

M.Tech. in Mechanical Design (MEM)
Programme Structure

	LTP	Credit
CORE		
Design & Optimization	3-0-2	4
Analytical Dynamics	3-0-0	3
Continuum Mechanics	3-0-0	3
CAD and Finite Element Analysis	3-0-2	4
Major Project Part I	0-0-12	6
Major Project Part II	0-0-24	12
TOTAL		32
ELECTIVES (A1) Twelve Credits from the following list		
Control	3-0-2	4
Vibration and Noise	3-0-2	4
Designing with advanced materials	3-0-2	4
Tribological Systems Design	3-0-2	4
Automotive Design	3-0-2	4
Robotics	3-0-2	4
ELECTIVES (A2)		
At least two from (A2)		10

A2 is the list of the following courses. The templates for these courses are to be rewritten, preferably in 3-0-0 format or 2-0-2 format.

ELECTIVES (A2) At least two courses from the following list (10 credits)					
1	MEL744	MEL744	Design for Manufacture and Assembly	3-0-2	4
2	MEL746	MEL746	Design for Noise Vibration and Harshness	3-0-2	4
3	MEL749	MEL749	Mechatronic Product Design	2-0-2	3
4	MEL732	MEL737	Machine Tool Design	3-0-2	4
5	MEL743	MEL743	Plant Equipment Design	3-0-0	3
6	-	MEL750	Biomechanics of trauma and automotive design	3-0-0	3
7	-	MEL849	Special topics in Systems Design-I	3-0-0	3
8			Special topics in Systems Design - II	2-0-0	2
9			Special Module in Systems Design	1-0-0	1
10	MEL738	MEL738	Dynamics of Multibody Systems	2-0-2	3
11	MEL739	MEL745	Advanced Robotics	2-0-2	3
12	MEL836	MEL740	Lubrication	3-0-0	3
13		MEL7**	Nanotribology	3-0-0	3
14		MEL7**	Nanomechanics	2-0-2	3

15	MEL837	MEL837	Advanced Mechanisms	2-0-2	3
16	MEL838	MEL838	Rotor Dynamics	3-0-2	4
17	MEL840	MEL840	Experimental Modal Analysis and Dynamic Design	2-0-2	3
18	MES830	MES830	Independent Study	0-3-0	3
19	-	MEL834	Vibroacoustics	2-0-2	3

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	Department/Centre/School proposing the course	Department of Mechanical Engineering		
2.	Course Title	Analytical Dynamics		
3.	L-T-P structure	3-0-0		
4.	Credits	3	Non-graded Units	Nil
5.	Course number	MEL731		
6.	Course Status (Course Category for Program) Core for MEM, PE for ME1 and ME2			
	Institute Core for all UG programs		(Yes / No) No	
	Programme Linked Core for:		No	
	Departmental Core for:		No	
	Departmental Elective for:		ME1 and ME2	
	Minor Area / Interdisciplinary Specialization Core for:		No	
	Minor Area / Interdisciplinary Specialization Elective for:		No	
	Programme Core for:		MEM	
	Programme Elective for:		MEP, MET	
	Open category Elective for all other programs (No if Institute Core)		(Yes / No) Yes	
7.	Pre-requisite(s)	MEL211 for UG students		
8.	Status vis-à-vis other courses			
8.1	List of courses precluded by taking this course (significant overlap)			Nil
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School		Nil
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School		Nil
8.2	Supersedes any existing course			No
9.	Not allowed for	Nil		

10.	Frequency of offering (check one box)	☐ Every semester ☒ I sem ☐ II sem ☐ Either semester
------------	---	--

11.	Faculty who will teach the course S.K. Saha, S.P. Singh, J.K. Dutt, S. Mukherjee
------------	---

12.	Will the course require any visiting faculty?	(Yes/no) No
------------	--	-------------

13.	Course objectives (about 50 words. "On successful completion of this course, a student should be able to..."): To teach different modeling techniques of a mechanical system in motion. Upon successful completion of the course the students will be able to write the dynamics equations of motion of a mechanical system, which is required for the design analyses of a product before it is brought to the market.
------------	---

14.	Course contents (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities): Review of Newtonian dynamics; Degrees of freedom; Generalized coordinates and constraints; Holonomic and nonholonomic systems; Principle of Virtual work; D'Alembert's principle; Euler-Lagrange equations of motion; Hamilton's principle; Rotating coordinate systems; Euler angles; Coordinate transformation; Kinematics of a rigid body; Euler's equations of rotation; Computer-oriented dynamic modeling; Orthogonal-complement based formulation of dynamic equations; Geometric theory; Stability; Lyapunov's direct method; Introduction to flexible-body dynamics.
------------	---

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1	Review of Newtonian dynamics	2
2	Degrees of freedom and constraints, holonomic and nonholonomic systems	3
3	Principle of virtual work	3
4	D'Alembert's principle	3
5	Euler-Lagrange equations of motion	4
6	Hamilton's principle	3
7	Coordinate system and Euler angles	4

8	Kinematics of rigid body, Euler's equation of rotation	4
9	Computer-oriented orthogonal complement based approaches	5
10	Geometric theory	3
11	Stability and Lyapunov's direct method	3
12	Introduction to flexible-body dynamics	5
Total Lecture hours (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	Not applicable	
Total Tutorial hours (14 times 'T')		

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
	Not applicable	
Total Practical / Practice hours (14 times 'P')		

18. Brief description of module-wise activities pertaining to self-learning component

(Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
1	Statics and dynamics of the UG level which makes the foundation of this course
2	Linear algebra
3	Differential calculus
4	Numerical analysis
5	Learning how to use MATLAB software
6	Learning how to use RecurDyn software
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Rao, K. Sankara, Classical Mechanics, Prentice Hall India, Ltd., 2009
Shabana, A., Dynamics of Multibody Systems, Cambridge University Press, 2005
Chaudhary, H., and Saha, S.K., Dynamics and Balancing of Multibody Systems, Springer, 2009
Shah, S.V., Saha, S.K., and Dutt, J.K., Dynamics of Tree-type Robotics Systems, Springer, 2013

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	MATLAB, RecurDyn, RoboAnalyzer
20.2	Hardware	PC to run the above software
20.3	Teaching aids (videos, etc.)	Video, .ppts
20.4	Laboratory	No.
20.5	Equipment	No
20.6	Classroom infrastructure	LCD projector
20.7	Site visits	Nil
20.8	Others (please specify)	No

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	10%
21.2	Open-ended problems	10%
21.3	Project-type activity	20% of students time to do two semester projects
21.4	Open-ended laboratory work	No
21.5	Others (please specify)	Nil

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	
---	--

The information on this template is as on the date of its approval, and is likely to evolve with time.

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	Department/Centre/School proposing the course	Mechanical Engineering	
2.	Course Title	Automotive Design	
3.	L-T-P structure	3-0-2	
4.	Credits	4	Non-graded Units Please fill appropriate details in S. No. 21
5.	Course number	<Dept Code>L/P/D/S/R/V<No.>	
6.	Course Status (Course Category for Program) (list program codes: eg., EE1, CS5, etc.)		
	Institute Core for all UG programs		(Yes / No)
	Programme Linked Core for:		-
	Departmental Core for:		-
	Departmental Elective for:		-
	Minor Area / Interdisciplinary Specialization Core for:		-
	Minor Area / Interdisciplinary Specialization Elective for:		-
	Programme Core for:		
	Programme Elective for:		MEM
	Open category Elective for all other programs (No if Institute Core)		(Yes / No) YES
7.	Pre-requisite(s)	UG CAD + FE course; PG: FEA&CAE	
8.	Status vis-à-vis other courses		
8.1	List of courses precluded by taking this course (significant overlap)		PG: 736; UG: Automotive Design
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	MEL736, UG: Automotive Design (50%)
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	
8.2	Supersedes any existing course		MEL736

9.	Not allowed for	
-----------	------------------------	--

10.	Frequency of offering (check one box)	☐ Every semester ☐ I sem ☒ II sem ☐ Either semester
------------	---	--

11.	Faculty who will teach the course A Chawla, S Mukherjee
------------	--

12.	Will the course require any visiting faculty?	(Yes/no) NO
------------	--	-------------

13.	Course objectives (about 50 words. "On successful completion of this course, a student should be able to..."): On successful completion of this course, a student should be able to The course aims to expose the students to different aspects of design of automobiles. Design process for the complete automobile, and the design principles for the different automotive components like the chassis, the suspension and breaks.
------------	--

14.	Course contents (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities): History of automotive design, Design cycle for an Automobile, Styling, Loads on the chassis, Chassis and structural Design for static loads, Dynamic and impact loads, Energy absorption in the vehicle, Computational tools for structural design, vehicle occupant system analysis, biomechanics of the human body and its implications for structural design, Designing for NVH, Designing the suspension system, Designing the brake system, Design of engine characteristics, Design requirement sof the transmissison and the driveline.
------------	--

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours
1	History of automotive design, Design cycle for an Automobile,	2
2	Styling,	2
3	Loads on the chassis, and structural Design for static loads,	5
4	Dynamic and impact loads, Energy absorption in the vehicle,	5
5	Computational tools for structural design, vehicle occupant system analysis,	5
6	biomechanics of the human body and its implications for structural design,	5
7	Designing vehicles for NVH considerations,	3

8	Designing the suspension system,	4
9	Designing the brake system,	3
10	Design of engine characteristics,	3
11	Design requirements of the transmission and the driveline.	3
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
1	Load analysis for different automotive bodies	4
2	Sizing of Sections	4
3	Estimation of energy requirements and Design of energy absorbing systems	6
4	Vehicle Occupant System Analysis	6
5	Design of suspensions	4
6	Design of brakes	4
Total Practical / Practice hours(14 times 'P')		28

18. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
1	Biomechanics of different parts of the human body under impact and its implications on designing for safety
2	Active Safety Systems
3	Computation of roll centers for different suspensions
4	Design of vibration isolators
5	Design of Power Train

(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Bois P. D., Vehicle CRashworthiness and Occupant Protection, American Iron and Steel Institute, 2004.
2. Juian Happian-Smith, Introduction to Modern Vehicle Design, Butterworth-Heinemann, 2002.
3. Brown J. C., Motor Vehicle Structure: Concepts and Fundamentals, Butterworth-Heinemann, 2002.

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	ANsys / Abaqus, ProEngineer / SolidWorks, LSDyna, Madymo, Hyperworks
20.2	Hardware	PCs / Workstations
20.3	Teaching aids (videos, etc.)	Styling, automotive technology videos, Crash Testing Videos
20.4	Laboratory	CAGIL.
20.5	Equipment	PCs / Workstations
20.6	Classroom infrastructure	LCD , OHP projectors.
20.7	Site visits	-
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	
---	--

The information on this template is as on the date of its approval, and is likely to evolve with time.

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	Department/Centre/School proposing the course	Mechanical Engineering	
2.	Course Title	Finite Element Method and CAE	
3.	L-T-P structure	3-0-2	
4.	Credits	4	Non-graded Units Please fill appropriate details in S. No. 21
5.	Course number	<Dept Code>L/P/D/S/R/V<No.>	
6.	Course Status (Course Category for Program) (list program codes: eg., EE1, CS5, etc.)		
	Institute Core for all UG programs		(Yes / No)
	Programme Linked Core for:		-
	Departmental Core for:		-
	Departmental Elective for:		-
	Minor Area / Interdisciplinary Specialization Core for:		-
	Minor Area / Interdisciplinary Specialization Elective for:		-
	Programme Core for:		MEM
	Programme Elective for:		
	Open category Elective for all other programs (No if Institute Core)		(Yes / No) YES
7.	Pre-requisite(s)	MCL211, AML140 / 150	
8.	Status vis-à-vis other courses		
8.1	List of courses precluded by taking this course (significant overlap)		(course number)
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	MEL414 (new number needed)
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	AM CAD and FE course (705, 706, 710)
8.2	Supersedes any existing course		MEL735
9.	Not allowed for	ME1, ME2, AM??	

10.	Frequency of offering (check one box)	☐ Every semester ☒ I sem ☐ II sem ☐ Either semester
------------	---	--

11.	Faculty who will teach the course Dr D Dubey, A Chawla, S Mukherjee, N Datla
------------	---

12.	Will the course require any visiting faculty? (Yes/no) NO
------------	--

13.	Course objectives (about 50 words. "On successful completion of this course, a student should be able to..."): On successful completion of this course, a student should be able to model engineering artifacts in compact mathematical forms. They would be able to manipulate shapes in 2/3 dimensions to understand the underlying principles of CAD packages and use them effectively. They would also be able to analyze these artifacts for stresses strains and deformations through computational analysis techniques. The course would cover linear static Finite Element Analysis and give a brief exposure to non-linear and dynamic analysis techniques.
------------	--

14.	Course contents (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities): Introduction and overview. Need and Scope of Computer Aided Machine Design. Role of Geometric Modelling, FE and Optimization; Introduction to the Finite Element Method, principles of minimization of potential energy: Rayleigh Ritz and Galerkin Methods, 1D elements and their analysis, analysis of bars, beams and trusses, axis-symmetric solids, 2D/3D solids, solution methods in FE, error analysis, Introduction to Dynamic and Non linear analysis; Limitations of FEM; 2D and 3D Geometric transformations, Orthographic and Perspective Projections. Euler angles, Windowing, view-portioning and viewing transformations, Modeling of cubics, beziers, b-splines, NURBS and advanced curves; Modeling of surfaces: ruled surfaces, surfaces of revolution, Bicubic, Bezier, B-splines; Feature Based Modeling and Feature Recognition,
------------	--

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours
1	Introduction and overview. Need and Scope of Computer Aided Machine Design. Role of Geometric Modelling, FE and Optimization;	2
2	Introduction to the Finite Element Method, principles of	5

	minimization of potential energy: Rayleigh Ritz and Galerkin Methods;	
3	1D elements, Derivation of Stiffness and Mass matrices for a bar, a beam, trusses	5
4	Analysis of Axisymmetric solids subjected to axisymmetric loading as an extension of 2D FE Formulation	6
5	Analysis of Beams on elastic supports	2
6	Solution methods and Error Control in FE	2
7	Introduction to Dynamic and Non linear analysis; Limitations of FEM	2
8	2D and 3D Geometric transformations,	2
9	Obtaining 2D views from 3D representations: Orthographic and Perspective Projections. Euler angles Windowing, view-porting and viewing transformations	3
10	Modeling of NURBS and advanced curves	5
11	Modeling of surfaces: ruled surfaces, surfaces of revolution, Bicubic, Bezier, B-splines;	3
12	Feature Based Modeling and Feature Recognition	5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
1	Solid Modeling using CAD Software	6
2	Assembly Modeling	2
3	Drawing / Orthographic View Generation	2
4	Transformations / Projections	2
5	1D problem using FE Solvers and convergence	2
6	2D problems using FE solver	4
7	3D meshing and FE solver	6
8	Interfacing CAD and FE packages	2
Total Practical / Practice hours(14 times 'P')		28

18. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
1	Matrix algebra and Gaussian Elimination
2	Truss analyses as an extension of 1D FE formulation using coordinate transformations
3	Numerical Integration
4	FEA using 2D and 3D elements; Plain strain and plain stress problems, plate / shell elements;
5	Importance of Finite element mesh, Mesh quality parameters, Automatic meshing techniques.
6	Thermal Analysis
7	Controlling Errors in FE
8	Implementation of Boolean CSG operators
9	Modelling of cubic, Bezier and B-spline curves
10	Modeling of solids–b-rep, CSG, octree, feature based modeling.
11	Regular Boolean Operations and their implementation
12	Geometric algorithms in CAD & FE (convexity, triangulation)
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1.	Chandrupatla T. & Belegundu A, An Introduction to FE in Engineering, Prentice Hall, 1991.
2.	Kurowski PM, Finite Element Analysis for Design Engineers, SAE Internaional 2004
3.	Cook RD, Malcus DL, Plesha ME Concepts and Applications of Finite Element Method, John Wiley, 1989
4.	Bathe KJ, Finite Element Procedures, PHI, 1996
5.	Mortenson M. E., Geometric Modeling, John Wiley and Sons, 1985
6.	Roger D. F., Mathematical Elements of Computer Graphics, Tata Mc Graw Hill Publishing, 1990
7.	Hearn D. & Baker, Principles of Computer Graphics, Prentice Hall, 1997

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	ANsys / Abaqus, ProEngineer / SolidWorks / Catia, Matlab / Visual C++
20.2	Hardware	PCs / Workstations
20.3	Teaching aids (videos, etc.)	Videos on Utube / NPTEL.
20.4	Laboratory	CAGIL.

20.5	Equipment	PCs / Workstations
20.6	Classroom infrastructure	LCD , OHP projectors
20.7	Site visits	-
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	
---	--

The information on this template is as on the date of its approval, and is likely to evolve with time.

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	Department/Centre/School proposing the course	Mechanical Engineering		
2.	Course Title	Automatic Control Systems		
3.	L-T-P structure	3-0-2		
4.	Credits	4	Non-graded Units	0
5.	Course number	<Dept Code>L/P/D/S/R/V<No.>		
6.	Course Status (Course Category for Program) (list program codes: eg., EE1, CS5, etc.)			
	Institute Core for all UG programs		(Yes / No) No	
	Programme Linked Core for:		List of B.Tech. / Dual Degree Programs	
	Departmental Core for:		List of B.Tech. / Dual Degree Programs	
	Departmental Elective for:		List of B.Tech. / Dual Degree Programs	
	Minor Area / Interdisciplinary Specialization Core for:		Name of Minor Area / Specialization Program	
	Minor Area / Interdisciplinary Specialization Elective for:		Name of Minor Area / Specialization Program	
	Programme Core for:		List of M.Tech. / Dual Degree Programs	
	Programme Elective for:		MEM	
	Open category Elective for all other programs (No if Institute Core)		(Yes / No) No	
7.	Pre-requisite(s)			
8.	Status vis-à-vis other courses			
8.1	List of courses precluded by taking this course (significant overlap)		(course number)	
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	MEL312 (>50%)	
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	EEL301 (40%), CHL261 (40%)	
8.2	Supersedes any existing course		(course number)	
9.	Not allowed for	ME1 as MEL312 is a core for them		

10.	Frequency of offering (check one box)	☐ Every semester ☒ I sem ☐ II sem ☐ Either semester
------------	---	--

11.	Faculty who will teach the course S Mukherjee, JK Dutt, SP Singh, SV Modak, JP Khatait
------------	---

12.	Will the course require any visiting faculty?	(Yes/no) No
------------	--	-------------

13.	Course objectives (about 50 words): On successful completion of this course, a student should be able to determine limits of stable operations of mechanical systems represented as transfer function or state space. Further, separation of system variables into those that can be manipulated and disturbance inputs allow determination of manipulated input to enhance dynamic performance and disturbance rejection. The specific systems in consideration will include mechatronic, vibratory, automotive and manufacturing systems.
------------	---

14.	Course contents (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities): An introduction to control systems; transfer function representation of mechanical and mechatronic systems; stability analysis, gain setting for stability; transient and steady-state response analyses; control system analysis and design by the Root-Locus method and the Frequency-Response method; PID controllers design and realization; State-Space representation, controllability and observability; control system design in State Space; digital implementation of classical controllers.
------------	--

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
	Introduction to the control problem	3
	Transient and steady-state response analyses	4
	Control system analysis and design by the Root-Locus method	5
	Control system analysis and design by the Frequency-Response method	6
	PID controllers design and realization	6
	State Space representation, controllability and observability	6
	State Space design of controllers	6
	Digital implementation of classical controllers	6
Total Lecture hours (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
	Modelling using Labview/ Simulink	4
	Simulation of linear system	2
	Simulation of feedback system	2
	Digital controller implementation	4
	Lead/ lag compensator	2
	Observer design	2
	Design of PID-controller	4
	Power screw in horizontal configuration	4
	LWR/Kuka robots – System identification, Controller design	4
Total Practical / Practice hours (14 times 'P')		28

18. Brief description of module-wise activities pertaining to self-learning component

(Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
	Virtual modelling tools – Labview, Simulink, Matlab
	Modelling of mechanical and mechatronic systems
	Construction of bode plots, root-locus plots
	Measurement Systems, Sources of uncertainty, and errors, Behaviour of first order and higher order instruments

(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Modern Control Engineering, K Ogata, Prentice Hall 2009, Edition: 5, ISBN-10:0136156738, ISBN-13:97801316156734
2. Control Systems Engineering, Norman S Nise, Edition: 6, Publisher: John Wiley & Sons, ISBN-10:0470547561, ISBN-13:978-0470547564
3. Theory And Applications Of Automatic Control, B C Nakra, New Age International Pvt Ltd, ISBN-10:8122411444, ISBN-13:9788122411447
4. Control Systems Engineering, I J Nagrath, M Gopal, New Age International Pvt Ltd 2006, ISBN-10:8122417752
5. Instrumentation Measurement & Analysis, B C Nakra, K K Chaudhry, ISBN: 9780070151277, JUL 09

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	Labview, MATLAB, SIMULINK, xPC
20.2	Hardware	DAQ cards, PC-based control system
20.3	Teaching aids (videos, etc.)	Description, Source , etc.
20.4	Laboratory	Type of facility required, number of students etc.
20.5	Equipment	Type of equipment required, number of access points, etc.
20.6	Classroom infrastructure	Type of facility required, number of students etc.
20.7	Site visits	Type of Industry/ Site, typical number of visits, number of students etc.
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	20%
21.2	Open-ended problems	10%
21.3	Project-type activity	10%
21.4	Open-ended laboratory work	10%
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	
---	--

The information on this template is as on the date of its approval, and is likely to evolve with time.

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	Department/Centre/School proposing the course	Mechanical Engineering	
2.	Course Title	Design and optimization	
3.	L-T-P structure	3-0-2	
4.	Credits	4	Non-graded Units 0
5.	Course number	<Dept Code>L/P/D/S/R/V<No.>	
6.	Course Status (Course Category for Program) (list program codes: eg., EE1, CS5, etc.)		
	Institute Core for all UG programs	(Yes / No) NO	
	Programme Linked Core for:	List of B.Tech. / Dual Degree Programs	
	Departmental Core for:	List of B.Tech. / Dual Degree Programs	
	Departmental Elective for:	List of B.Tech. / Dual Degree Programs	
	Minor Area / Interdisciplinary Specialization Core for:	Name of Minor Area / Specialization	
	Minor Area / Interdisciplinary Specialization Elective for:	Name of Minor Area / Specialization	
	Programme Core for:	MEM	
	Programme Elective for:	List of M.Tech. / Dual Degree Programs	
	Open category Elective for all other programs (No if Institute Core)	(Yes / No) NO	
7.	Pre-requisite(s)	Design (for UG)	
8.	Status vis-à-vis other courses		
8.1	List of courses precluded by taking this course (significant overlap)	(course number)	
	(a) Significant Overlap with any UG/PG course of the Dept./Centre/ School	(course number)	
	(b) Significant Overlap with any UG/PG course of other Dept./Centre/ School	(course number)	
8.2	Supersedes any existing course	MEL732 and MEL 742	
9.	Not allowed for	(indicate program names)	

10.	Frequency of offering (check one box)	☐ Every semester ☒ I sem ☐ II sem ☐ Either semester
------------	---	--

11.	Faculty who will teach the course Dr N Datla, A Chawla, JP Khatait, H Hirani, S Mukherjee
------------	--

12.	Will the course require any visiting faculty?	(Yes/no) NO
------------	--	-------------

13.	Course objectives (about 50 words. "On successful completion of this course, a student should be able to..."): Enhance expertise on design of Mechanical Systems with focus on mechanics based failure modes. Introduction to tools and principles of optimization appearing in context of mechanical engineering design.
------------	--

14.	Course contents (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities): Review of machine element design based on strength and distortion criterion; review of choice of materials and their treatment: Designing for fatigue, creep; Design criterion for fracture; Application of advanced design criterion to machine elements (like shafts, spur / bevel / worm gears); Design of structures, machines and equipment; Classical methods of unconstrained optimization (single variable and multi variable), classical methods of constrained optimization, Numerical optimisation techniques including i. genetic algorithms, (binary and real coded)ii.. simulated annealing. Case studies of Optimum Design (Gear Box, Power Transmission, shape and topology using FE)
------------	---

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours
1	Introduction (Failure principles recap, feasible and optimal design)	3
2	Design of Mechanical Systems - structures, machines and equipment; formulating system constraints, requirements,	3
3	Designing for fatigue, creep	4
4	Design for fracture	4
5	Stochastic principles in design	2
6	Application of advanced design criterion to machine elements (like shafts, spur / bevel / worm gears)	5
7	Classical methods of unconstrained optimization (single variable and multi variable)	5
8	Classical methods of constrained optimization (transformational, direct search, linearization methods); Kuhn Tucker Conditions	7

9	Advanced optimisation techniques including i. genetic algorithms, (binary and real coded)ii.. simulated annealing	5
10	Case studies of Optimum Design (Gear Box, Power Transmission, shape and topology using FE)	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
	Design of combined statically loaded components and assemblies	2
	Design of combined fatigue loaded components and assemblies	4
	Formulating system and sub-system constraints	4
	Implementations of single variable optimization	2
	Implementation of unconstrained multi variable optimization techniques	4
	Formulating Design case studies as optimization problems and solving using implemented tools	12
Total Practical / Practice hours (14 times 'P')		28

18. Brief description of module-wise activities pertaining to self-learning

component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
	Quadratic Programming
	Integer and Discrete Optimization problems
	Multi objective optimization and Pareto Optimal fronts
	Designing for wear and corrosion
	Dynamic modeling of mechanical systems
	Selection practice of bearings
	Material selection principles
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Mech Engg Design, Shigley, Mischke, Budynas, Nisbett, 8th Edn, 2010, McGraw Hill
2. Machine Design Handbook, Shigley and Mischke, McGraw Hill
3. Dieter:
4. Engineering Optimization, S.S.Rao, 3rd enlarged ed, New Age International publishers, 2010
5. Materials selection in Mechanical Design, M.F.Ashby, 3rd Edn, 2005, Elsevier\
6. Optimization for engineering design, Kalyanmoy Deb, PHI Learning, 2004

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	TK Solver, CES, FE Solvers, CAD tools
20.2	Hardware	PCs and Workstations
20.3	Teaching aids (videos, etc.)	Machine design videos
20.4	Laboratory	CAGI
20.5	Equipment	PCs
20.6	Classroom infrastructure	LCD projecto
20.7	Site visits	Possibly
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	75% of lab time
21.2	Open-ended problems	Yes
21.3	Project-type activity	Yes
21.4	Open-ended laboratory work	Yes
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	
---	--

The information on this template is as on the date of its approval, and is likely to evolve with time.

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	Department/Centre/School proposing the course	Mechanical Engineering	
2.	Course Title	Designing with Advanced Materials	
3.	L-T-P structure	3-0-2	
4.	Credits	4	Non-graded Units Please fill appropriate details in S. No. 21
5.	Course number	<Dept Code>L/P/D/S/R/V<No.>	
6.	Course Status (Course Category for Program) (list program codes: eg., EE1, CS5, etc.)		
	Institute Core for all UG programs	(Yes / No)	
	Programme Linked Core for:	List of B.Tech. / Dual Degree Programs	
	Departmental Core for:	List of B.Tech. / Dual Degree Programs	
	Departmental Elective for:	List of B.Tech. / Dual Degree Programs	
	Minor Area / Interdisciplinary Specialization Core for:	Name of Minor Area / Specialization Program	
	Minor Area / Interdisciplinary Specialization Elective for:	Name of Minor Area / Specialization Program	
	Programme Core for:	List of M.Tech. / Dual Degree Programs	
	Programme Elective for:	MEM	
	Open category Elective for all other programs (No if Institute Core)	(Yes / No) Yes	

7.	Pre-requisite(s)	MCL211 (or equivalent)
-----------	-------------------------	------------------------

8.	Status vis-à-vis other courses		
8.1	List of courses precluded by taking this course (significant overlap)	(course number)	
	(a) Significant Overlap with any UG/PG course of the Dept./Centre/ School	(course number)	
	(b) Significant Overlap with any UG/PG course of other Dept./Centre/ School	(course number)	
8.2	Supersedes any existing course	MEL844	

9.	Not allowed for	(indicate program names)
-----------	------------------------	--------------------------

10.	Frequency of offering (check one box)	☐ Every semester ☐ I sem ☒ II sem ☐ Either semester
------------	---	--

11.	Faculty who will teach the course N.V. Datla, S.K. Sinha
------------	---

12.	Will the course require any visiting faculty?	(Yes/no) No
------------	--	-------------

13.	Course objectives: Introduction to design with polymers, composites, and other advanced materials in the context of mechanical systems design. Students completing this course successfully should be able to design mechanical systems/components utilizing the specialized mechanical response of these material.
------------	---

14.	Course contents (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities): Introduction to polymers, composites and smart materials. Polymer microstructure and mechanical properties. Thermosets and thermoplastics. Viscoelastic creep and relaxation behavior, mechanical models, and polymer failure. Design considerations and practices for polymeric components with case studies. Composite materials and their applications. Micro and macro mechanics of lamina, failure criteria of lamina, classical laminate theory, strength of laminates. Design considerations and practices for composite structures with case studies. Structure, applications and design considerations of smart materials such as shape memory alloys and piezoelectric materials.
------------	---

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1	Introduction to polymers, composites and smart materials	2
2	Polymer microstructure, classification, and mechanical properties	4
3	Viscoelastic creep and relaxation behavior, mechanical models, superposition and correspondence principles, dynamic mechanical analysis	5
4	Failure mechanisms in polymers	3
5	Design considerations and practices for polymeric components with case studies	5
6	Composite materials and their applications	3
7	Micro and macro mechanics of lamina, classical laminate theory	5
8	Failure criteria of lamina, strength of laminates	4
9	Design considerations and practices for composite structures with case studies	5

10	Structure, applications, and design considerations of smart materials such as shape memory alloys and piezoelectric materials.	6
Total Lecture hours (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
Total Tutorial hours (14 times 'T')		

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
1	Material selection using CES package	4
2	Numerical modelling of systems with viscoelastic polymers	4
3	Composite laminate analysis using Commercial FE solver	6
4	Superelastic behavior modeling using FE solver	4
5	Realization of shape memory effect systems	4
6	Case studies for systems with advanced materials : numerical modelling and performance prediction.	6
Total Practical / Practice hours (14 times 'P')		28

18. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
1	Processing techniques for polymeric and composite materials
2	Fracture and fatigue failures in polymers
3	Micromechanics of discontinuous reinforcements
4	CLT applied to special laminate sequences
5	Viscoelastic behavior of composites
6	Design for aggressive environments
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Gerdeen and Rorrer, Engineering Design with Polymers and Composites, 2nd Ed., CRC Press, 2012.
2. Jones and Ashby, Engineering Materials 2: An introduction to Microstructure and Processing, 4th Ed., Butterworth-Heinemann, 2012.
3. Brinson and Brinson, Polymer Engineering Science and Viscoelasticity, 2nd Ed., Springer, 2015.
4. Jones, Mechanics of Composite Materials, 2nd Ed., CRC Press, 1999.

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	ANSYS, SolidWorks, Matlab
20.2	Hardware	PC's
20.3	Teaching aids (videos, etc.)	
20.4	Laboratory	CAGIL
20.5	Equipment	PC's
20.6	Classroom infrastructure	LCD projector
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	Eg. 25% of student time of practical / practice hours: sample Circuit Design exercises from industry
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: _____ (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	
---	--

The information on this template is as on the date of its approval, and is likely to evolve with time.

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	Department/Centre/School proposing the course	MECHANICAL ENGINEERING		
2.	Course Title	TRIBOLOGICAL SYSTEMS DESIGN		
3.	L-T-P structure	3 - 0 - 2		
4.	Credits	4	Non-graded Units	N/A
5.	Course number	MEL748		
6.	Course Status (Course Category for Program)			
	Institute Core for all UG programs			
	Programme Linked Core for:			
	Departmental Core for:			
	Departmental Elective for: UG and PG		Yes	
	Minor Area / Interdisciplinary Specialization Core for:			
	Minor Area / Interdisciplinary Specialization Elective for:			
	Programme Core for:		MTech (Mechanical Design)	
	Programme Elective for:		ME1, ME2, MEP, MET	
	Open category Elective for all other programs (No if Institute Core)		Yes	
7.	Pre-requisite(s)	Course in Machine Design (MCL211 or equivalent)		
8.	Status vis-à-vis other courses			
8.1	List of courses precluded by taking this course (significant overlap)			
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	NIL	
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	Less than 20% with MEL740	
8.2	Supersedes any existing course			
9.	Not allowed for	Nil		

10.	Frequency of offering (check one box)	☐ Every semester ☐ I sem ☐ II sem ☒ Either semester
------------	--	--

11.	Faculty who will teach the course (Minimum 2 names for core courses / 1 name for electives) Dr. R K Pandey, Prof. H Hirani, Dr. Sujeet K. Sinha
------------	---

12.	Will the course require any visiting faculty?	No
------------	--	----

13.	Course objectives (about 50 words. "On successful completion of this course, a student should be able to..."): On successful completion of this course, a student will be able to, analyze tribological systems for the design of load bearing surfaces under dynamic loading. Evolve analytical formulations relating surface conditions, different types of lubrications, bearing design, clutches, brakes etc. and conduct lubricant, materials and design selection for any given tribological requirement.
------------	---

14.	Course contents (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities): Lubrication, Friction and Wear aspects in Design; Tribological Surfaces – Measures of Roughness and associated mechanisms of Lubrication, Regimes of Lubrication; Boundary lubrication and lubricants. Friction and wear at different length scales. Viscosity - its representation and measurement, apparent viscosity. Selection of Bearings - Rubbing, Fluid Film, Rolling Element. Lubricants - Types and Selection, Bearing Design - Rubbing, Fluid Film Journal and Thrust, Dynamically Loaded, Rolling Element, Design of lubrication Systems. Introduction to maintenance of Bearings, Seals, Linear Bearing Design, Slideways. Material considerations for selected tribological applications.
------------	---

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1	Lubrication, Friction and Wear consideration in Design	3
2	Tribological Surfaces - Roughness	3
3	Mechanisms of Lubrication, Friction & Wear, Regimes of Lubrication	6
4	Boundary lubrication and lubricants,	4
5	Viscosity - its representation and measurement, Apparent Viscosity	3
6	Selection of Bearings - Rubbing, Fluid Film, Rolling Element	4
7	Lubricants - Types and Selection	3
8	Bearing Design - Rubbing, Fluid Film Journal and Thrust,	7

	Dynamically Loaded, Rolling Element, Linear Bearing Design, Slideways, Seals	
9	Lubrication Systems - Selection and Design Considerations, Maintenance of Bearings	5
10	Material Considerations for Various Tribological Applications	4
Total Lecture hours(14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	NA	
Total Tutorial hours(14 times 'T')		0

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
1.	Numerical and experimental studies for pressure and temperature distributions in journal bearings	4
2.	Pressure and temperature distributions in thrust pad/slider bearing	4
3.	Viscosity index and lubricity determination of lubricants	6
4.	Experimental studies for determination of friction and wear coefficients of metals and polymers under dry running condition	4
5.	Experimental studies for determination of friction and wear coefficients of metals and polymers under lubricated conditions	4
6.	Investigations for the correlations between surface topographies and tribological performances through testing and using profilometer and microscope	6
Total Practical / Practice hours(14 times 'P')		28

18. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
1	Physics of adhesion and surface forces
2	Tribological issues in micro/nano levels

(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Khonsari MM, Booser ER, Applied Tribology: Bearing Design and Lubrication, Second edition, John Wiley & Sons, 2008.
2. Williams J, Engineering Tribology, Cambridge University Press, 2005.
3. Hutchings IM, Tribology - Friction and Wear of Engineering Materials, CRC Press, 1992.
4. C. M. Mates, Tribology on the Small Scale: A Bottom up Approach to Friction, Lubrication, and Wear, Oxford University Press, 2007.
5. S. K. Sinha, N. Satyanarayana, S. C. Lim, Nano-tribology and Materials in MEMS, Springer Berlin, 2013.

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	
20.2	Hardware	
20.3	Teaching aids (videos, etc.)	Projector and screen for powerpoint presentations
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	20
21.2	Open-ended problems	20
21.3	Project-type activity	10
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	
---	--

The information on this template is as on the date of its approval, and is likely to evolve with time.

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	Department/Centre/School proposing the course	Mechanical Engineering Department	
2.	Course Title	DESIGN OF PRECISION MACHINES	
3.	L-T-P structure	3-0-0	
4.	Credits	3	Non-graded Units Please fill appropriate details in S. No. 21
5.	Course number	MEL7XX	
6.	Course Status (Course Category for Program) DE for ME1, ME2; PE for MEM(A2)		
	Institute Core for all UG programs	No	
	Programme Linked Core for:	List of B.Tech. / Dual Degree Programs	
	Departmental Core for:	List of B.Tech. / Dual Degree Programs	
	Departmental Elective for:	ME1, ME2	
	Minor Area / Interdisciplinary Specialization Core for:	Name of Minor Area / Specialization Program	
	Minor Area / Interdisciplinary Specialization Elective for:	Name of Minor Area / Specialization Program	
	Programme Core for:	List of M.Tech. / Dual Degree Programs	
	Programme Elective for:	MEM(A2)	
	Open category Elective for all other programs (No if Institute Core)	No	
7.	Pre-requisite(s)	For UG: AML140, MEL211, MEL311 For PG: MEL732	
8.	Status vis-à-vis other courses		
8.1	List of courses precluded by taking this course (significant overlap)	(course number)	
	(a) Significant Overlap with any UG/PG course of the Dept./Centre/ School	(course number)	
	(b) Significant Overlap with any UG/PG course of other Dept./Centre/ School	(course number)	
8.2	Supersedes any existing course	(course number)	
9.	Not allowed for	(indicate program names)	

10. Frequency of offering (check one box)	☐ Every semester ☐ I sem ☒ II sem ☐ Either semester
---	--

11. Faculty who will teach the course	Jitendra Prasad Khatait, Sudipto Mukherjee
--	--

12. Will the course require any visiting faculty?	(Yes/no) NO
--	-------------

13. Course objectives:	The course gives an insight in the conceptual design of precision mechanisms used in products, tools and equipment. The course aims to enable the student to recognize problem areas, generate design alternatives and make the design choices to achieve precision.
-------------------------------	--

14. Course contents:	Fundamental concepts in precision design; design for stiffness; controlling Degrees-of-Freedom, exact-constrained design; design of elastic mechanisms/ flexures/ compliant mechanisms; friction, hysteresis and micro-slip; actuators and sensors for precision motion; materials selection in precision machine design; slideways for long range precision motion; and dynamics of precision mechanisms.
-----------------------------	--

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
	Introduction to Precision Design	2
	Fundamental Concepts in Precision Design	4
	Design for stiffness	6
	Controlling Degrees of Freedom, Exact-constrained design	6
	Flexure Mechanisms	6
	Friction, Hysteresis and Microslip	3
	Actuators and Sensors for Precision Motion	3
	Materials in Precision Machine Design	3
	Slideways for Long Range Precision Motion	3
	Dynamics of Precision Mechanisms	6
Total Lecture hours (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

Total Tutorial hours (14 times 'T')		

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
Total Practical / Practice hours (14 times 'P')		

18. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
	CAD modelling, FEA

(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Soemers H.M.J.R., Design Principles for Precision Mechanism, 978-90-365-3103-0, 2011 2. Douglass L. Blanding, Exact Constraint: Machine Design Using Kinematic Principles, ASME Press, 1999 3. Smith S.T. and Chetwynd D.G., Foundations of Ultraprecision Mechanism Design, Volume 2 of Developments in Nanotechnology, CRC Press, 2003 4. Alexander H. Slocum, Precision machine design, Prentice Hall, 1992 5. Hiromu Nakazawa, Principles of Precision Engineering, Oxford University Press, 1994
--

--

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	CAD software, FEM software
20.2	Hardware	Nature of hardware, number of access points, etc.
20.3	Teaching aids (videos, etc.)	Description, Source , etc.
20.4	Laboratory	Prototyping facilities, machining lab
20.5	Equipment	Type of equipment required, number of access points, etc.
20.6	Classroom infrastructure	Type of facility required, number of students etc.
20.7	Site visits	Type of Industry/ Site, typical number of visits, number of students etc.
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	40
21.2	Open-ended problems	10
21.3	Project-type activity	50
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	
---	--

The information on this template is as on the date of its approval, and is likely to evolve with time.

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	Department/Centre/School proposing the course	MECHANICAL ENGINEERING		
2.	Course Title	NANOMECHANICS		
3.	L-T-P structure	2 - 0 - 2		
4.	Credits	3	Non-graded Units	N/A
5.	Course number	MEL7 * *		
6.	Course Status (Course Category for Program) (list program codes: eg., EE1, CS5, etc.)			
	Institute Core for all UG programs		NO	
	Programme Linked Core for:			
	Departmental Core for:			
	Departmental Elective for:		UG and PG	
	Minor Area / Interdisciplinary Specialization Core for:			
	Minor Area / Interdisciplinary Specialization Elective for:			
	Programme Core for:			
	Programme Elective for:		MED	
	Open category Elective for all other programs (No if Institute Core)		Yes	
7.	Pre-requisite(s)	NIL		
8.	Status vis-à-vis other courses			
8.1	List of courses precluded by taking this course (significant overlap)			
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School	NO	
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School	NO	
8.2	Supersedes any existing course			NO
9.	Not allowed for	Nil		

10.	Frequency of offering (check one box)	☐ Every semester ☐ I sem ☐ II sem ☒ Either semester
------------	---	--

11.	Faculty who will teach the course (Minimum 2 names for core courses / 1 name for electives) Drs. S P Singh, D K Dubey, J K Dutt
------------	---

12.	Will the course require any visiting faculty?	No
------------	--	----

13.	Course objectives (about 50 words. "On successful completion of this course, a student should be able to..."): The objective of this course is to introduce mechanical engineering students to fundamentals of nano-mechanics which is needed for a twofold purpose. Firstly, be able to analyze the behavior of micro- nano structural components which are assuming importance in new applications. Secondly and more importantly to impart students with an ability to analyze materials behavior at molecular level so that they are able to appreciate the gross material resulting out of these inter-molecular interactions. Students would also understand the limitations of such an approach.
------------	---

14.	Course contents (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities): Introduction to nanomechanics, need for studying nanomechanics, its scope and limitations; Dynamics of 2-atom, 3-atom molecules, and an N-atom chain; Crystal Lattice and Reciprocal Lattice; Dynamic Interaction Potentials and Periodic Boundary Conditions in molecular dynamics simulations; Role of different ensembles; Evaluation of atomic stresses and strains, Evaluation of Specific Heat, Dissipation of Energy in nano-mechanical Systems; Solutions for classical Nano scale structural components such as Carbon Nanotubes, Nano rods, Nanowires and Polymers; Correlations between Nano-mechanics and classical continuum theory of solids; Size effect; Introduction to multiscale modeling;
------------	---

15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1	Introduction to nanomechanics, need, scope, and limitations	2
2	Dynamics of 2-atom binary molecule, Dynamics of a 3-atom molecule	4
3	Dynamics of an N-atom chain	2
4	Classical Lattice Theory	2
5	Molecular dynamics simulations, role of different ensembles	2
6	Dynamic Interaction Potentials and Periodic Boundary Conditions in molecular dynamics simulations	2
7	Definition and evaluation of Atomic stresses, Atomic strains, and Specific heat	3

8	Dissipation of Energy in nano-mechanical systems	2
9	Solutions for classical Nano scale structural components such as Carbon Nanotubes, Nano rods, Nanowires and Polymers	5
10	Correlations between Nano-mechanics and classical continuum theory of solids	3
11	Size effect in material properties and introduction to multiscale modeling	1
Total Lecture hours(14 times 'L')		28

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	.	14
Total Tutorial hours(14 times 'T')		14

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
1	Learning to make atomistic models and visualization techniques	4
2	Nanomechanical simulation program for 2-atom, 3-atom	2
3	Nanomechanical simulation program for n-atom chain	2
4	Dynamic behavior of simple lattice systems	2
	Large scale molecular dynamics simulations using NAMD, LAMMPS, Material Studio on HPC	6
6	Molecular dynamics simulations and mechanical behavior analysis of Carbon nanotubes, Nanorods, Nanowires, and Polymers	8
10	Exposure to nanomechanical characterization equipment such as AFM, SEM, TEM etc. at NRF and NPL Comparing results from experiments and simulations and commenting on limitations and scope of both approaches	4
Total Practical / Practice hours(14 times 'P')		28

18. Brief description of module-wise activities pertaining to self-learning component

(Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
------------	-------------

1	Familiarization with HPC computing at IIT Delhi
2	Familiarization with molecular dynamics codes such as LAMMPS, NAMD
3	Learning molecular visualization softwares such as VMD, EndMol
4	Review of key papers related to nanomechanics, both experiments and simulations
5	Developing understanding about nanomechanical characterization techniques implemented in SEM, AFM, TEM etc.
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Foundations of Nanomechanics : Andrew N Cleland, Springer International , 2003
Nanomechanics : an extension of Continuum Mechanics to the nanoscale, by Kaibin Fu, VDM verlag, 2009
Introduction to Micromechanics and nanomechanics by Shaofan Li and Gang Wang, World Scientific, 2008
Molecular Dynamics Simulation: Elementary Methods : by J M Haile, Wiley Publication, 1997
Understanding Molecular Simulation : From Algorithms to Applications by Daan Frenkel and Berend Smit, Academic Press, 2001

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	MatLab, LAMMPS, Materials Studio, NAMD
20.2	Hardware	PCs / Workstations
20.3	Teaching aids (videos, etc.)	
20.4	Laboratory	No Specific lab, A Computer lab would be sufficient along with access to HPC systems
20.5	Equipment	Access to NRF facility
20.6	Classroom infrastructure	LCD , OHP projectors
20.7	Site visits	Yes (1-2 off-campus visits during the semester)
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	The course emphasis is on learning new methodologies for tackling dynamic behavior of nanostructures. Design
------	----------------------	--

		content is not emphasized
21.2	Open-ended problems	Some problems would be open-ended
21.3	Project-type activity	Visit to Nano Research Facility at IITD and relevant short demonstrations related to nanomechanical experiments by an expert Reviewing of research papers: Presentation of subject understanding from research papers
21.4	Open-ended laboratory work	Nil
21.5	Others (please specify)	Most of the problems would be such which have a closed solution, which clarify the fundamentals learnt

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate	
---	--

The information on this template is as on the date of its approval, and is likely to evolve with time.

COURSE TEMPLATE

(Please avoid changing the number of tables, rows and columns or text in dark black, but fill only the columns relevant to the template by editing the columns in grey letters or blank columns: this would help in automating the processing of template information for curricular use)

1.	Department/Centre/School proposing the course	Department of Mechanical Engineering		
2.	Course Title	Robotics		
3.	L-T-P structure	3-0-2		
4.	Credits	4	Non-graded Units	Nil
5.	Course number	MEL739		
6.	Course Status (Course Category for Program) Core for MEM, PE for MEP, MET, ME1 and ME2			
	Institute Core for all UG programs		(Yes / No) No	
	Programme Linked Core for:		No	
	Departmental Core for:		No	
	Departmental Elective for:		MEP, ME1 and ME2	
	Minor Area / Interdisciplinary Specialization Core for:		No	
	Minor Area / Interdisciplinary Specialization Elective for:		No	
	Programme Core for:		MEM	
	Programme Elective for:		MEP, MET	
	Open category Elective for all other programs (No if Institute Core)		(Yes / No) Yes	
7.	Pre-requisite(s)	MEL211 for UG students		
8.	Status vis-à-vis other courses			
8.1	List of courses precluded by taking this course (significant overlap)			Nil
	(a)	Significant Overlap with any UG/PG course of the Dept./Centre/ School		Nil
	(b)	Significant Overlap with any UG/PG course of other Dept./Centre/ School		Nil
8.2	Supersedes any existing course			No
9.	Not allowed for	Nil		

10.	Frequency of offering (check one box)	☐ Every semester ☒ I sem ☒ II sem ☐ Either semester
------------	---	---

11.	Faculty who will teach the course S.K. Saha, J. Khatait, S. Mukherjee
------------	--

12.	Will the course require any visiting faculty?	(Yes/no) No
------------	--	-------------

13.	Course objectives (about 50 words. "On successful completion of this course, a student should be able to..."): To understand the elements of a robot used in industries, and expose its construction, design, synthesis, analysis and control.
------------	--

14.	Course contents (about 100 words; Topics to appear as course contents in the Courses of Study booklet) (Include Practical / Practice activities): Type and components of robots; Classification of closed- and open-loop kinematic systems; Definition of mechanisms and manipulators; Kinematic constraints; Degrees of freedom and mobility; Rotation representation; Coordinate transformation; DH parameters; Matrix methods for forward and inverse kinematics analyses; Jacobian and singularity; Dynamic modeling; Euler-Lagrange and Newton-Euler equations of motion for serial type manipulators; DeNOC-based dynamic formulation; Inverse and forward dynamics algorithms; Parallel robots; Inverse and forward kinematics of parallel robots; Gain singularity of parallel robots; Introduction to control of robotic systems.
------------	--

15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours (not exceeding 5h per topic)
1	Types and components of robots; Classification of closed- and open-loop kinematics systems; Definition of mechanisms and manipulators	3
2	Rotation representation; Coordinate transformation; DH parameters	5
3	Forward kinematics with examples	4
4	Inverse kinematics with 6-DOF manipulators	5
5	Velocity analysis: Jacobian and singularity	4
6	Equations of motion: Euler-Lagrange formulation	4
7	Newton-Euler formulation and DeNOC-based recursive algorithms	5
8	Inverse and forward dynamics algorithms	2
9	Parallel robots: Classification and kinematics	4
10	Velocity analysis of parallel robots: Gain singularity	3
11	Introduction to control of robotic systems	3

Total Lecture hours (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	Not applicable	
Total Tutorial hours (14 times 'T')		

17. Brief description of Practical / Practice activities

Module no.	Description	No. of hours
1	Study components of KUKA robots in PAR Lab. and DH parameters	4
2	Perform forward kinematics and validate using RoboAnalyzer	4
3	Inverse kinematics of KUKA robots and validation using RoboAnalyzer	4
4	Use of RecurDyn software to perform dynamic analysis of industrial robots	4
5	Perform dynamic analyses of robots using MATLAB	4
6	Exposure of digital devices used in robotic systems	4
7	Analysis of parallel robots (kinematics)	4
Total Practical / Practice hours (14 times 'P')		28

18. Brief description of module-wise activities pertaining to self-learning component (Only for 700 / 800 level courses) (Include topics that the students would do self-learning from books / resource materials: Do not Include assignments / term papers etc.)

Module no.	Description
1	Kinematics and dynamics of mechanisms
2	Linear algebra
3	Differential calculus
4	Numerical analysis
5	Learning how to use RoboAnalyzer and MATLAB software
6	Learning how to use RecurDyn software
(The volume of self-learning component in a 700-800 level course should typically be 25-30% of the volume covered in classroom contact)	

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Saha, S.K., Introduction to Robotics, 2nd Ed., McGraw-Hill Higher Education, New Delhi, 2014
 Ghosal, A., Robotics, Oxford, New Delhi, 2006
 Craig, J.J., Introduction to Robotics: Mechanics and Control, Pearson, New Delhi, 2009

20. Resources required for the course (itemized student access requirements, if any)

20.1	Software	MATLAB, RecurDyn, RoboAnalyzer
20.2	Hardware	PC to run the above software
20.3	Teaching aids (videos, etc.)	Video, .ppts
20.4	Laboratory	No.
20.5	Equipment	No
20.6	Classroom infrastructure	LCD projector
20.7	Site visits	Nil
20.8	Others (please specify)	No

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	0%
21.2	Open-ended problems	10%
21.3	Project-type activity	20% of students time to do two semester projects
21.4	Open-ended laboratory work	No
21.5	Others (please specify)	Nil

Date: (Signature of the Head of the Department/ Centre / School)

Date of Approval of Template by Senate

The information on this template is as on the date of its approval, and is likely to evolve with time.