonlinear structural static and dynamic problems with discrete and continuum structures; transient nonlinear heat transfer problems with conduction, convection and radiation; steady and unsteady nonlinear incompressible and compressible fluid flow problems.

**2103626 Thermal Stress Analysis 3(3-0-9)**

Derivation of different classes for thermal stress differential equations and analytical solutions to thermal stress problems. Numerical methods for solving thermal stress problems with arbitrary continuum bodies and built-up structures.

**2103630 Industrial Robots II 3(3-0-9)**

*Condition: Prerequisite 2103530 or Consent of Faculty*

Arm kinematics, homogenous transformation, Denavit-Hartenberg representation, kinematic equations for manipulators, inverse kinematics solutions, differential relationships of arm kinematics, arm dynamics, Lagrange-Euler equations of motion of robot manipulator arms, Newton-Euler formulation, computer simulation of arm dynamics, control of multiple-joint manipulator arms.

**2103631 Control of Dynamic Systems 3(3-0-9)**

Classical control; linear system theory; response of linear, lumped-parameter stationary systems; stability of linear lumped-parameter stationary systems; scalar input-output systems and feedback control; frequency response; introduction to multi-variable control systems; linear digital control.

**2103632 Applied Nonlinear Control 3(3-0-9)**

Introduction; phase plane analysis; describing function analysis; feedback linearization; sliding control; adaptive control.

**2103633 Applied Optimal Control 3(3-0-9)**

Introduction; parameter optimization problems, optimization problems for dynamic systems, optimization problems for dynamic systems with path constraints, optimal feedback control, linear system with quadratic criteria.

**2103634 Dynamic System Modeling and Simulation 3(3-0-9)**

Mechanical background; mathematical modeling and numerical solution of engineering problems; modeling of mechanical systems; model representation and response; modeling of electrical, hydraulic and thermal system; modeling of mixed systems; time response analysis of linear dynamic systems; introduction to optimization and numerical solution; solution techniques for non-linear systems; signal processing.

**2103650 Advanced Engineering Thermodynamics 3(3-0-9)**

Review of principles and essential concepts; thermodynamic properties relations of mixtures and solutions, chemical reactions, introduction to phase and chemical equilibrium; thermodynamics of high speed flow.

**2103651 Advanced Fluid Mechanics 3(3-0-9)**

Review of principles and concepts; Cartesian tensor; transport eq., special model for steady laminar flow; shear flows, boundary layer equations, the concept of similarity; turbulent flow.

**2103652 Combustion Theory 3(3-0-9)**

Review of combustion processes, review of chemical thermodynamics, stoichiometric combustion analysis, equation of Arrhenius, activation energy, reaction orders, chain reactions, premixed laminar flames, thermal theories, comprehensive theory, Spalding's theory, ignition, minimum ignition energy, quenching distance, application in combustion engineering.

**2103653 Fluid Dynamic Aspects of Wind Turbines 3(3-0-9)**

Basic fluid dynamics, aerodynamic theory, boundary layers, aerofoils; basic wind turbines; characteristics and mathematical modelling, principles of testing.

**2103654 Conduction Heat Transfer 3(3-0-9)**

Introduction; definition of concept and statement of general laws; formulation of heat conduction equations; lumped integral and differential formulation of general laws; initial and boundary conditions. solutions for steady and unsteady problems, one; two and three dimensional problems; method of solution, separation of variables, Laplace transform, partial solution, etc.

**2103655 Convection Heat Transfer 3(3-0-9)**

Governing equations for heat and mass transfer, basic solutions for heat transfer in ducts and over external surfaces; heat and momentum transfer analogy, free convection; boiling and condensation.

**2103656 Radiation Heat Transfer 3(3-0-9)**  
 Physics of radiation, radiation properties, radiation shapes factor; radiative exchange between surfaces; radiation through absorbing and transmitting media, radiation properties of gases; solar radiation.

**2103658 Advanced Internal Combustion Engine 3(3-0-9)**  
 Standard air engine cycle, theory of combustion, fuel and combustion, reaction kinetics, reaction rates of air and fuel, engine combustion, gas exchange processes, heat transfer, principle of flow and combustion process modelling, engine's performance prediction.

**2103659 Utilization of Alternative Fuels 3(3-0-9)**  
 Special requirements for the use of alternative fuels in furnances, the use of alternative fuels in transport, engine-fuels matching and optimisation, alternative engines, durability, vehicle fuel storage options, engine-vehicle matching.

**2103663 Advanced Refrigeration and Air Conditioning 3(3-0-9)**  
*Condition: Prerequisite 2103443, 2103454 or Consent of Faculty*  
 Low temperature refrigeration, refrigeration system study, industrial applications of refrigeration, air conditioning system and building thermal environmental influences on air conditioning design, ventilation, direct contact, transfer processes between moist air and water, flow in ducts and a unconfined spaces, automatic control, testing, adjusting and balancing, economic factors in air conditioning, noise, and vibration control.

**2103664 Design of Thermal System 3(3-0-9)**  
 Engineering design, design of a workable system, economics, equation fitting and mathematical modelling, system simulation, optimization, Lagrange multipliers, search methods, dynamic programming, linear programming.

**2103665 Advanced Computational Fluid Dynamics 3(3-0-9)**  
 Mathematical and Numerical aspects of heat transfer and Fluid mechanics, finite difference and finite volume methods for solving basic governing equations of fluid flow and heat transfer: continuity, momentum and energy, discretisation methods for two and there dimensional problems, boundary conditions, numerical schemes and solvers, consistency, stability and convergence, advanced numerical techniques for CFD, applications of the method for some engineering problems.

**2103666 Finite Element Method for Computational Fluid Dynamics 3(3-0-9)**  
 Finite element method for solving fluid dynamics problems with complex geometries under different boundary conditions; solutions the problem of potential flows, inviscid and viscous flows, incompressible and compressible flows; finite element equations and corresponding computer programs in each case.

**2103701 Selected Topics in Mechanical Engineering 3(3-0-9)**  
 Topics are drawn from various fields of current interest in mechanical engineering.

**2103721 Fracture Mechanics 3(3-0-9)**  
*Condition: Prerequisite 2103612 or Consent of Faculty*  
 Rheology, model and law of material evolution in time, model of elastic material; model of non-elastic material; linear model of Newton, Maxwell and Voight Kehin; application of Zener's solid; elementary crystal model linear solid generalization; dynamic equation. Fracture mechanics, Griffith criteria; stress intensity, influence of plastic zone at notch root; crack opening displacement.

**2103790 Seminar in Mechanical Engineering 1(0-3-1)**  
 Discussion of special topics in the advent of mechanical engineering; written report is required.

**2103811 Thesis 12 credits**

**2103813 Thesis 18 credits**

**2103816 Thesis 36 credits**

**2103828 Dissertation 48 credits**

**2103829 Dissertation 60 credits**

**2103894 Doctoral Dissertation Seminar 0(0-0-0)**

**2103897 Qualifying Examination 0(0-0-0)**